DRIVER BOARD EBD5200

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 EBD5200 for SLEDs (Superluminescent Emitting Diodes) and pin-compatible laser diodes.

1.2 BOARD REVISION

This product specification is based on the EBD5200 production series, revision 4.3.

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 an SLED is an OEM, low-voltage, DC-powered laser component specifically designed for incorporation or integration into other equipment that is then sold as a final product, i.e., as a laser system that includes a power supply. As such, this driver board with integrated light source does not represent a standalone laser system as defined by 21 CRF 1040.10 and IEC/EN 60825-1:2014.

During installation it is crucial that the laser hazard is fully managed. In particular, the laser integrator (i.e., the manufacturer of the laser system as a final product) is required to provision the engineering requirements detailed in Clause 4.0 of IEC/EN 60825-1, classify the final 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 a final product might be as high as Class 3B per IEC 60825-1:2014, depending on the type of SLED. Refer to EXALOS' SLED specification documents for detailed information. For safe use of the laser system, appropriate laser safety measures including protective equipment such as laser safety glasses may be required depending on the mounted SLED module. Also, follow the legal regulations on occupational safety in your country.

3 PRODUCT DESCRIPTION

3.1 ARCHITECTURE

The EBD5200 is a high-performance analog driver board that consists of a multi-layer PCB board on which the 14-pin butterfly (BTF) 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.

3.2 FEATURES

The main characteristics of the EBD5200 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 EBD5200 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 JP3 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 EBD5200 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 EBD5200 is -20°C to +65°C (non-condensing).

The EBD5200 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 EBD5200 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 600 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.

3.4 ROHS COMPLIANCE

Based on the information obtained from our suppliers, the EBD5200 is compliant with the Restriction of Hazardous Substances (RoHS) directive 2011/65/EU and its subsequent amendments (including 2015/863/EU).

4 EBD5200 DRIVER BOARD

4.1 PRINTED CIRCUIT BOARD (PCB)

The EBD5200 board has a size of 70 mm (L) x 55 mm (W). Fig. 1 shows pictures of the front side of the EBD5200 board. Fig. 2 shows a schematic top view of the board and the names of connectors, switch and potentiometer.

