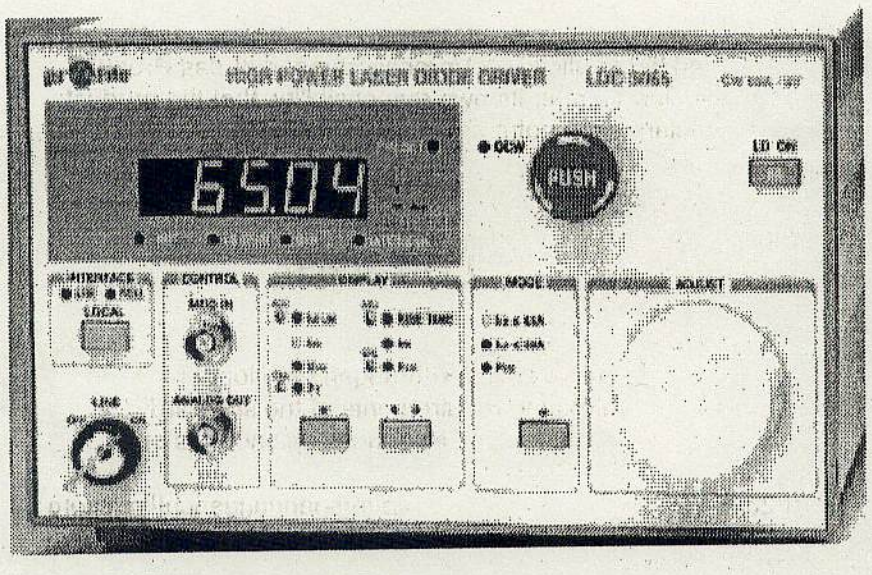
Operation Manual

Driver for high power diode lasers

LDC 3065



1999

Konformitätserklärung
Declaration of Conformity
Declaration de Conformité

Profile GmbH
Gaußstrasse 11
85757 Karlsfeld/München
Germany

erklärt in alleiniger Verantwortung, daß das Produkt:
declares under its own responsibility, that the product:
déclare sous notre seule responsabilité, que le produit:

LDC 3065

mit den Anforderungen der Normen
fulfills the requirements of the standard
satisfait aux exigences des normes

73/23/EWG 93/68/EWG GSG, 1.GSGV	Niederspannungsrichtlinie vom 19.02.1973
89/336/EWG EMVG DIN EN 50081-1 DIN EN 50082-1 DIN EN 61010-1	Elektromagn. Verträglichkeit vom 03.05.1989 (Sicherheitsbestimmungen für Meß- Steuer- Regelgeräte 3.94/5.96/11.98)

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and therefore corresponds to the regulations of the directive.
et répond ainsi aux dispositions de la directive.

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Contents

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to come up to your expectations and develop our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Profile Optische Systeme GmbH

This part of the instruction manual contains every specific information on how to operate a temperature module LDC 3065. A general description is followed by explanations of how to operate the unit manually. You will also find every information about remote control via the IEEE 488 or RS 232C computer interface.

☝Attention☝

This manual contains "WARNINGS" and "ATTENTION" label in this form, to indicate dangers for persons or possible damage of equipment.

Please read these advises carefully!

NOTE

This manual also contains "NOTES" and "HINTS" written in this form.

1 General description of the unit

1.1 Safety

☝ Attention ☝

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly.

Before applying power to your LDC 3065 system, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth contact of the socket outlet! Improper grounding can cause electric shock with damages to your health or even death!

The unit must only be operated with duly shielded connection cables.

Only with written consent from Profile may changes to single components be carried out or components not supplied by Profile be used.

This precision device is only dispatchable if duly packed into the complete original packaging including the plastic form parts. If necessary, ask for a replacement package.

The LDC 3065 must not be operated in explosion endangered environments!

☝ Attention ☝

High power laser modules can deliver up to several 100W of (maybe) invisible laser radiation!

When operated incorrectly this can cause severe damage to your eyes and health!

Be sure to pay strict attention to the safety recommendations of the appropriate laser safety class!
This laser safety class is marked on your external laser source used.

☝ Attention ☝

Mobile telephones, handy phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to EN 50 082-1.

To guarantee a safe operation of the LDC 3065 the ventilation slots beneath the front panel and the fan air outlet at the back panel must always be kept free of obstacles.

1.2 Warranty

Profile GmbH warrants material and production of the LDC 3065 modules for a period of 24 months starting with the date of shipment. During this warranty period *Profile* will see to defaults by repair or by exchange if these are entitled to warranty.
For warranty repairs or service the unit must be sent back to *Profile(Germany)* or to a place determined by *Profile*. The customer will carry the shipping costs to *Profile*, in case of warranty repairs *Profile* will carry the shipping costs back to the customer.
If no warranty repair is applicable the customer also has to carry the costs for back shipment.
In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Profile warrants the hard- and software determined by *Profile* for this unit to operate fault-free provided that they are handled according to our requirements. However, *Profile* does not warrant a faulty free and uninterrupted operation of the unit, of the soft- or firmware for special applications nor this instruction manual to be error free. *Profile* is not liable for consequential damages.

Restriction of warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient conditions stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. *Profile* does explicitly not warrant the usability or the economical use for certain cases of application.

Profile reserves the right to change this instruction manual or the technical data of the described unit at any time.

1.3 Features

The LDC 3065 especially excels in

- the universal possibilites of connecting components
- high operating comfort due to its compact construction
- extensive protections for the laser
- the possibility to drive two lasers in series at the same time
- support of high-power thermopile detectors
- CW mode with modulation input up to 10 kHz
- QCW mode with separate trigger input
- Interlock for automatic switch-off by an external control signal (e.g. cooling loop monitoring)
- Emergency-switch for manual switch-off in case of failure of the cooling loop
- LabVIEW®- and LabWindows/CVI® instrument drivers.

Please refer to our homepage http://www.profile-optsys.com for latest driver updates.

1.3.1 Protections for the laser diode

- **Key-operated power switch**
  Prevents unauthorized operation of the laser diode.

- **Softstart**
  The switch on delay of the softstart function protects the laser diode against undesired peaks. The rise time of this current ramp can be set with a 25-turn potentiometer installed at the front panel.

- **Limit for the injection current (hardware limit)**
  A manually adjustable current limit limits the maximum allowed laser current. The limit value is set with a 25-turn potentiometer at the front panel.

- **Interlock**
  The interlock input can realize several protection functions simultaneously.
  - Safety lock to prevent unintentional use
  - Cable damage monitoring
  - An additional Emergency switch may be connected
  - Application of external automatic protection equipment, e.g. for the temperature of the cooling water
  - ON/OFF LED of the laser diode

The laser can only be operated with the interlock input closed.

(Refer to chapter 1.8.3, "Using the interlock input" starting on page 15)

- **Emergency-switch**
  An emergency switch at the front of the unit allows immediate manual reaction to critical situations e.g. failure of the cooling loop.

- **Contact protection of the laser diode (open circuit)**
  If the line to the laser should be interrupted for a short time during operation an emergency switch off is released immediately.

- **Electronic short-circuit switch for the laser diode**
  With the current module switched off an electronic short-circuit switch will shortcircuit the laser diode so that no voltage is applied to the laser contacts.

- **Control LED for laser current being active**
  When the laser current is switched on an LED lights up in the switch LD ON.

- **Over-temperature protection**
  The LDC 3065 has an automatic over-temperature protection in case the allowed internal operation temperature of the LDC 3065 is exceeded. In this case the output is switched off and after temperature decay of about 10 °C the output current of the LDC 3065 can be switched on again.

- **Defined states after switch-on**
  When switching on the LDC 3065 with the mains switch the laser current output is always switched off. The LDC 3065 will always wake up in constant current mode (30 A range).

- **Mains filter**
  Protection against line failures and transients.

- **Line failure monitoring**
  In case of line failure/line interruption the LDC 3065 will wake up anew as if it has been switched on. So the laser output is switched off.

1.4 Technical data

General Data	
Line Voltage	90 ... 254 V
Line frequency	50 ... 60 Hz
Operating temperature	0 ... + 40 °C
Storing temperature	- 40 °C ... + 70 °C
Warm up time for rated accuracy	≤ 10 min
Weight	< 10 kg
Dimensions	220 x 132 x 351 mm
Current control	
Range of laser current I_{LD}	0 ... 30A / 65 A
Compliance voltage	> 5 V
Rise / fall times (QCW)	≤ 50 µs
Resolution	10 mA
Setting accuracy	± 100 mA
Noise without ripple (10 Hz ... 10 MHz, rms)	< 100 mA
Transients	≤ 500 mA
Drift (30 min. 0 ... 10 Hz)	< 20 mA
Temperature coefficient	≤ 50 ppm/°C
Power control	
Control range	0.5 ... 100 W
Resolution (power)	10 mW
Setting accuracy	± 0.1 W
Measurement range (photo current)	0 ... 20 mA
Resolution (photo current)	0.1 mA
Input voltage (thermopile)	0 ... 20 mV
Current limit	
Setting range poti I_{LIM}	0 ... > 65 A
Resolution	10 mA
Accuracy	± 300 mA

