



User Manual

LDP-CW 20-50 Safety

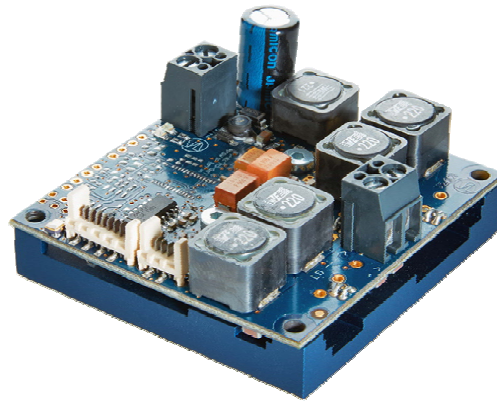


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LDP-CW 20-50

Rev. 1905

Fully digital cw Driver for High Power Laser Diodes



- Output current: 1 .. 20 A
- Compliance voltage: 0 .. 50 V
- Output power: 1 kW
- Coverage of cw range
- Analog modulation
- Half brick size (35 cm²)
- Several protective features
- High efficiency

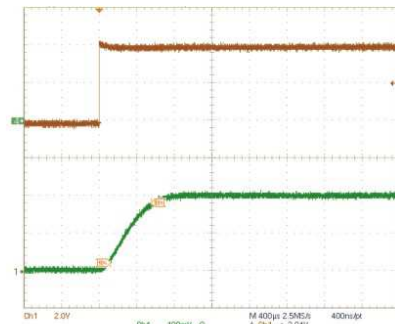


Figure: Soft Start, Current monitor output, scale: 10A/Div

Technical Data*

Output current	1 .. 20 A
Max. compliance voltage	1 .. 50 V
Current ripple	< 1 %
Ripple frequency	> 1 MHz
Current overshoot	Refer to manual**
Analog modulation (10 A _{nom})	Refer to manual**
Current settling time (full-scale)	Refer to manual**
Current setting input	Analog or digital
Supply voltage	12 .. 55 V DC (min. 5 V above laser diode voltage)
Max. power dissipation	< 45 W
Dimensions in mm	60.9 x 57.8 x 29
	Half brick size
Weight	194 g
Operating temperature	0 to +55 °C

Product Description

The LDP-CW 20-50 is a very affordable, compact and efficient current supply for an output power up to 1 kW.

The capability ranges from continuous output current to analog modulated waveforms like sinusoidal, rectangular or triangular. The modulation is limited usually by the load inductance.

Intended field of application are laser soldering and welding as well as generic surface treatment and show lasers.

The innovative current regulation concept of the LDP-CW 20-50 produces, compared to the commonly used linear regulation concept, considerably less losses. Hence, only one supply voltage is needed for the control logic and the power stage. The current consumption drawn from the power supply only needs to cover the average laser power and is typically much less than 20 A.

* Specifications measured with a fast recovery diode instead of a laser diode. Technical data is subject to change without further notice.

** Actual values depend on hardware setup

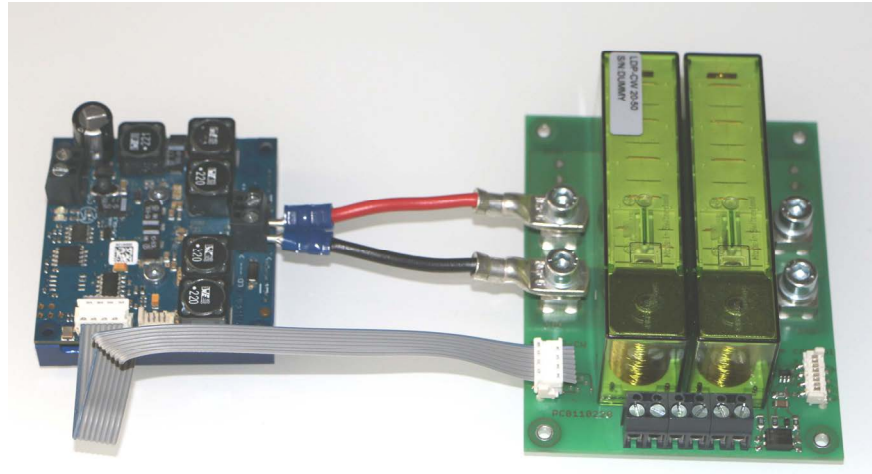
Designed to shield your laser diode from damage, the LDP-CW 20-50 features a number of powerful protective safeguards:

- Innovative current regulation concept actively prevents laser diode from overshoots and overcurrent
- Integrated Soft Start
- Overtemperature shutdown
- Enable/Disable input
- Driver status output
- Protection of the laser diode against reverse currents

Optional Accessories: LDP-C BOB
PLB-21

Description of Connections

The LDP-CW 20-50 Safety is using the LDP-CW 20-50 and an external safety relay board.



The shown wires are part of the box. It contains:

- 1 x LDP-CW 20-50
- 1 x Set of DC cables (20 cm long)
- 1 x Communications cable (25 cm long)
- 1 x Relays sub board

The Relays Sub Board is not available as a stand alone product and it must not be used on any different driver.

PicoLAS will provide the LDP-CW 2050 SAFETY only in one board upon customer requirements (including driver and relays on one PCB).

The used safety relays have main braking contacts to interrupt the current which still might flow during any fault conditions. There are 2 independent relays connected in series, both having a 2s2p contact configuration. This will help the end user to build up a system according to the safety standards up to SIL4 (performance level e).




The contact data of the main contacts are:

Data of main breaking contacts	
Contact material	AgSnO ₂
Nominal breaking capability	250 VAC (440VAC) 16 A AC1 4'000 VA
Electr. lifetime AC1(360 S/h)	ca. 250'000
Max. current (contacts closing)	60 A for 20 ms
Breaking voltage range	5 .. 250 VDC (480 VAC)
Current range*	10 mA .. 16 A
Range of interruptible power*	120 mW .. 4'000 W(VA)
Nominal Contact resistance (new contacts)	≤100 mΩ / 6 V / 100 mA

*Standard values


Additionally there are two independent control contacts, which can be used for additional supervisory by end user.