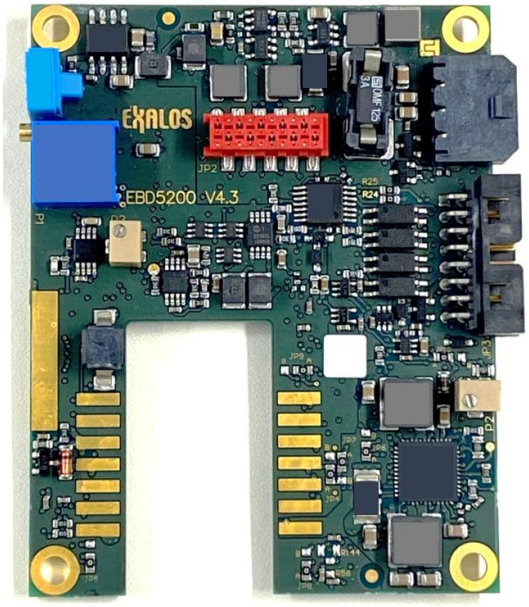

Fig. 1 Top view of the EBD5200 board

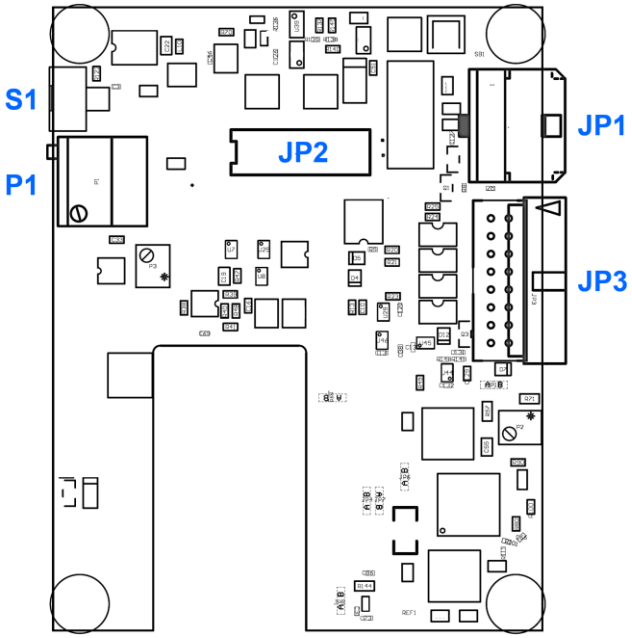

Fig. 2 Schematic top view of the EBD5200 indicating the user interfaces.

4.2 ELECTRICAL USER INTERFACES

When the EBD5200 is, together with an SLED module, assembled into a metal case only connector JP1, JP3, four LED indicators 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 and code switch S1, which allows for the selection of various operating modes. Table 1 provides a list of all electrical connectors that belong to the user interface.

Name	Connector on EBD5200 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 connector JP1 and JP3. The corresponding pinout information is listed in Table 2 and Table 3, respectively.

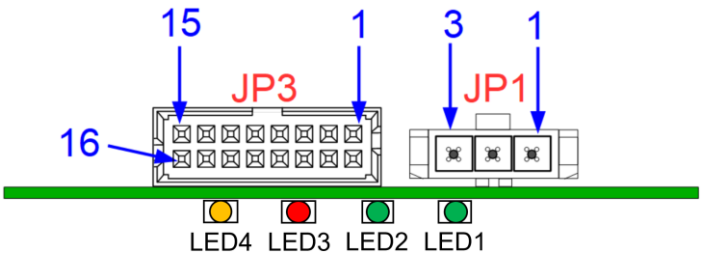

Fig. 3 Front view of the four status LEDs and headers JP3 and JP1 with pin indication. The green bar indicates the PCB of the EBD5200.

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

Table 2 Pinout of header JP1

Pin	Name	Function	Description / Comment
1	Modulation	Input	(LV)TTL digital modulation signal
2	+5Vin	Output	5V supply voltage from JP1, for configuration purposes only, e.g., to enable the SLED by shortening pin3 and pin2
3	SLEDenable	Input	(LV)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	MPDcurrent	Output	Analog voltage output proportional to internal monitor photodiode (MPD) current with 1 V corresponding to 1 mA MPD current. To be terminated with high impedance.
6	SLEDcurrent	Output	Analog voltage output proportional to SLED current with 100 mV corresponding to 100 mA SLED current. To be terminated with high impedance.
7	SLED_enabled	Output	Open-collector output indicating the light (SLED) output is on
8	AIN_enabled	Output	Open-collector output indicating that the SLED current is controlled through pin15/pin16
9	AIN_alarm	Output	Open-collector output indicating an excessive analog input voltage at pin15/pin16 is applied and limited to +2.5V
10	TEC_alarm	Output	Open-collector output indicating the read temperature of the SLED being either 1.5°C above or below the set temperature
11	GNDext	Output	GND reference for pin7, pin8, pin9, pin10
12	GNDext	Output	GND reference for pin7, pin8, pin9, pin10
13	AINenable	Input	(LV)TTL digital signal to enable the SLED current control through pin15/pin16
14	+5Vin	Output	5V supply voltage from JP1, for configuration purposes only, e.g., create a short to pin13 to enable analog current control
15	+AINextern	Input	Analog input voltage (0-2.5V) to control SLED current
16	-AINextern	Input	GND reference of analog input signal (pin15)

Table 3 Pinout of header JP3

Pin7 to pin10 of connector JP3 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 pin11 and pin12 of JP3. These alarm and status signals are also logically connected to the four LEDs on the board.