Analog modulation input	
Input impedance	10 kΩ
3 dB Bandwidth	DC ... 6 kHz
Laser diode modulation coefficient (CC)	6.5 A/V±5%
Laser voltage	
Measurement principle	4-wire
Measurement range	0 ... > 5 V
Resolution	1 mV
Accuracy	± 10 mV
Analog control output	
Load resistance	≥ 100 kΩ
Modulation coefficient	0.15 V/A±5%
Computer Interface	
Setting resolution	16 Bit
Measurement resolution	12 ... 19 Bit[1)]

1 depending on the oversampling rate

1.5 Operating elements on front panel

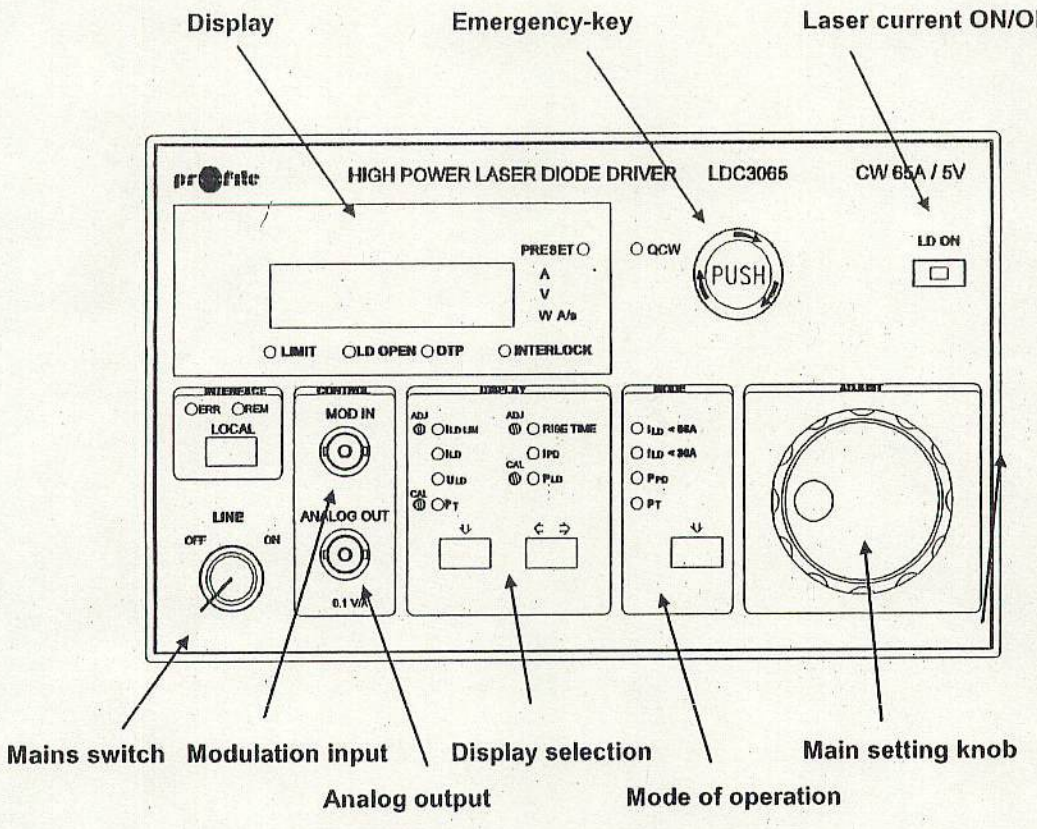


Figure 1 Operating elements on front panel

Line	Key operated power switch
Interface	Change between remote and local
LED Display	4 ½ digit display and 9 LED's
Mode	Select operation mode
Adjust	Main tuning knob
Display	Select the value to be displayed
Control	Modulation in / analog out BNC-jacks

Emergency switch and laser on/off switch

1.6 Operating elements on back panel

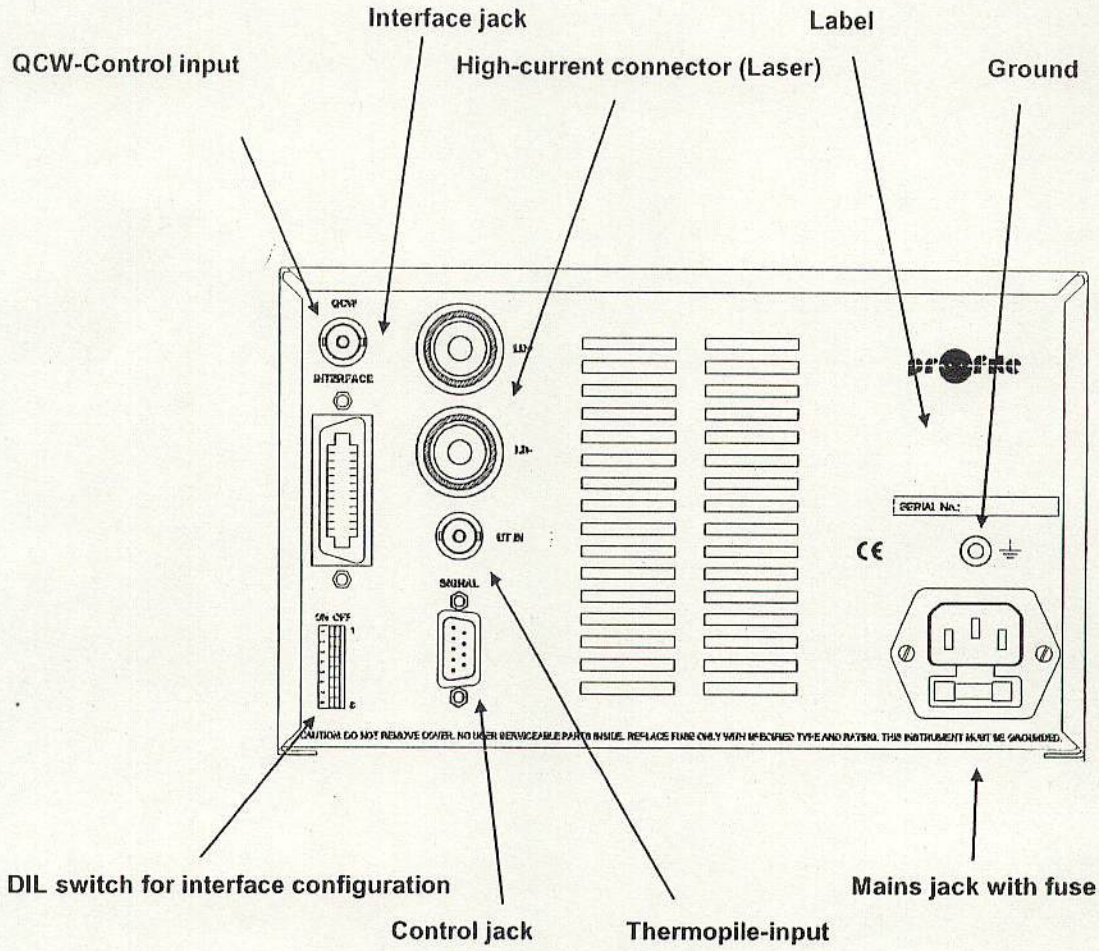


Figure 2 Operating elements on back panel

The rear panel of the laser diode controller LDC 3065 contains the mains connector with fuse, the control jack (9pin D-SUB), the QCW control input (BNC), the thermopile input (BNC) as well as the two high-current jacks to connect the high-power laser diode.

If the laser diode controller LDC 3065 is equipped with the IEEE488 interface (option IEEE488-3065) there is an additional 8 step DIP switch to set the IEE 488 device address and terminator as well as the 24pin IEEE488 jack.

If the laser diode controller LDC 3065 is alternatively equipped with the RS232C-interface (option RS232C-3065) there is an additional 8 step DIP switch to set the transmission parameters as well as a 9pin D-sub jack.

1.7 Pre-settings

1.7.1 Setting the limit value of the laser current

To protect the high power diode laser the maximum possible current at the output of the LDC 3065 can be limited.

This hardware limit is set with the 25-turn potentiometer marked $I_{LD\ LIM}$ at the front of the LDC 3065 an can be measured continuously on the display. Therefore the display $I_{LD\ LIM}$ must be selected.

1.7.2 Switch on rise time

When the laser current is switched on it will rise slowly to its set value with a defined rise time.

The rise time will prevent damage to the laser diode caused by parasitical inductivities (causing transients) in the setup during switch on.

The LDC 3065 allows to adapt the rise time (current ramp) to the setup in a range of about. 1 A/s to 100 A/s.

The rise time is set with the 25-turn potentiometer marked "RISE TIME" at the front of the LDC 3065 and can be read continuously on the display. Therefore the display parameter "RISE TIME" must be selected.

1.8 Connecting components

1.8.1 Pin assignment of the 9pin D-sub control jack

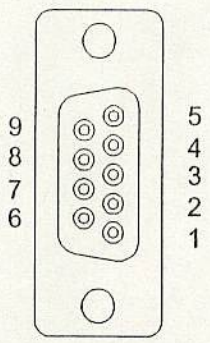


Figure 3 Pinning of the 9-pin D-SUB jack

Pin	Connector
	Interlock
1	Active output interlock
5	Ground interlock

(For using the interlock please refer to chapter 1.8.3, "Using the interlock input" starting on page 15)

Monitor diode	
2	Monitor diode negative pin. (mostly anode)
3	Measurement ground
4	Monitor diode positive pin. (mostly cathode)
7	Positive pin for the bias voltage of the monitor diode
8	Negative pin for the bias voltage of the monitor diode
	Measurement input for the laser diode voltage
9	Laser diode anode
6	Laser diode cathode

1.8.2 Connecting the laser diode

Estimating the voltage drop in the connecting cables
• Per meter of 6 mm^2 copper wire at 65A about 0.2 V will drop. This amounts to about 0.8 V in case of a cablelength of 2 meters. • For every cable shoe / spiral contact a further voltage drop of 0.1 V should be considered.