Data of control contacts	
Contact material	AgSnO ₂ + 0.2 μm Au
Nominal breaking capability	250 VAC 6A AC1 1'500VA
Electr. lifetime AC1(360 S/h)	ca. 100'000
Max. current (contacts closing)	15 A for 20 ms
Breaking voltage range	5 up to 250 VDC/VAC
Current range*	5 mA bis 6 A
Range of interruptible power*	60 mW bis 1'500 W(VA)
Nominal contact resistance (new contacts)	≤100 M Ω / 6 V / 100 mA

Isolation information		
	- basic insulation - air and creepage distance - test voltage	bei 250VAC > 4 mm 2'500V/50 Hz/1min
	- Double / augmented insulation - air and creepage distance - test voltage	bei 250 VAC > 8 mm 4'000 V/50 Hz/1min
	- Double / augmented insulation - air and creepage distance - test voltage	bei 250 VAC > 10 mm 5'000V/50 Hz/1min
Test voltage, contacts open		1'500V/50Hz/1min
Creep resistance		CTI 250
Degree of contamination		2
Overvoltage category		III
Isolation resistance for up to 500 VDC		>100M Ω

Additional Information	
Mechanical lifetime	>10x10 ⁶ switching cycles
Max. switching frequency (mechanical limitation)	15 Hz
Time to close contacts	typ. 18 ms
Time to open contacts **	typ. 5 ms
Bounce time AK	typ. 8 ms
Bounce time RK	typ. 12 ms
Shock withstanding capability (16 ms)	AK > 10g RK > 8g
Vibration withstanding capability (100 – 200 Hz)	AK > 10g RK > 5g
Ambient temperature range	-40 °C .. +70 °C
Thermal resistance	40 K/W
Assembly position	any
Protection class	RT II

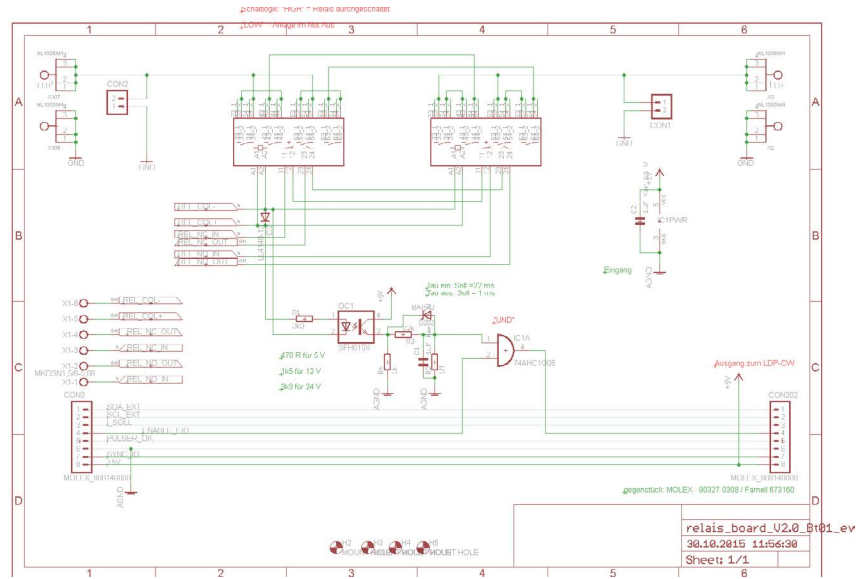
** without connected coil

Approvals	
Approbations	
UL File E188953	Sec. 4
Isolation classification after IEC 60664-1	250VAC
Protection class II	VDE 0106
Fire protection classification	UL 94 / V0

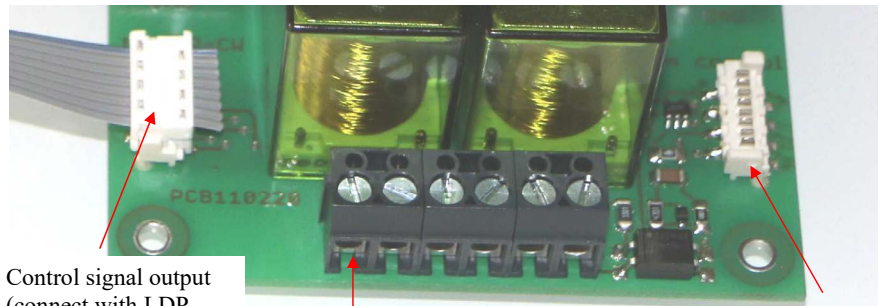
The Relays Sub Board is able to interrupt the maximum current of the LDP-CW 20-50 caused by any fault situation safely. During normal operation the lifetime is greater than 10 Million operations. After a severe fault condition the relays have to be checked and replaced after 10 full load interruptions. To ensure regular operation the current is controlled to zero before the contacts open or close.

Controlling the Relays

The relays have to be driven by the customer. Only a high-signal on the inductor coils will activate the contacts and allows enabling the driver. The operating principle of the board is required to pass the safety standard approvals and is depicted below:



Pin description of the control interface:



Control signal output
(connect with LDP-
CW 20-50)

Relays control screw terminals,
Pin 1 is highlighted.

Control signal input
(connect the analog
/TTL control cable here)

Screw terminal pin description:

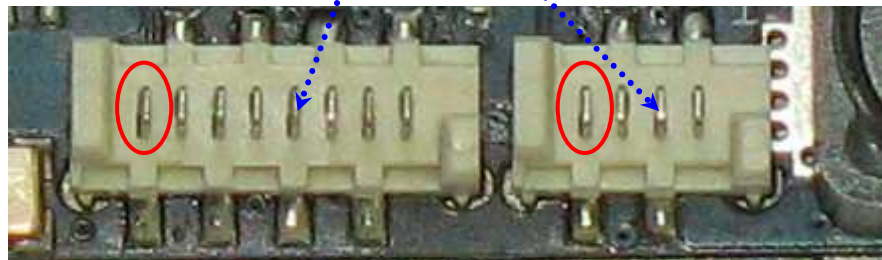
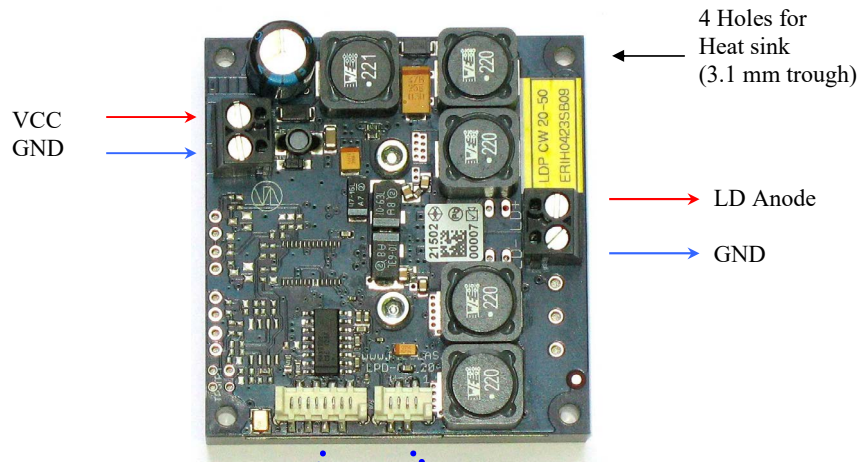
Pin #	Description	How to use
1	Rel-NO-IN	Control contact of the relays. Both “normally opened” contacts are connected in series. Only for control function of the end user.
2	Rel-NO-rtn	
3	Rel-NC-IN	Control contact of the relays. Both “normally closed” contacts are connected in series. Only for control function of the end user.
4	Rel-NC-rtn	
5	Rel-Coil positive	Provide a 24 V DC (polarity is sensitive) with a capacity of > 60 mA to drive the relays
6	Rel-Coil negative	

Pin 1 to 4 are mandatory use to control if all contacts were moved.