LED	Name	Description / Comment
LED1 (green)	Power	Indicating supply voltage with correct polarity, measured after the fuse, brown-out and spike detector. Blinking indicates an undervoltage <4.9V or an overvoltage >5.5V.
LED2 (green)	SLED_enabled	Indicating that the SLED and thus the optical output is enabled.
LED3 (red)	TEC_alarm	Blinking indicates that the read temperature of the SLED is either 1.5°C above or below the set temperature. This LED is permanently on when the SLED has been switched off due to a continued temperature alarm.
LED4 (orange)	AIN_enabled	Indicating that the SLED current is controlled via AINextern. Blinking indicates overvoltage of AINextern >2.5V.

Table 4 Configuration of LED indicators

The left side of connector JP3 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. Pin15 and pin16 allow for applying an analog control voltage (0 to +2.5V) in order to control the SLED current and to use the EBD5200 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. The analog bandwidth of the AIN input is very small as this input was optimized for cw operation; it is, therefore, not suitable to perform fast analog modulation of the optical output.

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 EBD5200 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 JP3 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 pin15 and pin16 of JP3. In order to enable the control through an external analog signal an active-HIGH (5V) signal needs to be applied to pin13 of JP3, for example by shortening pin13 and pin14. 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 BTF modules with an internal Peltier element the default configuration of S1 has the TEC enabled as it cannot be enabled electronically.

4.3 OPERATING CONDITIONS

Table 6 shows the typical, minimum and maximum operating conditions of the EBD5200 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 6 Operating conditions of the EBD5200

4.4 PERFORMANCE CHARACTERISTICS

Table 7 shows the typical performance of an EBD5200 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., the drift over 24 hours (at constant temperature) is typically around 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 800 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 (3σ) 24h	±0.002°C	±0.005°C	Constant ambient temperature (3)
TEC temperature stability rms	12 ppm	30 ppm	Constant ambient temperature (3)
TEC temperature drift 1000h	±0.07 ppm/h	±0.10 ppm/h	Linear interpolation over 1000 h
Temperature-related TEC stability	±0.0004°C/K	±0.0010°C/K	
Current stability ptp (3σ) 24h	±75 ppm	±100 ppm	Constant ambient temperature (3)
Current stability rms 24h	30 ppm	50 ppm	Constant ambient temperature (3)
Current stability ptp (3σ) 1h	±75 ppm	±100 ppm	Constant ambient temperature (3)
Current stability rms 1h	20 ppm	30 ppm	Constant ambient temperature (3)
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) around 200 mA drive current around 600 mA drive current	 ±7 µA/K ±10 µA/K	 ±10 µA/K ±15 µA/K	Average value after 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-off delay typical 70 µs
Turn-on delay on-off modulation (2)	10 ms		
10:90 rise time on-off modulation (2)	100 µs		90:10 fall time typical 1 µs
Max. on-off modulation frequency	10 kHz		
Max. analog modulation frequency	3 Hz		At AIN inputs pin15/pin16 of JP3

(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 EBD5200 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): Ambient temperature and thus board temperature is stable within ±0.5°C

Table 7 Typical performance characteristics of the EBD5200

5 PACKAGED SLED DRIVER MODULE

The EBD5200 was designed as an OEM board to be used in various system environments. The EBD5200 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 EBD5200 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 screwdriver 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 and JP3.