NOTE

The LDC 3065 can drive all high power diode lasers with grounded anode. As the output current is negative in technical sense a negative voltage at the laser diode will built up in relation to ground.

The high currents of up to 65 A set high demands to the wiring and contacting. Therefore we give some hints here to guarantee a reliable operation of the laser diode.

- All contacts must be heavy duty types and should to be screwed down if possible to keep voltage drops at the junctions as low as possible. **This is of special interest if two laser diodes are operated in series with the LDC 3065 since the maximum compliance voltage at the 6 mm high-current jacks is only 5 V.**
- To protect the laser diodes please ensure that the cables are connected vibration and shock proof.
- To connect the LDC 3065 only the matching 6 mm high-current banana connectors must be used. On request you can get these individual from *Profile*.
- The cable should be made of copper band.
- The cross section must be at least 6 mm^2 everywhere.
- In CW mode the cable must not be longer than 2 meters.
- When operating two laser diodes in series the connection cable must be respectively shorter if the voltage drop gets too high.

Modulation or QCW mode

- If the cable is not coaxial the length of the cable must not be more than 50 cm.
- If the cable is coaxial the length of the cable must not be more than 2 m.

Using the connection cable CAB 3000-30 (option)

By means of this special coaxial cable of 2 meters length the laser diode can be connected to the LDC 3065 quite easily. The two 6 mm high-current banana jacks are inserted in the respective jacks at the rear of the LDC 3065. At the other side of the cable there are cable shoes for M6 scews which must be screwed to the laser contacts in a suitable way.

1.8.3 Using the interlock input

The interlock consists of two pins that have to be connected (closed) in operation.

These are pin 1 and pin 5 of the 9 pin D-SUB jack at the rear of the unit.

If the two pins are not connected (Interlock loop open) the laser cannot be switched on.

Furthermore a red LED "INTERLOCK" on the front panel of the LDC 3xx will indicate the interlock to be open.

Should the interlock open with the laser switched on there will be an acoustic signal and the laser is switched off immediately.

It is possible to connect several switches in series to the interlock pins setting up a closed loop that can be opened by each switch. Thus different protective functions can be realized simultaneously via the interlock.

1.8.3.1 Examples of various protective functions

Emergency key at the front panel of the LDC 3065

The emergency key at the front is internally switched in series with the interlock. So the emergency key is always part of the interlock loop.

External Emergency key in the lab

An external emergency key (opener) is connected to the two pins of the interlock or in series to other interlock switches.

Temperature control

Sometimes you may want to monitor the cooling loop of a high-power diode laser. A suitable setup offers a switch that will open in case of an error.

If only a certain temperature range is to be monitored a suitable (fast) thermo switch can be used.

This switch (opener) is connected to the two pins of the interlock.

Safety-door monitoring

If the laser is to be operated in a closed setup (lab) a switch can be installed in a suitable position interrupting when the setup (lab-door) is opened.

This switch (opener) is connected to the two pins of the interlock.

Cable damage monitoring

If the interlock line is led in parallel to the laser current line a cable damage monitoring may be realized as well.

An interruption of this line will open the interlock.

Laser ON/OFF-Display

The interlock can also be closed with a red LED with anode to pin 1 and cathode to pin 5. The current is about 7 mA this will make any commercially available LED light up.

This LED (only one LED is allowed) may be looped in at any point into the interlock line and may thus serve as an independent ON/OFF display.

1.8.4 Connecting the monitor diode

(Refer to chapter 1.8.1, "Pin assignment of the 9pin D-sub control jack" on page 12)

We recommend to use "twisted pair" wiring for the monitor diode current, bias voltage and laser voltage measurement respectively in a common shield. The shield must be connected to ground (pin 3).

If an external monitor diode is used it must be connected via coaxial cable with the outer conductor to pin 2 and the inner conductor to pin 4.

The monitor diode input is realized as transimpedance amplifier with virtual ground (input impedance 0 Ω). The two pins are floating i.e. they are not in direct connection to the laser diode ground. The common voltage against ground must not exceed ± 5 V. It is allowed to connect any pin of the monitor diode to the laser diode ground.

Should this be necessary (e.g. with laser diodes with integrated monitor diode and common ground) the connection of the ground lines should be done as near as possible to the laser diode to avoid measurement errors in measuring the monitor diode current.

The monitor diode input may be used without or with bias voltage (5 V) depending on the connection of the monitor diode to the 9pin D-sub jack.

1.8.5 Possibilities to connect the photodiode

Monitor diode floating

Anode	on	pin 2
Cathode	on	pin 4

Monitor diode anode grounded

Anode	on	pin 2 and laser diode ground
Cathode	on	pin 4

Monitor diode cathode grounded

Anode	on	pin 2
Cathode	on	pin 4 and laser diode ground

Monitor diode floating with bias 5 V

Anode	on	pin 4
Cathode	on	pin 7
		connect pin 2 with pin 3

Monitor diode anode grounded with bias 5 V

Anode	on	pin 3 and laser diode ground
Cathode	on	pin 2
		connect pin 4 with pin 7

Monitor diode cathode grounded with bias 5 V

Anode	on	pin 4
Cathode	on	pin 3 and laser diode ground,
		connect pin 2 with pin 8

1.8.6 Connecting a thermopile detector

With the LED 3065 thermopile detectors can be used to show the optical power of the laser diode.

A thermopile detector converts the optical signal into a proportional voltage. This voltage is in the mV range.

The thermopile input at the rear side of the LDC 3065 is a high impedance input voltage amplifier. The allowed input voltage range is from 0 ... 25 mV.

1.8.7 Laser voltage measurement

(Refer to chapter 1.8.1, "Pin assignment of the 9pin D-sub control jack" on page 12)

The LDC 3065 constantly measures the laser voltage at the output jacks of the unit. For a precise measurement connect pin 6 directly to the LD-cathode and pin 9 directly to the LD-anode to avoid measurement errors due to the voltage drop on the high current wiring (4 pole measurement).

We recommend to use twisted pairs of lines for monitor diode current, bias voltage and laser voltage measurement respectively in a common shield. The shield must be connected to ground (pin 3).

1.8.8 Modulation input

At the modulation input (BNC jack) a modulation signal can be fed in.

(Refer to chapter 2.4, "Modulation" on page 30)

1.8.9 Analog output

The laser current can be monitored at the front jack ANALOG OUT showing the laser current in a proportional voltage. The bandwidth of this output is high enough to show the laser current exactly in its actual course of time.

The transmission coefficient of this output is 0.15 V / A.

The shape of the output signal of the LDC 3065 is limited by the bandwidth and the rise time of the laser output. This may lead to deviations in the shape of the signal at the control input and at the control output.

2 Operating the LDC 3065

2.1 General description

Attention

Prior to switch on your LDC 3xx please check if the line voltage set with the voltage selector at the rear panel corresponds to your mains voltage!

The high-power diode laser is operated unipolar with respect to ground (anode to ground). This is of advantage regarding stability of the laser current, noise and RF interferences.

A fixed adjustable hardware limit limits the maximum obtainable laser current to be reached in each operating mode.

Two current ranges offer a maximum resolution of the laser current for all common high-power diode lasers.

The monitor diode input is a transimpedance amplifier (input impedance 0 Ω) thus making it possible to use any photodiode as monitor diode. Both polarities of the monitor diode are allowed. The monitor diode may either be operated photovoltaic (without bias voltage) or photoconductive, i.e. with bias voltage (U_{BIA} = 5V). The operation mode is defined by the wiring of the monitor diode input.

The thermopile input operates with positive input voltage and is specified for a voltage range from 0 ... 20 mV.

All settings are possible by the operating elements of the LDC 3065.

There are 25-turn potentiometer to set:

- the limit value for the laser diode current (hardware limit)
- the rise time when switching on the laser current
- the coefficient η (sensitivity in mW / mA) of the monitor diode (calibration of the power display in operation with a monitor diode)
- the sensitivity (in mW / mV) of the thermopile detector (calibration of the power display in operation with a high-power thermopile detector)

These values cannot be changed by the control PC. If for example the optical power at a preset laser diode current is requested a value is read out that has been calculated for the sensitivity of the monitor diode out of the moniitor diode current and the respective potentiometer position.

Constant current mode

In constant current mode the laser diode current is kept constant.

(Refer to chapter 2.2, "Using constant current mode" starting on page 29)

Constant power mode

In constant power mode the optical output power is kept constant.

(Refer to chapter 2.3, "Using constant power mode" 29)

2.1.1 Display

The display section consists of a 4 ½ digit LED-display and 9 LEDs

The display shows continuously the value selected in the field"Display selection".

If the shown value is a set value (i. e. the laser current with the output switched off) this is indicated by the LED "PRESET".

If the shown value is a measurement value (e.g. laser current with the output switched on) the LED "PRESET" will not light up.