Pin 5 & 6 must be driven by customer as in an emergency stop line.

All connectors on the LDP-CW 20-50 are protected against ESD as described by the human body model.

The following drawing shows all connections that are available to the user.



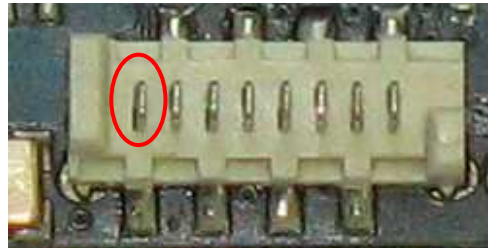
LDP-C BOB connector (Pin 1 marked)

RS232 / PLB-Conn.(Pin 1 marked)

VCC	Supply voltage 12 .. 48 V, (56 V absolute maximum)
GND (next to Vcc)	Supply ground
LD+	Positive laser diode output (anode).
GND (next to anode on the right side)	Negative laser diode output (cathode) ground. Do not use the input ground!
LDP-C BOB Conn.	Mini-MOLEX connector for analog/TTL-control of the driver (see below)
RS232/PLB-21 Conn.	Mini-MOLEX connector for RS232 communication or the PLB-21 (see below)

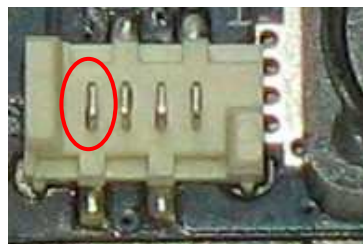
For a more convenient use of the driver (e.g. in laboratory use) we offer an optional product accessory LDP-C BOB board.

Pin-assignments and description of the MOLEX-pin header:



The Connector is a MOLEX_908140008, a suitable female connector would be a MOLEX - 90327-0308 like Farnell 673160.

Pin Number	Description	Direction	Comments
1 (marked in red)	reserved		Do not connect! (first pin on the left)
2	reserved		Do not connect!
3	I-Soll	Input	Scale: 0 .. 5 V equals 0 .. 20 A Other scaling upon request!
4	Enable-Ext	Input	0 V = disabled, 3.3 V = driver enabled
5	Pulser-Ok ("pulser" is used here as a synonym for driver)	Output	0 V = laser diode driver not ok or power up self test not passed yet; 3.3 V = driver ok / test passed
6	GND	Output	
7	reserved		do not connect
8 (right)	+5V	Output	since HW rev. 2.1: 5 V / 100 mA output



The Connector is a MOLEX_908140004, female connector MOLEX - 90327-0304 like Farnell 673146.

Pin Number	Description	Direction	Comments
1 (marked in red)	+12 V	Output	Only for the use with the PLB-21, prevent any overload or short! (max. 100 mA)
2	TXD	I/O	RS232-Standard serial interface
3	RXD	I/O	RS232-Standard serial interface
4 (right)	GND	Output	

How to get started (quick-start without PLB-21)

Step	What to do	Note
1	Unpack your device.	
2	Connect a load to the output. Screw connectors are on the right side. Pay attention to the polarity when connecting a diode.	For tests the load might be a resistor or a dummy diode.
3	Apply the supply voltage. Connect the VCC input on the upper left to your power source. (Fix your wires with the screws at the connector.)	Apply any voltage between +12 V and + 48 V at “VCC” with respect to GND. This voltage must be at least 5 V higher than the expected compliance voltage of the laser diode - Make sure there is no voltage surge that could destroy the unit when switching the power supply on!
4	Wait until “pulser-ok” is high (“pulser” is used here as a synonym for driver)	Pin 5 with respect to Pin 6 must change from 0 V to 3.3 V
5	Apply the current setpoint (scale: 250 mV / A)	For example: apply 2.5 V to Pin 3 of the BOB connector with respect to GND (Pin 6) if you want to set current to 10 A
6	Set enable pin “high”.	Apply 3.3 V to pin 4 of the BOB connector. The current will ramp up now.
7	Check	If the driver is not properly cooled, it will shut down.

How to get started with a PLB-21

Step	What to do	Note
1	Unpack your device.	
2	Connect the PLB-21.	Use the PLB-21 pin header and the special cable.
3	Apply the supply voltage. Connect the Vcc input on the upper left to your power source. (Fix your wires with the screws at the connector.)	Apply any voltage between +12 V and +48 V to "VCC" with respect to GND. The voltage must be at least 5 V higher than the expected compliance voltage of the laser diode. Make sure there is no voltage surge that could destroy the unit when switching the power supply on!
4	Wait until "pulser-ok" is high (pin5) ("pulser" is used here as a synonym for driver)	Pin 5 with respect to Pin 6 must change from 0 V to 3.3 V
5	Apply the current setpoint.	Use the PLB-21 to switch from external to internal setpoint, set the setpoint by turning the dial
6	Set enable pin "high" (pin 4).	Apply 3.3 V to pin 4 of the BOB connector. The current will ramp up now.
7	Check	If the driver is not properly cooled, it will shut down.

Enabling / disabling the Driver

The output of LDP-CW 20-50 can either be enabled via an external signal (BOB connector) or a bit in the LSTAT register. This behaviour can be altered via the config menu in the PLB-21 menu or via the serial interface. When the LDP-CW 20-50 is configured for internal enable, the ENABLE pin of the BOB connector is ignored.

Dos and Don'ts

Never make a short at the output. This will not do any harm to the laser driver but will result in an incorrect current measurement.

Never disconnect and reconnect the load while the driver is enabled. Disconnecting the load is not dangerous, but the reconnect will damage the driver! To avoid this disable the output before reconnecting.

Keep the connection between power supply and driver as well as the connection between driver and laser diode as short as possible.

Mount the driver on an appropriate heat sink. The driver will shut down under overtemperature circumstances. Depending on the desired current a slight airflow across the black coils on top is necessary. Please keep the temperature of these devices below 85 °C

This driver uses a "high-side" current sensing technique. The GND of the VCC terminal is the same as the GND of the LD terminal.

Make sure that the control ground is connected to the supply ground. Any unexpected current flow through the control board may damage the driver.

The driver is cw operation only.