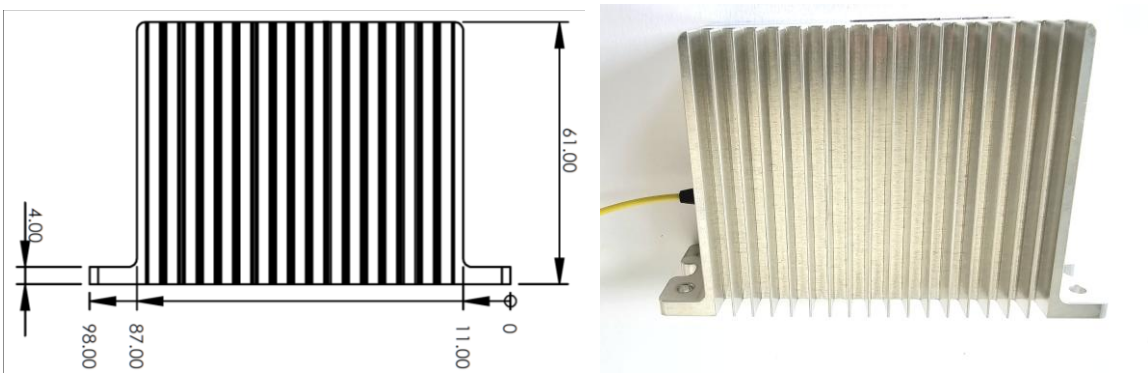

Fig. 4 Side view of the EBD5200 metal case: Mechanical drawing on left and photograph on right (fiber output is on the left side).

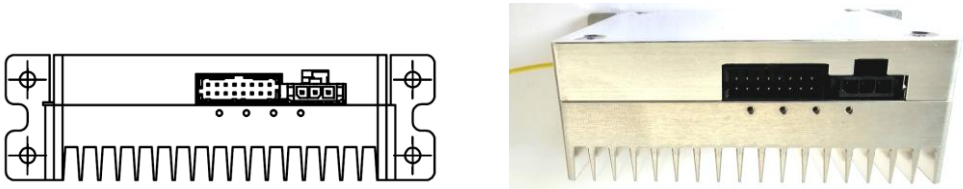

Fig. 5 Top view of the EBD5200 metal case: Mechanical drawing on left and photograph on right (fiber output is on the left side).

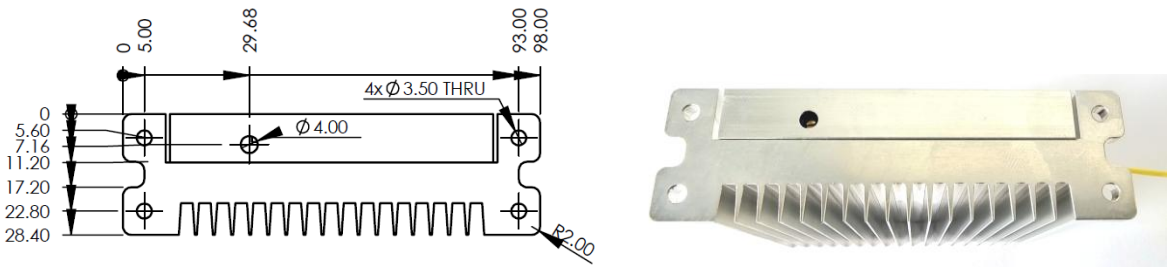

Fig. 6 Bottom view of the EBD5200 metal case: Mechanical drawing on left and photograph on right (fiber output is on the right side).

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. The conductive passivation of the metal enclosure typically provides sufficient electrical conductivity and low impedance for good connectivity to a PE-reference heatsink or base plate. Alternatively, the conductive passivation surface finish may be 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 -20°C to +65°C, unless specified differently by EXALOS.

6.2 HEATSINKING

Make sure that the EBD5200 housing is mounted on a suitable heatsink that provides a flat surface and sufficient thermal conductivity to spread the heat generated of the light source assembly. For high-power light sources or for operation at high ambient temperatures, the internal Peltier cooler (TEC) will have to operate harder, which means that more heat is generated by the TEC and by the electronics, resulting in a stronger warm-up of the metal enclosure. Therefore, for certain light sources and for certain operating conditions, it might be required to have additional forced air to remove heat through convection at the fins of the metal enclosure.

6.3 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 tests, it might be therefore useful to set the current limit to 1.5-2.0 A. The replaceable 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. Afterwards, the current limit should be set to 3A to allow for sufficient margins for operation at high ambient temperatures, for example to handle large in-rush currents. The EBD5200 is not sensitive to noise on the supply voltage as it features various filter networks and ground decoupling stages as well as a spike and brown-out detector.