Four LEDs show the unit of the selected value (A, V, W and A/s) and four LEDs indicate possible errors:

LIMIT lights up if a limit value is reached

LD OPEN lights up if the wiring to the laser is interupted with the laser switched on or if the compliance voltage is to low (i. e. driving two lasers in series requiring more than 5V at the 6mm output jacks or too high path resistance)

(In this case please refer to chapter 1.8.2, "Connecting the laser diode" on page 13)

OTP lights up if the internal temperature of the LDC 3065 is too high. Please wait until the LED extinguishes. Then the LDC 3065 can be operated again.

INTERLOCK lights up if the interlock loop is open or if the emergency button is not unlocked.

2.1.2 Selecting the value to be displayed

Seven different values can be displayed. The value is selected with the buttons " " and "⇐ ⇒" in the field "DISPLAY":

- Laser diode limit current $I_{LD\ LIM}$
- Laser diode current I_{LD}
- Laser diode voltage U_{LD}
- Optical power measured with an external thermopile detector P_T
- Rise time when switching the output on RISE TIME
- Monitor diode current IP_D
- Optical power measured with the monitor diode P_{LD}

2.1.3 Adjusting the hardware limit

(Please refer to chapter 1.7.1, "Setting the limit value of the laser current" on page 11)

2.1.4 Adjusting the rise time

(Please refer to chapter 1.7.2, "Switch on rise time" on page 11)

2.1.5 Emergency key

In case of danger for the laser diode (e.g. sudden failure of the water cooling system) a hit on this key switches off the laser current immediately.

First the key has to be armed by turning it about 30° clockwise. It snaps out and is active now.

When hit the key interrupts the interlock loop which is indicated by the interlock LED. The laser is immediately switched off and cannot be switched on again since the emergency key must first get armed again.

2.1.6 Tuning knob

This 10-turn setting knob allows to change the set values or actual values for laser current, monitor current or optical power according to operating mode and on/off status.

If the laser current is switched off the LED "PRESET" lights up. The set value of the selected parameter is displayed.

If the laser current is switched on the LED "PRESET" remains off. The actual value of the selected parameter is displayed.

2.1.7 Mains switch

With the mains switch (key-operated power switch) the LDC 3065 is switched on and off.

NOTE

Do not switch off the unit with the key-operated power switch if the laser current is still switched on!

2.1.8 Select the mode of operation

Two modes of operation can be selected

- Constant current mode with 30 A or 65 A full scale
- Constant power mode using a monitor diode

A corresponding LED indicates the selected mode.

2.1.9 Adjusting the power display using a monitor diode

In the field "DISPLAY" a 25-turn potentiometer marked "CAL" next to the LED P_{LD} serves to calibrate the power display in operation with a monitor diode.

The potentiometer determines which optical power corresponds to which monitor current. The setting range is from 0 W/mA to about 10 W/mA.

Adjustment

During the whole procedure the laser remains switched off.

First select the operating mode P_{PD} and the display I_{PD} at the LDC 3065.

The datasheet of the laser diode gives you the maximum optical output power and the according monitor current. Eventually you must calculate one value using the monitor diode efficiency (parameter η).

Now set the pre-set value for the monitor current to this value.

Finally change to the display P_{LD} so that the power belonging to the set monitor diode current is shown. Use the potentiometer CAL to adjust the display to the corresponding power value.

2.1.10 Power display with thermopile

In the field "DISPLAY" a 25-turn potentiometer marked "CAL" next to the LED P_T serves to calibrate the power display in operation with a thermopile detector.

The potentiometer determines which detector voltage corresponds to which optical power. The setting range is from 0 W/mV to about 8 W/V.

Adjustment

You need:

- A digital millivoltmeter
- A suitable BNC-T adapter connected to the millivoltmeter

Connect the thermopile to the millivoltmeter and the millivoltmeter to the LDC 3065 thermopile input. This allows a precise measurement of the thermopile voltage.

Select the operating mode I_{LD} (30 or 65A, depending on the laser), select a laser current in the upper allowed power range of the laser and switch on the laser current. Then point the laser beam to the thermopile detector.

Before switching on please set an appropriate laser current limit!
(refer to chapter 1.7.1, "Setting the limit value of the laser current" on page 11)

The voltage measured by the millivoltmeter can now be related to the equivalent optical power (refer to the data sheet of the thermopile detector).

Change to display P_T and use the potentiometer "CAL" to adjust the displayed value to the calculated optical power.

2.1.11 Laser current ON/OFF (LD ON)

This key switches the laser current on or off. When the LDC 3065 is powered up with the mains switch this switch is always in position OFF to prevent the laser to be activated inadvertedly.

The laser current cannot be switched on if

- the interlock loop is not closed
- the emergency key is not armed
- the LDC 3065 is overheated (display OTP)
- no laser is connected (display LD OPEN when trying to switch on)

In these cases a try to switch on is denied by a short beep.

☝ Attention ☝

Before switching on the laser current first set the laser diode current limit $I_{LD\,LIM}$ (hardware limit) for the applied laser diode with a screw-driver.

The corresponding potentiometer is marked $I_{LD\,LIM}$ and is situated at the front panel of the LDC 3065.

2.2 Using constant current mode (CC)

In constant current mode the laser diode current is kept constant. Thermal changes in the active zone of the laser lead to a change of the output power due to changed efficiency and to a change in central wavelength.

Attention

If in constant current mode the laser is cooled down during operation the efficiency of the laser will increase. With some types of lasers this may cause the optical output power to exceed the allowed range and lead to a permanent damage of the laser.

2.3 Using constant power mode (CP)

In constant power mode the current in the monitor diode which corresponds to the optical output power is kept constant. Thermal changes of the active zone of the laser do not result in a change of the output power however a change of the central wavelength occurs.

Attention

If using a laser bar or laser stack some lasers fail in constant power mode the laser current may be increased more and more without being noticed. Thus the current through the remaining lasers may exceed the maximum allowed value and lead to more and faster destruction. Therefore we urgently recommend to set the limit value for the laser current carefully.

NOTE

For "constant power" mode a monitor diode is required.

2.4 Modulation

2.4.1 Modulation of the laser current

The laser diode controller LDC 3065 has an input to modulate the laser diode current in constant current mode.

As the internal set value for the laser diode current is modulated all protective circuits remain active (!).

The modulation input is designed for input voltages between -10V ...+10V and specified for small signal operation. In large signal operation the 3 dB bandwidth of 6 kHz is not quite reached.

Commonly you select a DC current with the main dial knob and modulate this current via the modulation input. Please note that this DC current and the modulation current are added so you must use a modulation voltage without DC share!

The modulation coefficient is 6.5 A / V.

NOTE

Overmodulation is defined as producing a **set value** for the laser diode current of below 0 A, above the limit value or above 65 A.

To gurantee a proper operation of the LDC 3065 please avoid overmodulation because it can lead to overshoots in laser current.

If you are uncertain please try with a high current rectifier instead of the laser diode and supervise the analog output. You should never see overshoots!

2.4.2 QCW mode with TTL trigger input

The LDC 3065 has a trigger input to pulse the laser diode current.

If this input is used the LED "QCW" will light up. A trigger signal at the input is automatically detected.

The rise and fall times that can be reached depend on the length of cables and number of laser diodes. Typical times are between 30 - 60 µsec.

3 Communication with a control computer

NOTE

The following operating elements are still working under remote control:

- The display
- The display selection
- All potentiometers exept the main dial knob

NOTE

All analog values are read and written in SI units i.e. A (not mA), W (not mW) etc. Letters may be written in small or capital letters.

☝ Attention ☝

Before programming a LDC 3065 first set the limit value of the laser diode current $I_{LD\,LIM}$ (hardware limit) for the applied laser diode with a screwdriver.

The corresponding potentiometer is marked ADJ and located next to the LED $I_{LD\,LIM}$ situated at the front of the LDC 3065.

The value $I_{LD\,LIM}$ is constantly measured and can be checked in the $I_{LD\,LIM}$ display.

3.1 RS232 Interface

The RS232 interface fulfils the IEEE1174 standard for programmable instruments.

3.1.1 Interface specifications

Electrical characteristics	EIA RS232C
Connector	9pin DSUB (male)
Communication	Full duplex
Baud rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Start bit	1 bit
Stop bit	1 bit
Data lenght	8 bit
Parity	No parity
Handshaking	RTS/CTS, XON/XOFF
Receive buffer lenght	256 bytes
String Terminator	LF (ASCII 0AH)

3.1.2 Setting up the Interface

The communication parameters are selected with the DIP switch of the interface card (right below the RS232 connector) at the rear panel.