Absolute maximum Ratings

- Supply voltage range: +12 V .. +56 V (destroying limit)
- Maximum input current: 20 A
- Maximum laser diode output current: 20 A
- Maximum laser diode compliance voltage: 50 V
- BOB connector input and output voltages: 0 V to 3.3 V (terminals are 5 V proof)
- I-setpoint: 0 V to + 5 V
- BOB connector output currents: 1 mA
- Auxiliary 5 V supply voltage output current: 30 mA (Pin 8 of BOB connector planned for Rev 2.1)
- Auxiliary 12 V supply voltage output current: 100 mA (Pin1 of PLB-21 connector)
- Operating temperature: 0 - 55 °C

Ordering Options / Product changes

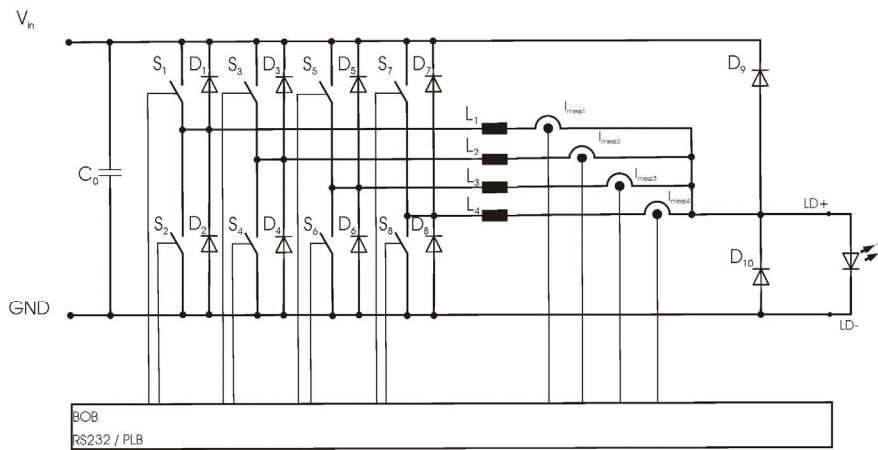
- LDP-CW 20-50 or LDP-CW 20-50 **-S50** yields the standard unit with the scaling (5 V = 20 A)
- LDP-CW 20-50 **-S33**: Input scaling is 0 .. 3.3 V correspond to 0 .. 20 A. If you require this furthermore, please order with the **-S33** option.

Note: This affects the analog input only.

Functional Description

The LDP-CW operates with four parallel buck converters (S1, S2, D1, D2, L1; S3, S4, D3, D4, L2; S5, S6, D5, D6, L3; S7, S8, D7, D8, L4). Every single converter has an independent control loop with a current sensor (Imeas1, Imeas2, Imeas3 and Imeas4). The setpoint current that is defined by the user is evenly spread over all four converters.

Several security features protect the laser diode and LDP-CW from damage. D8 protects the laser diode from reverse currents while D7 protects the driver in case of a load failure. In case of a failure, the control unit disables the LDP-CW. A soft-start mechanism slowly raises the current after enabling the LDP-CW.

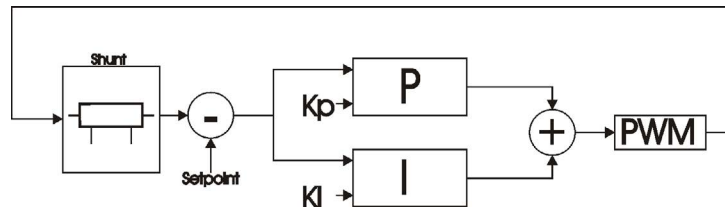


Operation Principle of LDP-CW 20-50 driver

Element	Function
S1, S2, S3, S4, S5, S6, S7, S8, D1, D2, D3, D4, D5, D6, D7, D8, L1, L2, L3, L4	Buck converter
C0	Input buffer capacitor
D7, D8	Laser diode and driver protection diodes

Current Regulator

The LDP-CW 20-50 is equipped with a software controller P-I current regulator. The following diagram shows a simplified version of the regulator.



Simplified P-I current regulator

As shown in the diagram, the current regulator is controlled by the parameters K_p and K_i which can be altered by the user. These parameters define the behaviour of the output current. The default values for K_i and K_p supplied by PicoLAS guarantees a safe operation with nearly zero current overshoot, but at a cost of a relative high current settling time and low analog modulation capabilities. (~1 ms current setting time and ~500 Hz modulation rate). To achieve the lowest possible setting time -and therefore the highest analog modulation rate- the factory defaults ($K_p = 2400$, $K_i = 2500$) needs to be adapted to the connected load and the supplied operating voltage.

The current setpoint resolution is 0.1 A.

In order to optimize the regulation behaviour, the customer has to monitor the output current using a high speed current clip on instrument connected to an oscilloscope. It is then possible to monitor the regulators behaviour to the modified parameters.

Please note that if the current regulator has adjusted to its setpoint, the reaction of modified K_i and K_d parameters is pretty low. To achieve correct measurement results the setpoint needs to be altered after modifying the regulator parameters.

Current Limiter

The LDP-CW 20-50 is equipped with a software-based current limiter. This can be used to configure a maximum valid current setpoint (analog and digital) which cannot be overstepped.

Please note that this will not protect the load from current overshoots due to wrong P-I parameters!

External Setpoint

An external voltage can be applied to the LDP-CW 20-50 which defines the setpoint current. The scaling of this voltage depends on the version of the driver. See datasheet for more information.

In order to switch between external and internal setpoint the bit 1 of the LSTAT register must be altered. Please note that this only works if the driver is disabled!

The external setpoint can be scaled in two different ways, depending on the state of bit 7 of the LSTAT register:

When this bit is "0" the external setpoint scales between the minimum and maximum current.

When this bit is "1" the external setpoint scales between zero and the maximum current. If a voltage is applied that defines a current which is lower than the valid minimum current, the output is disabled.

The external setpoint voltage is converted by an analog to digital converter into a digital value. The resolution of this converter is 10 bit. This may lead to some current jitter as this resolution is not equal to the current resolution of 0.1 Ampere.

The input impedance on this input pin is greater or equal to 10 kohms.