6.4 IN-RUSH CURRENTS

Every electronics may show in-rush or surge currents when the supply voltage is turned on. These in-rush currents may be several times the normal full-load current under steady-state operation. These large in-rush currents may only last a fraction of a millisecond but might be still challenging for a DC power supply, especially if the output capacitance of the power supply is smaller than the input capacitance of the electronics, which can result in voltage drops and, in some cases, even to repetitive voltage brown-outs and voltage oscillations.

The EBD5200 has an input capacitance of 110 µF. A general recommendation is that the output capacitance of the DC power supply should be, at least, five times larger than the input capacitance, which would mean that the DC power supply should have a minimum output capacitance of ~550 µF in order to deliver a stable 5V supply voltage.

The magnitude of the in-rush current I_{surge} generally depends on the supply voltage U_{supply} and on the cable resistance R_{cable} and is given by $I_{surge} = U_{supply} / R_{cable}$. Table 8 provides some examples of expected in-rush currents for the 5V supply voltage of the EBD5200 for various cable connections:

Cable resistance	**1 Ohm**	**0.5 Ohm**	**0.2 Ohm**
Magnitude of in-rush current	5 A	10 A	25 A

Table 8 Estimated in-rush currents for various cable connections.

6.5 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. The metal case has a transparent, electrically conductive passivation that is suited for providing solid connectivity to a PE-referenced heatsink. In addition, a toothed washer could be used to remove locally the passivation when realizing the connection to the PE of the surrounding system.

6.6 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 (LED3 and pin10 of JP3) being off.

6.7 ENABLING THE SLED

The SLED is enabled and the optical power is turned on either by applying a 5V signal to pin3 of JP3 (active-HIGH) or by turning the code switch S1, for example to '1'. When using an electronic enable signal, e.g., 5V TTL or also 3.3V LVTTL, make sure that the voltage is relative to the GNDext on pin4 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 while 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.

6.8 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 pin15 and pin16 of JP3. When adjusting the current level electronically, make sure that the analog control is enabled (AINenable, pin13 of JP3) or that the code switch S1 is in a position that enables the analog control, for example position '2'. When using a signal for AINenable, e.g., 5V TTL or 3.3V LVTTL, make sure that the voltage is relative to the GNDext of JP3.

The analog input voltage is limited on the board to 2.5V to ensure safe operation. AIN voltages larger than 2.5V are clipped and an alarm signal is enabled (LED4 and pin9 of JP3).

6.9 ON-OFF MODULATION

The SLED current can be turned on and off with a TTL or LVTTL modulation signal through pin1 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 or 3.3V LVTTL, make sure that the voltage is relative to the GNDext on pin4 of JP3. Fig. 7 shows the modulation behavior and modulation bandwidth of the EBD5200 driver board in its standard configuration. The maximum modulation frequency is specified in Table 7.