Select the baud rate by setting SW1 to SW3 according to the following table:

Baud rate	SW3	SW2	SW1
1200	Off	Off	Off
2400	Off	Off	On
4800	Off	On	Off
9600	Off	On	On
19200	On	Off	Off
38400	On	Off	On
57600	On	On	Off
115200	On	On	On

Select the handshake protocol by setting SW4:

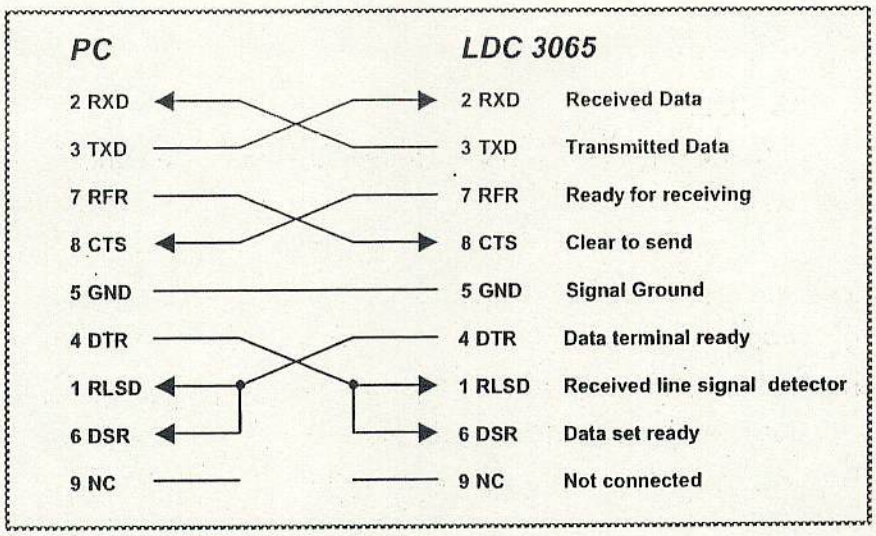
Handshake	SW4
RTS/CTS	Off
XON/XOFF	On

NOTE

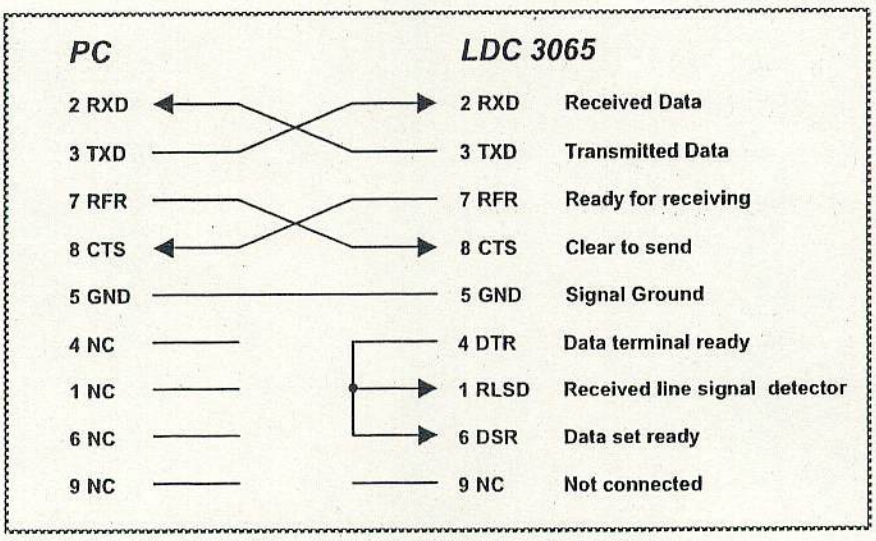
The communication parameters are only valid after switching the unit off and on again.

3.1.3 Connecting the control computer

The control computer and the LDC 3065 are connected via 9pin D-SUB nullmodem cable with the following pinning.



If your control PC does not support DSR/DTR signalling you have to use a nullmodem cable which is connected like shown below.



NOTE

If you use a cable without DSR/DTR signalling the LDC 3065 will not switch to LOCAL mode after disconnecting the cable.

3.1.4 Emulating the IEEE488 bus commands

As the RS232 interface does not offer hardware control lines like the IEEE488 bus the according IEEE488 bus command are emulated by specials commands.
(Please refer to chapter 3.2.4, "IEEE488 bus commands" starting on page 42)

Device clear

Syntax: `"&DCL"`

Clears the input buffer and output queue. Resets the parser unit and the execution unit

Go to local

Syntax: `"&GTL"`

Description: Returns the LDC 3065 into LOCAL mode. The previously set values for laser current, laser power etc. will be no more valid.
The set values are determined by the main dial knob.

Local lockout

Syntax: `"&LLO"`

Description: Disables the 

button. Switching back into LOCAL mode (manual operation) is only possible with the command `"&GTL"`.

Poll Status-byte

Syntax: `"&POL"`

Description: Reads the status byte and clears bit 6 (MSS). This command is used to emulate a service request.

3.1.5 Service request emulation

To get the instruments status byte asynchronously the service request sequence is used:

- In case the device needs a service request, it will send `[&SRQ]` to the PC.
- Now the PC should query the status byte with `"&POL"`.
- The device will then answer with `[&nnn]`, where `nnn` represents the status byte in decimal notation.

(Please refer to chapter 3.9, "Status reporting" starting on page 66)

3.2 IEEE488 Interface

The IEEE488 interface of the LDC 3065 is based on the IEEE488.2 standard. This includes the IEEE488.1 standard for the hardware settings. There is a standard 24pin IEEE488 jack at the rear of the unit. The address of the LDC 3065 must differ from that of other devices at the IEEE488 bus.

(Please refer to chapter 3.2.2, "Setting up the interface" starting on page 39)

3.2.1 IEEE 488 interface subsets

Function	Part set
Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T6
Listener	L4
Service Request	SR1
Remote/Local	RL1
Parallel Poll	PP0
Device Clear	DC1
Device Trigger	DT0
Electrical Interface	E1

3.2.2 Setting up the interface

Address

The device address of the LDC 3065 can be changed by means of the IEEE488 DIP switch on the back side of the LDC 3065. SW1 to SW5 have to be set according to this table:

Address	SW5	SW4	SW3	SW2	SW1
0	Off	Off	Off	Off	Off
1	Off	Off	Off	Off	On
2	Off	Off	Off	On	Off
3	Off	Off	Off	On	On
4	Off	Off	On	Off	Off
5	Off	Off	On	Off	On
6	Off	Off	On	On	Off
7	Off	Off	On	On	On
8	Off	On	Off	Off	Off
9	Off	On	Off	Off	On
10	Off	On	Off	On	Off
11	Off	On	Off	On	On
12	Off	On	On	Off	Off
13	Off	On	On	Off	On
14	Off	On	On	On	Off
15	Off	On	On	On	On

continued next page

Address	SW5	SW4	SW3	SW2	SW1
16	On	Off	Off	Off	Off
17	On	Off	Off	Off	On
18	On	Off	Off	On	Off
19	On	Off	Off	On	On
20	On	Off	On	Off	Off
21	On	Off	On	Off	On
22	On	Off	On	On	Off
23	On	Off	On	On	On
24	On	On	Off	Off	Off
25	On	On	Off	Off	On
26	On	On	Off	On	Off
27	On	On	Off	On	On
28	On	On	On	Off	Off
29	On	On	On	Off	On
30	On	On	On	On	On or Off

NOTE

The device address is only valid after switching off and on again.

String terminator

The terminator of the LDC 3065 is preset to **<LF><EOI>**. This is fixed and cannot be changed.

The LDC 3065 will accept any combination of **<LF>** and **<EOI>** as terminator.

3.2.3 Connecting the PC

- Connect the LDC 3065 and the PC to the line
- Connect both units with shielded IEEE488 cables
- Switch on all units on the bus and the control computer

To guarantee a safe data transmission the IEEE488 cable between two units should not be longer than 2 meters and the total cable length should not exceed 20 meters.

The LDC 3065 automatically enters REMOTE mode after the first character is transferred to the LDC 3065.

NOTE

Programming the control software will vary with the type of computer, the user interface, the programming language, the interface card used as well as with the driver software and the correspondingly supplied software interfaces. Please refer to the documentation of these components.

(Also refer to chapter 3.10, "Hints for setting up control programs" on page 73)

3.2.4 IEEE488 bus commands

To communicate via the IEEE488 bus the standard control signals [MLA], [MTA], [UNL], [UNT], [ATN], [REN], [SPE], [SPD] are used.

If the control programm for the LDC 3065 is written in a language as e.g. BASIC then these IEEE488 control signals are automatically transmitted to the LDC 3065 according to the used driver software and do not have to be produced explicitly in the control program.

In the LabVIEW®- or LabWindows/CVI®-drivers from *Profile* these functions are also implemented.

The following functions are executed receiving the IEEE488 bus commands **[GET], [LLO], [GTL], [DCL]** and **[SDC]**:

[LLO] Local Lockout

The command **[LLO]** disables the button LOCAL. Return to LOCAL mode (manual operation) is only possible with the command **[GTL]** (see below).

[GTL] Go To Local

The command **[GTL]** returns the LDC 3065 to LOCAL mode (manual operation). The previously set values for laser current, laser power etc. will no more be valid. The set values are determined by the main dial knob.

[DCL] Device Clear

The command [DCL] will switch off the output and will set back all values that are usually set back when switching the unit on.

The LDC 3065 will behave as if it has been switched on anew but will be in REMOTE mode.

NOTE

The command [DCL] sets back all units connected to the IEEE488 bus.

[SDC] Selected Device Clear

The command [SDC] switches the output off and sets back all values that are usually set back when switching the unit on.

The LDC 3065 will behave as if it has been switched on anew but will be in REMOTE mode.

NOTE

In contrast to the command [DCL] the command [SDC] will only set back the device addressed.