Test Load

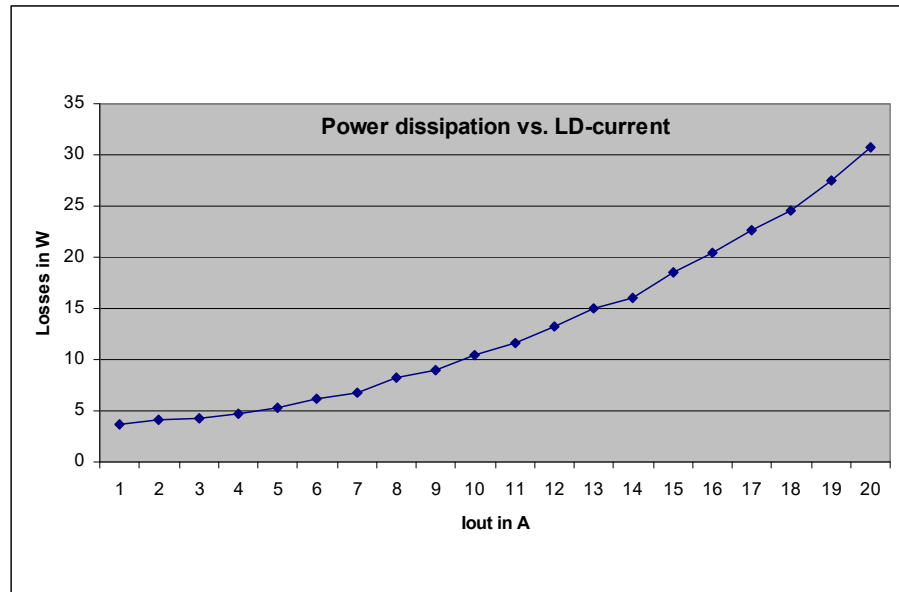
A common method to test the driver is to connect a regular silicon rectifier diode to the driver output. Attention has to be paid to the junction capacitance of the diode. Only fast recovery diodes (or similar) have a low parasitic capacitance as laser diodes have. To achieve reasonable test results - especially when you plan to use the driver with AM modulation - the parasitic elements of the test diode and the connection must be very similar to a laser diode approach. Regular silicon rectifier diodes have a junction capacitance of several microfarads and are not a suitable test load! The use of these diodes will yield in incorrect current measurement at the pulse edges!

Power Supply

The power supply must be able to cover the output power plus the internal power losses (please see next section). Example: you have a 48 V power supply and a Jenoptik JOLD-75-FC-11 laser diode with up to 20 V compliance voltage and a 12 A current (max. values). At 12 A the driver needs at least additional 12 W to cover the internal losses. The total power consumption will be: $20\text{ V} \times 12\text{ A} + 12\text{ W} = 252\text{ W}$. Divided by 48 V this yields 5.25 A (better 6 A) of current consumption at the DC-terminals.

Cooling

The driver produces up to 31 W of losses. Thus the base plate has to be mounted on a heat sink to ensure proper operation and prevent an over temperature shutdown. If working with high currents above 10 A it is recommended to cool the power inductors as well. This can be achieved easily by placing the driver with its heat sink in the air flow of a fan.



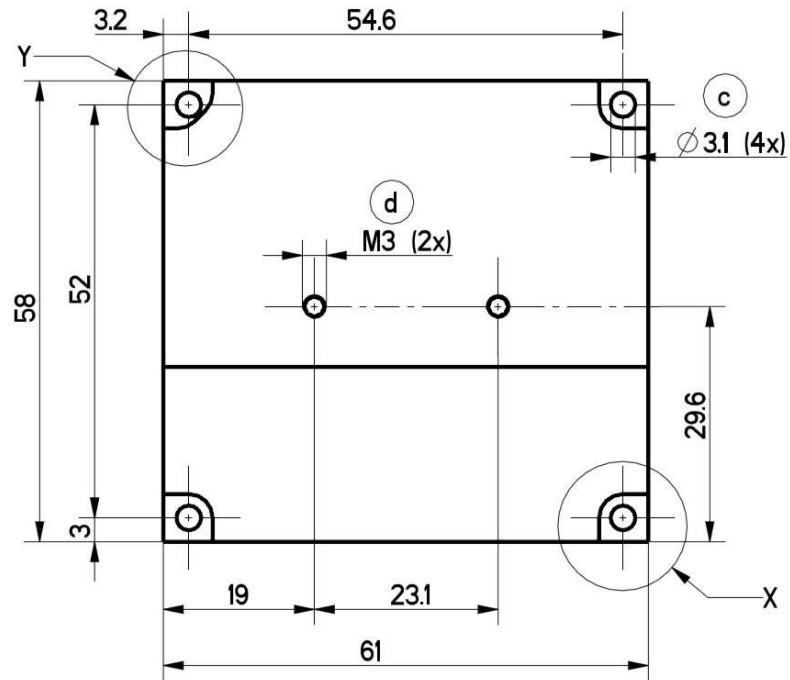
Power dissipation over output current

Overtemperature Shutdown

To protect itself, the LDP-CW automatically shuts down itself if its temperature rises above 80 °C. This condition is latched and the appropriate bit in the ERROR register is set. To re- enable the LDP-CW the ENABLE pin must be toggled (set low and then high).

Mechanical Dimensions

Over all height: 30 mm
All dimensions in mm



Power on self test

Each time the driver is powered up, it performs a test of its internal safety features. The driver cannot be enabled until a self test has been performed successfully. The PULSER_OK signal will be pulled high when the test has been successful. The test will take less than 5 seconds, but can take up to 15 seconds due to internal time-outs if any failures are detected.

Controlling the Driver

The driver can be operated stand alone, with a PLB-21 or a PC connected to it via a serial link (RS232 interface, for USB you need an USB-RS232 adaptor). It remembers all settings from the last time it had been powered on, unless configured to load default values on power-on. In latter case it loads pre-configured settings each time the power is applied. Connecting a digital control to the driver does not alter the internal settings.

No digital control (factory default)

If no digital control (PLB-21 or serial link to PC) is attached, only the BOB connector could be used to control the driver. If configured so, the pin 3 at the BOB connector (“I_{setpoint}”) can be used to control the setpoint current. To enable the output pin 4 at the BOB connector (“ENABLE”) must be set HIGH. If an error occurs (e.g. over temperature), the driver will be disabled and the pin 5 of the BOB connector (“PULSER_OK”) is pulled low. The “enable” pin has to be toggled to enable the driver again.

PLB-21

If a PLB-21 is attached to the driver, it can be used to control the behavior of the driver. The PLB-21 may ask for a driver to download. This must be confirmed with “yes” in order for the PLB-21 to work properly. This must always be done when the PLB-21 was connected to any other PicoLAS product. After the download all operating parameters can be accessed using the PLB-21. For a detailed description see chapter PLB-21 below.

RS232

If the driver is connected to a PC using a serial cable, all operating parameters can be accessed via a serial RS232 terminal program or the PicoLAS protocol. The PLB-21 is automatically disabled if a serial connection is established. For a detailed description of the serial text protocol and the PicoLAS protocol see below.

PC

If the driver is connected to a PC, all operating parameters can be accessed via a serial RS232 terminal program or the PicoLAS protocol. For a detailed description of the serial text protocol and the PicoLAS protocol see below.

Controlling the Driver using a PLB-21

When the PLB-21 is connected the first time to the LDP-CW 20-50 driver, the user is asked to download a new firmware driver. This must be confirmed by “yes” in order for the PLB-21 properly.

Menu Structure

The following diagram shows the structure of the PLB-21 menu which affects the driver. All entries are described in detail. All other menu entries are described in the PLB-21 manual. For detailed instructions see the PLB-21 manual.