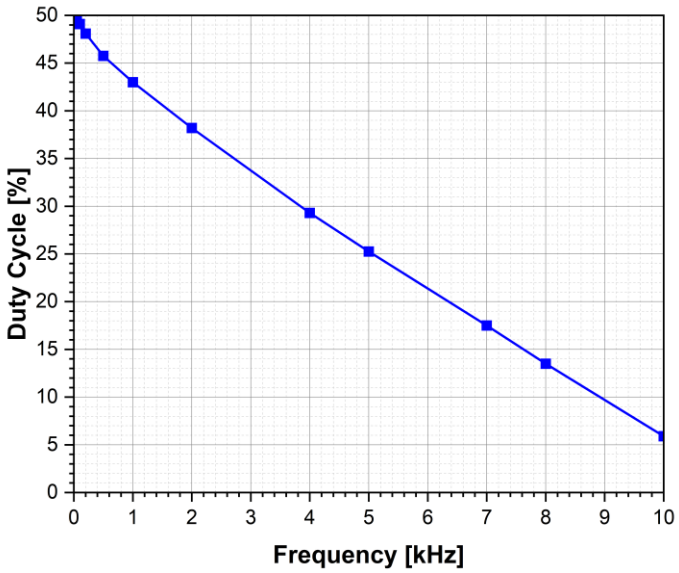

Fig. 7 Duty cycle of SLED current or optical output power for a TTL-modulated input signal with 50% duty cycle with varying modulation frequency. Because of the inverted logic of the modulation input, this graph also shows the required duty cycle of the electrical modulation input signal to achieve 50% duty cycle for the optical output.

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 current through pin1 of JP3 will also not power down the OpAmps of the driver stage.

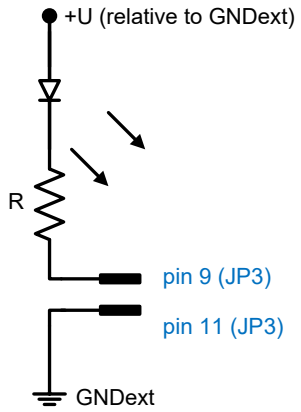

Fig. 8 Example of using an open-collector alarm output at JP3 to illuminate an external LED. The load resistor R limits the current to max. 20 mA.

6.10 DISABLING THE SLED

To disable the SLED and hence the optical output, apply 0V to pin3 of JP3. 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 EBD5200 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 EBD5200 has a warm-up time until, for example, the current drift during the turn-on phase is minimized. The typical warm-up time (with power-up from a cold state) for ultimate current stability is 20 minutes, see Fig. 9 below, but might be faster depending on the SLED current and on the ambient temperature.

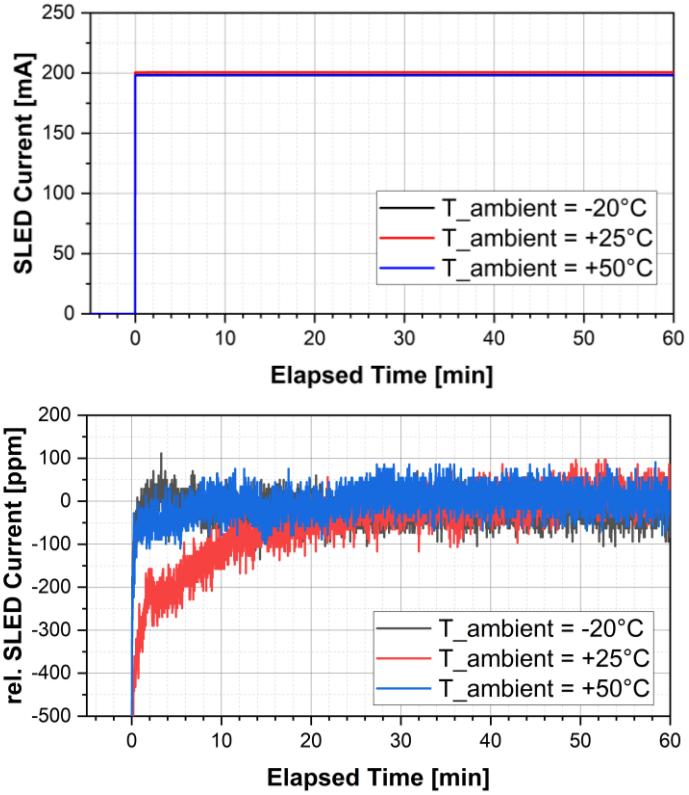

Fig. 9 Recorded SLED current after powering up the EBD5200 for different ambient temperatures (top). Zoom-in of top graph showing relative current drift (bottom).

6.13 LONG-TERM STABILITY

Fig. 10 shows the typical long-term stability of the SLED temperature (top) and SLED current (bottom) over a test period of 25 hours. The environmental temperature was fixed at 22.0°C during the test. The average recorded SLED temperature was 25.01056°C with an rms standard deviation of 0.00028°C (11 ppm), demonstrating that there is very little long-term drift of the SLED temperature and that the stability (standard deviation) of the TEC controller is basically not changing over time.