3.3 Before Programming

3.3.1 Nomenclature

Program messages (PC LDC 3065) are written in inverted commas:	`"*IDN?"`
Response messages (LDC 3065 PC) are written in brackets:	`[MODE CC]`
There is a decimal point:	`1.234`
Parameters are separated by comma:	`"PLOT 2,0"`

3.3.2 Program and response messages

Blocks of message data are transfered between the controller and the LDC 3065 during communication. Messages sent from the controller to the LDC 3065 are called program messages and messages sent back from the LDC 3065 to the controller are called response messages. If a program message contains a query command i.e. a command which requests a response the LDC 3065 returns a response message.

Program messages

With program messages settings are done (command) at the LDC 3065 and response messages are selected (query). Program messages can be separated by semicolon. All program messages are executed sequentially (one after the other).

Examples:

`":MODE CC"`	selecting the mode "constant current" (command)
`"*IDN?"`	requesting the identification (query)
`":MODE CC;:LASER ON"`	switching the operating mode and the output.

Response messages

With response messages measurement values and status information is transferred to the PC. All response messages are generated when the query (program message) is parsed.

Example:

`[:ILD:ACT 7.123456E+00]` measuring the actual laser diode current

3.3.3 Data format

According to the IEEE488.2 specifications all data variables are divided into 4 different data formats:

Character response data (<CRD>)

Is a single character or a string. Examples:

`A` or `ABGRS` or `A125TG` or `A1.23456A`

(Refer to IEEE488.2-1992 standard, chapter 8.7.1)

Numeric response data Type 1 (<NR1>)

Is a numerical value with sign in integer notation. Examples:

`1` or `+1` or `-22` or `14356789432`

(Refer to IEEE488.2-1992 standard, chapter 8.7.2)

Numeric response data Type 2 (<NR2>)

Is a numerical value with or without sign in floating point notation without exponent. Examples:

`1.1` or `+1.1` or `-22.1` or `14356.789432`

(Refer to IEEE488.2-1992 standard, chapter 8.7.3)

Numeric response data Type 3 (<NR3>)

Is a numerical value with or without sign in floating point notation with exponent with sign . Examples:

`1.1E+1` or `+1.1E-1` or `-22.1E+1` or `143.56789432E+306`

(Refer to IEEE488.2-1992 standard chapter 8.7.4)

3.4 Common commands and queries

The common commands are independent of the instrument's functions and are specified in the IEEE488.2 standard.

3.4.1 Identification query

Syntax: `"*IDN?"`
Response: `[PROFILE, LDC3065, 0, 2.17]`
Description: A reply consists of the following sequence:
<Manufacturer>, <Model>, <Serial No.>, <Firmware version>

3.4.2 Reset

Syntax: `"*RST"`
Description: All set values are reset to the default values. The output is switched off.

3.4.3 Self-test query

Syntax: `"*TST?"`
Response: `[0]`
Description: 0: Self-test finished successfully.

3.4.4 Set Operation-complete bit

Syntax: `"*OPC"`
Description: The LDC 3065 will set the OPC-bit in the Standard-Event-Status-Register.

3.4.5 Operation-complete query

Syntax: "*OPC?"
Response: [1]
Description: 1: Operation completed.

3.4.6 Wait

Syntax: "*WAI"
Description: The LDC 3065 will wait until the last operation is completed.

3.4.7 Event-Status-Enable-Register (ESE)

Programming:
Syntax: "*ESE <NR1>"
Valid Range: 0..255
Default Value: 0
Description: Sets the Event-Status-Enable-Register (ESE).

Reading:
Syntax: "*ESE?"
Response: [<NR1>]
Description: Queries the Event-Status-Enable-Register (ESE) and returns the content in decimal notation. The content is not modified.

3.4.8 Query Standard-Event-Status-Register (ESR)

Syntax: "*ESR?"
Response: [<NR1>]
Description: Queries the Standard-Event-Status-Register (ESR) and returns the content in decimal notation. The content is cleared.

3.4.9 Service-Request-Enable-Register (SRE)

Programming:

Syntax: `"*SRE <NR1>"`

Valid Range: 0..255

Default Value: 0

Description: Sets the Service-Request-Enable-Register (SRE).

Reading:

Syntax: `"*SRE?"`

Response: `[<NR1>]`

Description: Queries the Service-Request-Enable-Register (ESE) and returns the content in decimal notation. The content is not modified.

3.4.10 Query Status-Byte-Register (STB)

Syntax: `"*STB?"`

Response: `[<NR1>]`

Description:Queries the Status-Byte-Register (STB) and returns the content in decimal notation. Bit 6 (MSS) is set to 0 the other bits stay unchanged.

3.5 System command group

3.5.1 Answer mode

Programming:

Syntax: `":SYST:ANSW FULL"`
`":SYST:ANSW VALUE"`

Default Value: FULL

Description: When switched to `"VALUE"` the LDC 3065 will send only the requested parameter without designator.

Example: When requesting the actual laser diode current with `":ILD:ACT?"` the LDC 3065 will only send `[5.123456E+01]` instead of `[:ILD:ACT 5.123456E+01]`. This is **not** according to the IEEE488.2 standard but useful if you want to increase speed.

Reading:

Syntax: `":SYST:ANSW?"`

Response: `[:SYST:ANSW FULL]`
`[:SYST:ANSW VALUE]`

Description: Queries the answer mode.

3.5.2 Error-LED mode

Programming:

Syntax: `":SYST:ERRLED OFF"`
`":SYST:ERRLED ON"`

Default Value: OFF

Description: When switched to `"ON"` the LDC 3065 will switch on the interface ERRor LED as long as there are errors in the error queue. When switched to `"OFF"` the interface ERRor LED will be dark.

Reading:

Syntax: `":SYST:ERRLED?"`

Response: `[:SYST:ERRLED OFF]`
`[:SYST:ERRLED ON]`

Description: Queries the Error-LED mode.

3.5.3 Queriing the error queue

Syntax: `":SYST:ERR?"`

Response: `[0, "No Error"]`

Description: Queries the error queue of the LDC 3065. The reply consists of the following sequence: <Error No.>, "<Error text>". If the error queue is empty: `[0, "No error"]` will response.

(Please refer to chapter 3.8, "Error messages of the LDC 3065" starting on page 61)

3.5.4 Oversampling rate

Programming:

Syntax: `":SYST:OSR <NR1>"`

Valid Range: 0..7

Default Value: 5

Description: Sets the LDC 3065 oversampling rate (see table below).

Reading:

Syntax: `":SYST:OSR?"`

Response: `[<NR1>]`

Description: Queries the oversampling rate.

Sampling rate	Resolution	Measurement speed
0	11 Bit + sign	18 / s
1	12 Bit + sign	13 / s
2	13 Bit + sign	10 / s
3	14 Bit + sign	8 / s
4	15 Bit + sign	6 / s
5	16 Bit + sign	4 / s
6	17 Bit + sign	3 / s
7	18 Bit + sign	2 / s

3.6 Status command group

(Refer to chapter 3.9, "Status reporting"on page 66)

3.6.1 Query Device-Error-Condition-Register (DEC)

Syntax: `":STAT:DEC?"`
Response: `[<NR1>]`
Description: Queries the Device-Error-Condition-Register (DEC) and returns the content in decimal notation. The content is not modified.

3.6.2 Query Device-Error-Event-Register (DEE)

Syntax: `":STAT:DEE?"`
Response: `[<NR1>]`
Description: Queries the Device-Error-Event-Register (DEE) and returns the content in decimal notation. The content is cleared.

3.6.3 Device-Error-Event-Enable-Register (EDE)

Programming:
Syntax: `":STAT:EDE <NR1>"`
Valid Range: 0...65535
Default Value: 0
Description: Sets the Device-Error-Event-Enable-Register (EDE).

Reading:
Syntax: `":STAT:EDE?"`
Response: `[<NR1>]`
Description: Queries the Device-Error-Event-Enable-Register (EDE) and returns the content in decimal notation. The content is not modified.

3.7 LDC 3065 specific commands

3.7.1 Operation mode (MODE)

Programming:

Syntax: `":MODE CC"`
`":MODE CP"`

Assumption: The laser diode output is switched off.

Description: Switches the mode of operation. Sets the laser diode current, the photo diode current and the optical power to default values.

Reading:

Syntax: `":MODE?"`

Response: `[:MODE CC]`
`[:MODE CP]`

Description: Queries the mode of operation.

3.7.2 Reading the modulation mode (QCW)

Syntax: `":QCW?"`

Response: `[:QCW OFF]`
`[:QCW ON]`

Description: Reading "ON" will retun when a modulation signal is applied and the LED "QCW" is on.

3.7.3 Switching the output on and off (LASER)

Programming:

Syntax: `":LASER OFF"`
`":LASER ON"`

Default Value: OFF

Assumption: To switch the output on there must be no device errors (interlock open, open circuit, over temperature, ...).

Description: Switches the laser diode output on or off.

Reading:

Syntax: `":LASER?"`

Response: `[:LASER OFF]`
`[:LASER ON]`

Description: Queries the state of the laser diode output.

NOTE

To switch on the laser with "open circuit" error (see Device Error Condition Register) you have to reset the "open circuit" error with the command: `":LASER OFF"`. With the next command `":LASER ON"` the laser can be switched on again.

3.7.4 Reading the laser diode hardwarelimit (LIMCP)

Syntax: `":LIMCP:ACT?"`
Response: `[:LIMCP:ACT <NR3>]`
Description: Queries the laser diode limit current (adjusted via potentiometer).