Menu root

- Setpoint
 - o Cur(ext/int)F₁
 - o Cur Limit
- Regler (controller)
 - o P
 - o I
- Config
 - o Enable Ext
 - o Enable
 - o I scale
- Temp
 - o Temp Off
 - o Temp
- Defaults
 - o Def. pwron
 - o Load defaults
 - o Save defaults

Setpoint

In this menu the setpoint current can be modified.

Cur (ext/int) F₁

This value defines the setpoint current. It can be switched between internal (int) and external (ext) setpoint by pressing the F₁ key.

When using the internal setpoint, the value can be modified by the user.

When using the external setpoint, the value shown is measured value supplied at Pin 3 of the BOB connector. The display is updated every few seconds, so it is not accurate when using analog modulation.

Cur Limit

This value defines the software current limitation value. Please see chapter “Current limiter” for more details.

Regler (controller)

The LDP-CW 20-50 implements a PI control loop - that controls the current. The control parameters P and I can be altered within this submenu. Please see chapter "Current regulator" for more details.

Config

The LDP-CW 20-50 can be configured to use an software enable signal instead of the hardware Ppin of the BOB connector. This can be configured here.

Enable Ext.

When this item is set to "on", the LDP-CW 20-50 uses the hardware enable pin of the BOB connector. Otherwise it uses the menu point below.

Enable

When "Enable Ext" is set to "off" the LDP-CW 20-50 becomes enabled when this item is set to "on". Otherwise this shows the state of the ENABLE pin of the BOB connector.

I scale

When enabled, the external current setpoint reaches from zero to the configured current limiter value, otherwise it reaches from the minimum current to the configured limit

Temp

The LDP-CW 20-50 is equipped with an onboard temperature sensor. The actual measured temperature of the PCB as well as the shutdown temperature can be monitored here.

Defaults

The driver can load a default setting each time it powers up or the user commands it to do so. This is done within this submenu.

Def. pwron

When enabled, the driver loads the saved settings each time it powers up.

Load

When activated via turning the Jogdial or the ENTER key all internal registers are changed to the previously saved values. The output stage has to be re-enabled via the L_ON bit or the FIRE Key afterwards.

Save

When activated via turning the Jogdial or the ENTER key all internal registers are stored into an internal EEprom for later usage.

If an Error Occurs

If an error occurs during operation the pulse output is switched off, the “pulser_ok_ext” signal on the BOB connector is pulled low and a message is displayed on the PLB-21. If no other action is described on the display, a toggle of the ENABLE pin resets the error condition and re- enables the driver.

Controlling the Driver via a PC

Introduction

When the LDP-CW is connected to a PC, it allows communications over a serial text interface as well as the PicoLAS protocol. While the text interface is designed for communication with a terminal program, the PicoLAS protocol is designed as a system interact protocol.

The switching between the two protocols occurs automatically as soon as the driver receives a certain sequence. The corresponding commands are:

- **PING** for the PicoLAS protocol
- **“init”** followed by <Enter> for the text interface

Description of the RS232 Interface

The LDP-CW 20-50 implements a standard RS232 interface. It can be connected to a PC using a three-wire connection. For USB connection you need a USB-RS232 adaptor (USB-serial adapter).

The connection settings are:

Baud rate	115200
Data bits	8
Stop bits	1
Parity	even

The Serial Text Interface

The following section describes the structure and commands of the text interface.

Structure

Every command that is sent to the LDP-CW must be completed with a CR (Carriage Return = Enter). It consists of a command word followed by one or more parameters. If the command has been executed successfully a "00" is sent, otherwise a "01". If there is an error pending, the response will be "10", otherwise "11". If the command requires an answer parameter, this parameter is sent before the confirmation is given.

Example 1:

The user would like to read out the actual setpoint current:

```
User input:          gcur<Enter>
Output of the LDP-CW: 12.25<CR><LF>
                    00<CR><LF>
```

Example 2:

The user would like to set a new setpoint current:

```
User input:          scur 15.7<Enter>
Output of the LDP-CW: 15.7<CR><LF>
                    00<CR><LF>
```

Input is done in ASCII code and is case sensitive. Every terminal can be used which supports this standard.

Commands for the LDP-CW

The following table contains a command reference for the LDP-CW.

Command	Parameter	Answer	Description
scur	Current in A	--	Sets the pulse current to the indicated value. A dot is used as decimal point. No more than one decimal place is used! (12.225 is the same as 12.2)
gcur	--	Current in A	Outputs the present output current
gcurmin	--	Current in A	Outputs the minimum output current
gcurmax	--	Current in A	Outputs the maximum output current
scurlimit	Current in A	Current in A	Sets the current limiter to the given value in A. A dot is used as decimal point. No more than one decimal place is used! (12.225 is the same as 12.2)
gcurlimit	--	Current in A	Outputs the actual current limiter value
gcurlimitmin	--	Current in A	Outputs the minimum current limiter value
gcurlimitmax	--	Current in A	Outputs the maximum current limiter value
on	--	--	Activates the output
off	--	--	Deactivates the output
curext	--	--	Use external current setpoint
curint	--	--	Use internal current setpoint
gerr	--	32 bit number	Outputs the ERROR register
gerrtxt	--	error text	Description of every pending error
slstat	32 bit number	--	Sets the LSTAT register to the value
glstat	--	32 bit number	Outputs the LSTAT register
gserial	--	serial number	Returns the device serial number
gname	--	device name	Returns the devices internal name
ghwver	--	hardware version	Prints out the hardware version
gswver	--	software version	Prints out the software version
ps	--	current settings	Prints out an overview of all settings
loaddefault	--	--	Loads previously saved settings
savedefault	--	--	Saves the current settings as defaults
sp	32 bit number	--	Sets the parameter of the P-controller
gp	--	P value	Returns the parameter of the P-controller

Command	Parameter	Answer	Description
gpmin	--	minimum P value	Returns the minimum parameter of the P-controller
gpmax	--	maximum P value	Returns the maximum parameter of the P-controller
si	32 bit number	--	Sets the parameter of the I-controller
gi	--	I value	Returns the parameter of the I-controller
gimin	--	minimum I value	Returns the minimum parameter of the I-controller
gimax	--	maximum I value	Returns the maximum parameter of the I-controller
enable_ext	--	--	Switches the driver to external enable
enable_int	--	--	Switches the driver to internal enable
enable	--	--	Enables the driver (when internal enable is used)
disable	--	--	Disables the driver (when internal enable is used)
ext_scale	0 or 1	--	Sets the scaling of the external current setpoint
gtemp	--	--	Returns the actual measured PCB temperature in °C
gtempphys	--	--	Returns the re-enable temperature after an over temperature shutdown in °C
gtempoff	--	--	Returns the shutdown temperature in °C
gvcc	--	--	returns the actual measured supply voltage
gudiode	--	--	returns the actual measured compliance voltage

If an Error Occurs

If an error occurs during operation the driver output is switched off and the return value of a command is no longer "00" or "01" but "10" or "11". Errors have to be acknowledged with a toggle of the ENABLE signal (switch off and on again), otherwise switching on again of the LDP-CW output is not possible. For more details see the description of the ERROR register.