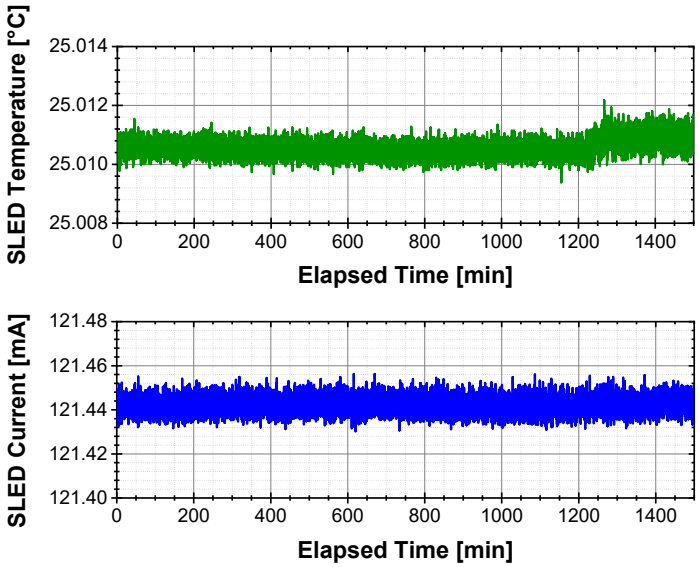

Fig. 10 SLED temperature (top) and current (bottom) during a 24-hours stability test.

The SLED current was set at a nominal drive current of 120 mA. The average recorded SLED current was 121.4418 mA with an rms standard deviation of 0.0035 mA (29 ppm), also demonstrating that there is no long-term drift and no long-term change in stability.

With this stability performance, the EBD5200 driver board meets highest requirements of optical power stability or wavelength stability. For example, an optical power stability of better than ±0.015% (3σ value over 24 hours) or a wavelength stability of better than ±0.5 ppm (3σ value over 24 hours) can typically be achieved for a system with stable ambient temperature.

6.14 TEMPERATURE ALARM

In case of a permanent temperature alarm for more than 30 seconds, the drive current is automatically disabled in order to protect the SLED. This may happen if the heat sinking of the optical module is insufficient or if the ambient temperature is exceeding the specified operating range, or if otherwise the TEC is unable to control the SLED temperature.

7 REVISION HISTORY

Rev.	Description	ECN Number	Released
0.1	Initial document for EBD5200	-	04.10.2009
0.2	Revised photographs & mechanical drawings; Revised information on modulation	-	05.11.2009
1.0	First full specification release	-	13.12.2010
1.1	Added information on protective earth connection in section 5 and on input/output connectors in section 3.2; renamed "Temperature_alarm" in "TEC_alarm"	0499	29.02.2012
1.2	Modified housing for EBD5200	0507	13.03.2012
1.3	Updated information on user interface connector due to new driver board version V3.1 of EBD5000 with 16-pin connector JP3 instead of JP4 and JP5; added section 5.13 about temperature alarm shut-off	0527	24.05.2012
1.4	Added section 2 about laser safety. Corrected pin indication in Fig. 8 and section 6.6	1309	18.02.2021
1.5	Updated RoHS reference in section 3.4	1371	02.12.2021
2.0	New board revision 4.3: • Replaced obsolete components • Further improved thermal stability • Improved ESD robustness of JP3 • Faster modulation capability • Replaceable onboard fuse • Additional output signals on JP3: monitor photodiode current and SLED current • New status LEDs	1508	13.03.2023
2.1	• Updated section 5 showing photographs of new housing (transparent passivation instead of blue anodization) • New section 6.2 about heatsinking • New section 6.4 about in-rush currents • Updated section 6.5 about PE connectivity	1872	10.07.2026