(Refer to Chapter 1.7.1, "Setting the limit value of the laser current" on page 11)

3.7.5 Laser diode current (ILD)

Programming:
Syntax: `":ILD:SET <NR3>"`
Valid Range: Depends on the instrument type.
Default Value: 0 A
Assumption: The operation mode is switched to constant current.
Description: Sets the laser diode current. Unit: [A].

Reading the set current:
Syntax: `":ILD:SET?"`
Response: `[:ILD:SET <NR3>]`
Description: Queries the programmed laser diode current. Unit: [A].

Reading the minimum current:
Syntax: `":ILD:MIN?"`
Response: `[:ILD:MIN <NR3>]`
Description: Queries the minimum allowed laser diode current. Unit: [A].

Reading the maximum current:
Syntax: `":ILD:MAX?"`
Response: `[:ILD:MAX <NR3>]`
Description: Queries the maximum allowed laser diode current. Unit: [A].

Reading the actual current:
Syntax: `":ILD:ACT?"`
Response: `[:ILD:ACT <NR3>]`
Description: Queries the actual laser diode current. Unit: [A].

3.7.6 Monitor diode current (IMD)

Programming:

Syntax: `":IMD:SET <NR3>"`

Valid Range: Depends on the instrument type.

Default Value: 0 A

Assumption: The operation mode is switched to constant power.

Description: Sets the photo diode current. Unit: [A].

Reading the set current:

Syntax: `":IMD:SET?"`

Response: `[:IMD:SET <NR3>]`

Description: Queries the programmed photo diode current. Unit: [A].

Reading the minimum current:

Syntax: `":IMD:MIN?"`

Response: `[:IMD:MIN <NR3>]`

Description: Queries the minimum allowed photo diode current. Unit: [A].

Reading the maximum current:

Syntax: `":IMD:MAX?"`

Response: `[:IMD:MAX <NR3>]`

Description: Queries the maximum allowed photo diode current. Unit: [A].

Reading the actual current:

Syntax: `":IMD:ACT?"`

Response: `[:IMD:ACT <NR3>]`

Description: Queries the actual photo diode current. Unit: [A].

3.7.7 Calibrating a photo diode (CALPD)

Programming:

Syntax: `":CALPD:SET <NR3>"`

Valid Range: Depends on the instrument type.

Default Value: 1.0 A/W

Assumption: The laser diode output is switched off.

Description: Sets the sensitivity (η) of the monitor diode. Unit: [A/W].

Reading the set sensitivity:

Syntax: `":CALPD:SET?"`

Response: `[:CALPD:SET <NR3>]`

Description: Queries the programmed sensitivity of the monitor diode. Unit: [A/W].

Reading the minimum sensitivity:

Syntax: `":CALPD:MIN?"`

Response: `[:CALPD:MIN <NR3>]`

Description: Queries the minimum allowed sensitivity of the monitor diode. Unit: [A/W].

Reading the maximum sensitivity:

Syntax: `":CALPD:MAX?"`

Response: `[:CALPD:MAX <NR3>]`

Description: Queries the maximum allowed sensitivity of the monitor diode. Unit: [A/W].

NOTE

This calibration is used for the command "POPT". It differs from the calibration factor set with the potentiometer located next to the LED P_{LD} which is responsible for the 4 ½ digit display. If the value on the display shall be equal to that read back via the interface a manual calibration has to be done too.

(Refer to chapter 2.1.9, "Adjusting the power display using a monitor diode" on page 26)

3.7.8 Optical power (POPT)

Programming:

Syntax: `":POPT:SET <NR3>"`

Valid Range: Depends on the instrument type and the programmed sensitivity of the monitor diode.

Default Value: 0 W

Assumption: The operation mode is switched to constant power.

Description: Sets the optical power. Unit: [W].

Reading the set power:

Syntax: `":POPT:SET?"`

Response: `[:POPT:SET <NR3>]`

Description: Queries the programmed optical power. Unit: [W].

Reading the minimum power:

Syntax: `":POPT:MIN?"`

Response: `[:POPT:MIN <NR3>]`

Description: Queries the minimum allowed optical power. Unit: [W].

Reading the maximum power:

Syntax: `":POPT:MAX?"`

Response: `[:POPT:MAX <NR3>]`

Description: Queries the maximum allowed optical power. Unit: [W].

Reading the actual power:

Syntax: `":POPT:ACT?"`

Response: `[:POPT:ACT <NR3>]`

Description: Queries the actual optical power. Unit: [W].

(See note at command CALPD on page 57)

3.7.9 Reading the optical power from the display (POPTP)

Syntax: `":POPTP:ACT?"`

Response: `[:POPTP:ACT <NR3>]`

Description: Queries the actual optical power calculated from the position of the potentiometer marked CAL next to the LED P_{LD}. This is the optical power shown on the display. Unit: [W]

NOTE

This queries the optical power measured by the internal monitor diode that is displayed on the 4 ½ digit display.

3.7.10 Reading the optical power from the thermopile input (POPTP)

Syntax: `":POPTTP:ACT?"`

Response: `[:POPTTP:ACT <NR3>]`

Description: Queries the actual optical power that is calculated from the position of the potentiometer marked CAL next to the LED P_T. This is the optical power shown on the display. Unit: [W]

NOTE

This queries the optical power measured by the thermopile input that is displayed on the 4 ½ digit display.

3.7.11 Reading the rise time (RISET)

Syntax: `":RISET:ACT?"`
Response: `[:RISET:ACT <NR3>]`
Description: Queries the actual laser diode current rise time. Unit: [A/s]

3.7.12 Reading the laser diode voltage (VLD)

Syntax: `":VLD:ACT?"`
Response: `[:VLD:ACT <NR3>]`
Description: Queries the actual laser diode voltage. Unit: [V]

3.7.13 Reading the thermopile voltage (VTP)

Syntax: `":VTP:ACT?"`
Response: `[:VTP:ACT <NR3>]`
Description: Queries the actual thermopile voltage. Unit: [V]

3.8 Error messages of the LDC 3065

Devices following the IEEE488.2 standard provide an error queue storing errors one by one.

An Error may occour as a result of a program message (refer to chapter 3.3.2, "Program and response messages" on page 44).

Errors are divided into four categories (refer to chapter 3.9.1, "Standard event status register (ESR)" on page 68).

Every query `":SYST:ERR?"` will read out one error from the error queue until the error queue is empty (refer to 3.5.3, "Queriing the error queue" on page 51).

The error queue can keep 32 errors.

If the queue is empty the error message `[0, "No error"]` is sent to the PC

3.8.1 General errors

`[0, "No error"]`
Category: None
Possible reason: The error queue is empty.

`[100, "Unknown command"]`
Category: Command Error
Possible reason: `":HELLO WORLD"`. This string sent to the LDC 3065 was not recognized as valid command.

`[101, "Invalid character"]`
Category: Command Error
Possible reason: `"!"`. This character sent to the LDC 3065 does not belong to the allowed set of characters.

`[102, "Invalid numeric parameter"]`
Category: Command Error
Possible reasons: `":ILD:SET 1.2a3"`. This parameter is not valid.

[103, "Invalid text parameter"]

Category: Command Error
Possible reasons: "**:MODE hhh**". This parameter is not valid.

[109, "Wrong compound"]

Category: Command Error
Possible reason: "**:ITE:ERR?**". This combination is not allowed.

[110, "Unknown compound"]

Category: Command Error
Possible reason: "**:ITE:XXX?**". This compound is not known.

[111, "Wrong parameter"]

Category: Command Error
Possible reason: "**:MODE THL**". This compound is not valid for this command.

[190, "Parser buffer overflow"]

Category: Command Error
Possible reason: The string sent to the LDC 3065 was too long for the parser.

[200, "Data out of range"]

Category: Execution Error
Possible reason: "**:ILD:SET 10E+30**" sent to the LDC 3065 but this current is much too high.

[300, "Hardware error"]

Category: Device Error
Possible reason: Many. Device must probably be maintained.

[301, "Software error"]

Category: Device Error
Possible reason: Unexpected error. Please contact *Profile*.

[302, "Not implemented yet"]

Category: Device Error
Possible reason: Feature not enabled. Please contact *Profile*.

[303, "Key emulation error"]

Category: Device Error
Possible reason: Internal communication problem. Please contact *Profile*.

[400, "Too many errors"]

Category: Device Error
Possible reason: Error queue overflow (32 errors max).

[410, "Query interrupted"]

Category: Query Error
Possible reason: More than one query sent to the LDC 3065 before the read command.

[420, "Query unterminated"]

Category: Query Error
Possible reason: There is no data in the output buffer.

[500, "IEEE488 receive buffer overflow"]

Category: Device Error
Possible reason: The string sent to the LDC 3065 was too long for the IEEE488 receive buffer (250 char max).

[600, "Serial receive buffer overflow"]

Category: Device Error
Possible reason: RS232 input buffer overflow.

[601, "Serial send timeout occured "]

Category: Device Error
Possible reason: No RS232 receiver detected - timeout.

3.8.2 LDC 3065 operation error messages

[2101, "Interlock is open"]

Category: Execution Error

Possible reason: Try to switch on the output while the interlock line is open.

(Refer to chapter 1.8.3, "Using the interlock input" starting on page 15)

[2102, "Open circuit"]

Category: Execution Error

Possible reason: Try to switch on the output while the cable to the laser diode has opened or the compliance voltage is not high enough.