To retrieve the error, use the **gerr** command for the content of the ERROR register or the **gerrtxt** command for a human readable form.

The PicoLAS Protocol

The following section describes the structure and valuable commands of the PicoLAS protocol.

Structure

Each transmission consists of 12 bytes – called a frame in the following – that must be sent consecutively. Otherwise the system times out and the transmission must start again from the beginning.

A frame has a fixed structure. The first two bytes describe the command, the following eight bytes the parameters, followed by one reserved byte and one checksum byte. The checksum is calculated out of the first 11 bytes that are linked by a bitwise XOR.

Thus a frame has the following structure:

Byte	Meaning
1	Bit 8-15 of the command
2	Bit 0-7 of the command
3	Bit 56-63 of the parameter
4	Bit 48-55 of the parameter
5	Bit 40-47 of the parameter
6	Bit 32-39 of the parameter
7	Bit 24-31 of the parameter
8	Bit 16-23 of the parameter
9	Bit 8-15 of the parameter
10	Bit 0-7 of the parameter
11	Reserved, always 0x00
12	Checksum

A properly received frame must be acknowledged by the recipient with an answer that is also a frame. If the acknowledgement does not occur the command has not been processed and the sending procedure should be repeated.

If the recipient recognizes the command as valid, but not the parameters, it will answer with an ILGLPARAM (0xFF12) as command.

In the case the recipient receives an invalid command it will answer with UNCOM (0xFF13).

If a faulty checksum is recognized, the answer is RXERROR (0xFF10). If this error occurs often, the connection should be checked.

Using the REPEAT (0xFF11) command the recipient can instruct the sender to send the most recent frame again.

General Commands

The following list contains an overview of the general commands that are supported by every product from PicoLAS making use of this protocol. The explanation of the individual commands is given further below.

Command Name	Sent Frame		Answer Frame	
	Command	Parameter	Command	Parameter
PING	0xFE01	0	0xFF01	0
IDENT	0xFE02	0	0xFF02	ID
GETHARDVER	0xFE06	0	0xFF06	Version
GETSOFTVER	0xFE07	0	0xFF07	Version
GETSERIAL	0xFE08	0 ... 20	0xFF08	Refer to description
GETIDSTRING	0xFE09	0 ... 20	0xFF09	Refer to description

PING

This command is used to determine the presence of a connected driver and to initialize its interface. It does not change any registers. The command parameter is always 0, the answer parameter as well.

IDENT

This command is used to determine the device ID of an attached recipient. It has no effect on the condition of the recipient. The parameter is always 0. The answer contains the ID.

GETHARDVER

Instructs the driver to send back the version number of its hardware. The parameter is always 0. The answer contains the hardware version number. The format of the answer is: 0x000000<major><minor><revision>. In other words, one byte for each of the three elements of the version number.

As example, version 1.2.3 has the parameter 0x000000010203.

GETSOFTVER

Instructs the driver to send back the version number of its firmware. The parameter is always 0.

The answer contains the software version of the recipient. The format of the answer is: 0x000000<major><minor><revision>. In other words, one byte for each of the three elements of the version number.

As example, version 2.3.4 has the parameter 0x000000020304.

GETSERIAL

Instructs the driver to send back its serial number. If 0 is sent as parameter, the answer contains the number of (ASCII) digits of the serial number; otherwise the respective position of the serial number is sent in ASCII format.

GETIDSTRING

Instructs the driver to send back its name. If 0 is sent as parameter, the answer contains the number of digits of the string, otherwise the respective position of the serial number is sent in ASCII format.

Commands for the Driver

The following table contains a list of the commands which the LDP-CW supports in addition to the generally applicable commands. An explanation of the individual commands and its parameters follows afterwards.

Command	Sent Frame		Received Frame	
	Command	Parameter	Command	Parameter
GETTEMP	0x0001	--	0x0113	16 bit signed integer
GETTEMPOFF	0x0002	--	0x0113	16 bit signed integer
GETTEMPHYS	0x0004	--	0x0113	16 bit signed integer
GETSOLL	0x0010	0	0x0101	32 bit unsigned integer
GETSOLLMIN	0x0011	0	0x0101	32 bit unsigned integer
GETSOLLMAX	0x0012	0	0x0101	32 bit unsigned integer
SETSOLL	0x0013	Refer to description	0x0101	32 bit unsigned integer
GETSOLLEXT	0x0014	0	0x0101	32 bit unsigned integer
GETSOLLLIMIT	0x0015	0	0x0101	32 bit unsigned integer
GETSOLLLIMITMIN	0x0016	0	0x0101	32 bit unsigned integer
GETSOLLLIMITMAX	0x0017	0	0x0101	32 bit unsigned integer
SETSOLLLIMIT	0x0018	Refer to description	0x0101	32 bit unsigned integer
SETSOLLNOSAVE	0x0019	Refer to description	0x0101	32 bit unsigned integer
GETLSTAT	0x0020	0	0x0103	32 bit unsigned integer
GETERROR	0x0021	0	0x0114	32 bit unsigned integer
GETREGS	0x0022	0	0x0105	64 bit value
SETLSTAT	0x0023	Refer to description	0x0103	32 bit unsigned integer
CLEARERROR	0x0024	0	0x0104	0
SAVEDEFAULTS	0x0027	0	0x0112	0

Command	Sent Frame		Received Frame	
	Command	Parameter	Command	Parameter
LOADDEFAULTS	0x0028	0	0x0112	0
GETVCC	0x003A	0	0x0108	16 bit unsigned integer
GETKPMIN	0x0040	0	0x010A	32 bit unsigned integer
GETKPMAX	0x0041	0	0x010A	32 bit unsigned integer
GETKP	0x0042	0	0x010A	32 bit unsigned integer
SETKP	0x0043	Refer to description	0x010A	32 bit unsigned integer
GETKIMIN	0x0044	0	0x010B	32 bit unsigned integer
GETKIMAX	0x0045	0	0x010B	32 bit unsigned integer
GETKI	0x0046	0	0x010B	32 bit unsigned integer
SETKI	0x0047	Refer to description	0x010B	32 bit unsigned integer

Description of the Individual Commands

GETTEMP

The return value contains the actual measured PCB temperature in steps of 0.1 °C.

GETTEMPOFF

The return value contains the over temperature shutdown value in steps of 0.1 °C.

GETTEMPHYS

The return value contains the temperature at which the driver will be re-enabled after an over temperature shutdown. The value is measured in steps of 0.1 °C.

GETSOLL

The return value contains the actual setpoint value in steps of 0.1A.

GETSOLLMIN

The return value contains the minimum setpoint value in steps of 0.1A.

GETSOLLMAX

The return value contains the maximum setpoint value in steps of 0.1A. It is modified by the SETSOLLIMIT command.

SETSOLL

This command sets the current setpoint to the given value in steps of 0.01A. The value must be within the borders defined by the minimum and maximum current values given by the *GETSOLLMIN* and *GETSOLLMAX* command.
The return value contains the actual setpoint value.

GETSOLLEXT

The return value contains the measured and converted value of the external analogue setpoint in steps of 0.01A.

GETSOLLIMIT

The return value contains the actual configured current limiter value in steps of 0.1A.

GETSOLLIMITMIN

The return value contains the minimum current limiter value in steps of 0.1A.

GETSOLLIMITMAX

The return value contains the maximum current limiter value in steps of 0.1A.

SETSOLLIMIT

This command sets the current limiter to the given value in steps of 0.01A. The value must be within the borders defined by the minimum and maximum current values given by the *GETSOLLIMITMIN* and *GETSOLLIMITMAX* command.
The return value contains the actual current limiter value.

SETSOLLNOSAVE

Same as *SETSOLL*, but does not save the new value into the internal EEPROM. The execution time of this command is significantly faster.

GETLSTAT

This command returns the value of the LSTAT register. For a complete description of this register see below.

GETERROR

This command returns the value of the ERROR register. For a complete description of this register see below.

GETREGS

This command returns the value of the LSTAT and ERROR register combined in a single 64bit value. The lower 32 bit represents the LSTAT register, the upper 32 bit the ERROR register.

SETLSTAT

This command sets the LSTAT register to the given value. The return value contains the new register value.

CLEARERROR

This command clears a part of the internal ERROR register. For a detailed description of the ERROR register see below.

SAVEDEFAULTS

This command saves all settings to an internal EEPROM.

LOADDEFAULTS

This command loads previously saved settings into the driver.

GETVCC

The return value contains the actual measured supply voltage in steps of 0.1V.

GETKPMIN

The return value contains the minimum value of the P-controller.

GETKPMAX

The return value contains the maximum value of the P-controller.

GETKP

The return value contains the maximum value of the P-controller.

SETKP

This command sets the value of the P-controller to the given value. The value must be within the borders defined by the minimum and maximum current values given by the *GETKPMIN* and *GETKPMAX* command.

The return value contains the actual value.

GETKIMIN

The return value contains the minimum value of the I-controller.

GETKIMAX

The return value contains the maximum value of the I-controller.

GETKI

The return value contains the maximum value of the I-controller.

SETKI

This command sets the value of the I-controller to the given value. The value must be within the borders defined by the minimum and maximum current values given by the *GETKIMIN* and *GETKIMAX* command.

The return value contains the actual value.

Register Description

Description of the LSTAT Register

The following list contains a description of the individual LSTAT bits. These can be read with GETLSTAT and written with SETLSTAT. With SETLSTAT a complete 32 bit word must always be written. Thus, to change individual bits, first the register must be read out with GETLSTAT, and then the desired bits changed and finally passed back to the LDP-CW with SETLSTAT.

Bit	Name	Read/Write	Meaning
0	L_ON	Read/write	Switch on/off the pulse output. Note that this bit is automatically set high every time the driver is powered on.
1	ISOLL_EXT	Read/Write	When "1" the external setpoint current is used. Only modifiable when ENABLE_OK is "0".
2	ENABLE_OK	Read(/Write)	When bit 6 is set to "1" this bit indicates that the external enable is given. (Read only) When bit 6 is set to "0", this bit determines whether the driver is enabled ("1") or disabled ("0"). (Read/Write)
3	PULSER_OK	Read	Indicates that the driver is in no error condition
4	DEFAULT_ON_PWRON	Read/Write	When "1" the driver will load the default values at each power-up.
5	Reserved	Read	Reserved
6	ENABLE_EXT	Read/Write	Determines whether the driver is enabled via the ENABLE pin of the BOB connector ("1") or via the ENABLE bit in this register("0") Note: Available since version 1.0.5
7	ISOLL_EXT_SCALE	Read/Write	Defines whether the external setpoint voltage ranged from min ... max current ("0") or from zero to max ("1") Note: Available since version 1.0.12
8-31	Reserved	Read	Reserved

Description of the ERROR Register

The following list contains a description of the individual bits in the ERROR register. Is the bit a “1” it will deactivate the unit output.

The Bits 5 and 7 are set during the power on self test. They can not be cleared by the ENABLE pin or the CLEARERROR command. If one of these bits is set, the supply voltage should be switched off and on again. If the error persists, the LDP-CW needs to be repaired.

Bit	Name	R / W	Meaning
0	DRV_OVERTEMP	Read	Indicates an over temperature shutdown of the output stage.
1	DRV_FAIL	Read	Indicates a shutdown of the LDP-CW due to a load failure or an over current.
2	VCC_FAIL	Read	Indicates that the supply voltage is not within safe operation range.
3	CRC_DEVDRV_FAIL	Read	Indicates that the internally stored PLB-21 driver is invalid. The driver can still be used, but it is impossible to download the driver into the PLB-21.
4	CRC_DEFAULT_FAIL	Read	Indicates that the internal default registers are corrupt. The default values should be re- saved.
5	CRC_CONFIG_FAIL	Read	Indicates that the internal configuration register is corrupt. If this error persists, the LDP-CW needs to be repaired.
6	Reserved	Read	Reserved
7	CRC_CAL_FAIL	Read	Indicates that the internal calibration registers are corrupt. If this error persists, the LDP-CW needs to be repaired.
8	FAILED_TO_LOAD_DEFAULTS	Read	Indicates that the last attempt to load the default values failed.
9	TEMP_OVERSTEPPED	Read	Indicates that the maximum operating temperature was overstepped.
10	TEMP_HYSTERESIS	Read	Indicates that the driver is cooling down after an overtemperature shutdown. The driver cannot be re-enabled until this bit flips back to “0”.
11	TEMP_WARNING	Read	Indicates that the operation temperature is near the shutdown temperature.
12	ENABLE_DURING_POWERON	Read	Indicates then the ENABLE pin of the BOB connector was high during power-on. Only valid if ENABLE_EXT the LSTAT register is set to “1”

Bit	Name	R / W	Meaning
13	ENABLE_DURING_ENCHANGE	Read	Indicates that the ENBLE pin of the BOB connector was high while setting ENABLE_EXT to “1” in the ENABLE register.
14	PID_MAX_ERROR	Read	This indicates that the internal PI controller has reaches its maximum duty cycle and was unable to reach the programmed setpoint current. Check if the load is connected properly and the compliance voltage is 5 volts lower than the supply voltage. Note: Available since version 1.0.17
15	IIST_ERROR	Read	This indicates that the output current was outside safe areas. This may happen if the supply voltage can not deliver enough power or if the PI values are wrong. Note: Available since version 1.0.17
16-31	Reserved	Read	Reserved