[2103, "Over temperature"]

Category: Execution Error

Possible reason: Try to switch on the output while the internal temperature is too high. Wait until the LDC 3065 has cooled down. Maintain proper air flow.

[2104, "Internal power failure"]

Category: Execution Error

Possible reason: Try to switch on the output while an internal power failure occoured.

[2107, "No setting of ILD during constant power mode"]

Category: Execution Error

Possible reason: The set value of the laser diode current can not be changed during constant power mode.

[2108, "No setting of IMD during constant current mode"]

Category: Execution Error

Possible reason: The set value of the monitor diode current or the optical power can not be changed during constant current mode.

[2114, "No calibrating of PD during laser on"]

Category: Execution Error

Possible reason: The monitor diode may not be calibrated during laser on.

`[2116, "No mode change during laser on"]`

Category: Execution Error

Possible reason: The mode of operation may not be changed during laser on.

3.9 Status reporting

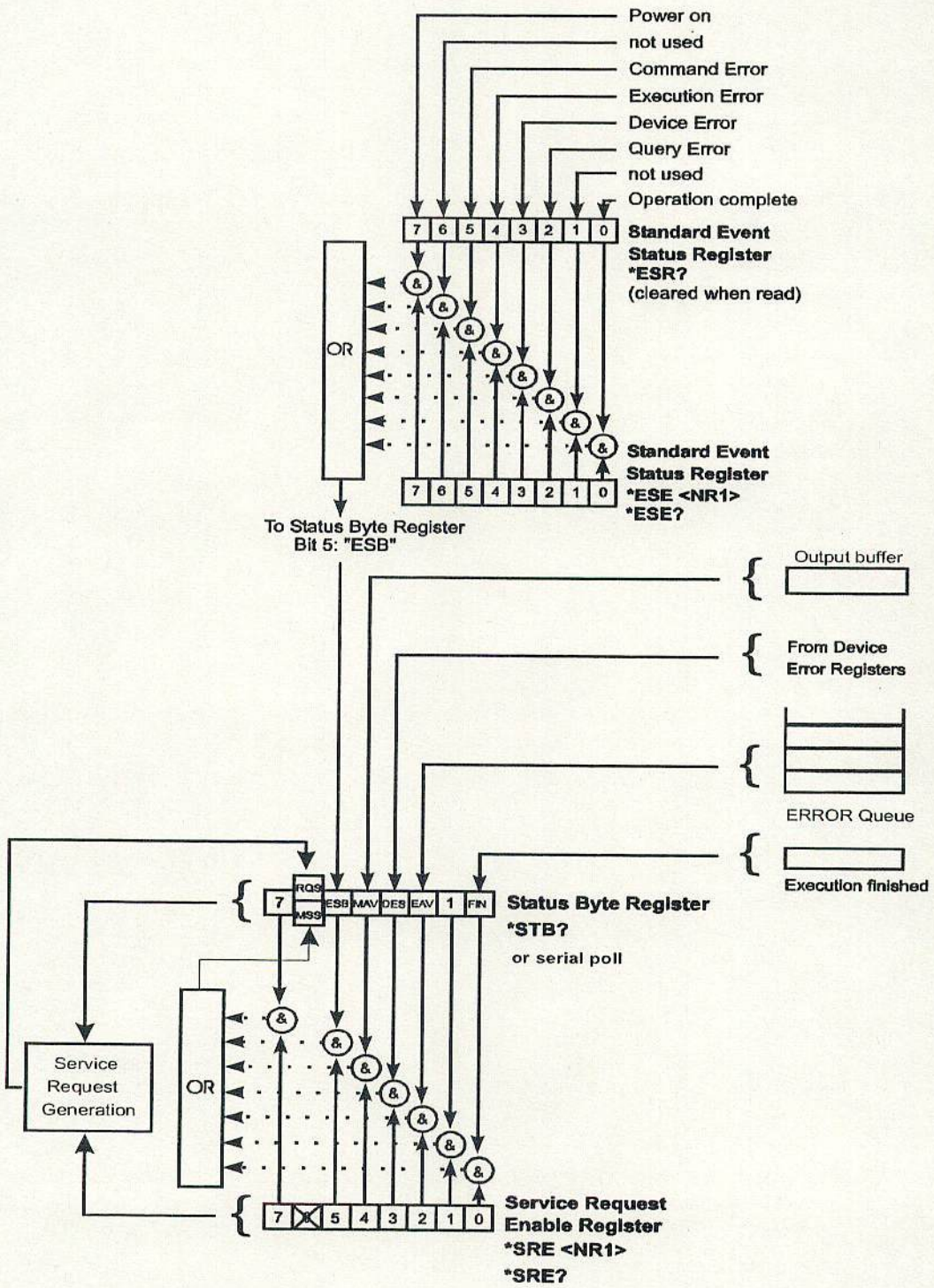


Figure 4 The service request and standard event registers

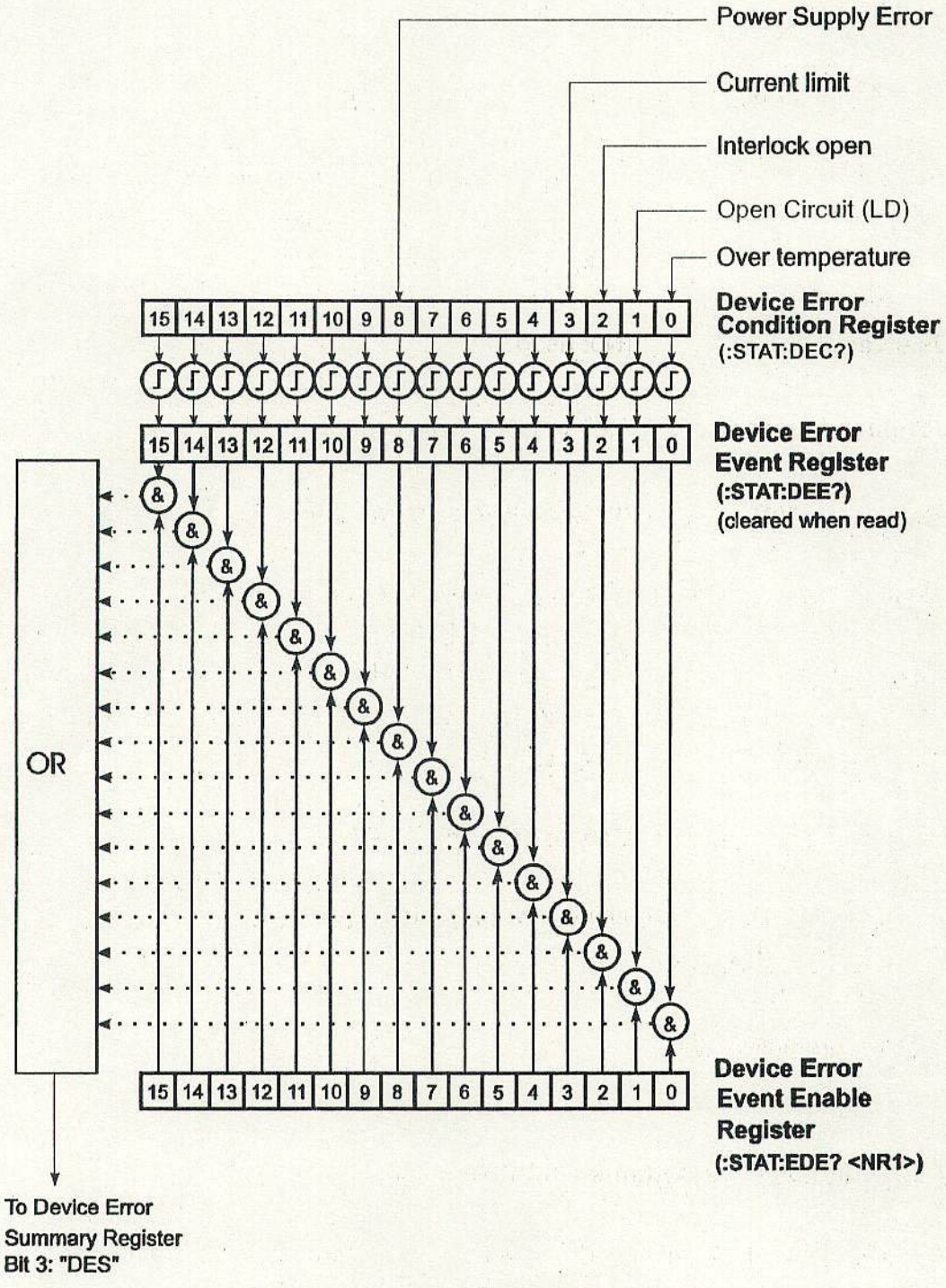


Figure 5 The device error registers EDE, DEE and DEC

The LDC 3065 provides four 8 bit registers ESR, STB, ESE and SRE and three 16 bit registers DEC, DEE and EDE to program various service request functions and status reporting.

(Please refer to the IEEE488.2-1992 standard chapter 11)

3.9.1 Standard event status register (ESR)

The bits of this register represent the following standard events:

Power on	This event bit indicates that an off to on transition has occured in the power supply. So it is high after switching on the device for the first time.
User request	(Not used)
Command error	A command error occured.
Execution error	An execution error occured.
Device dependent error	A device dependent error occured.
Query error	A query error occured.
Request control	(Not used)
Operation complete	Can be set with "***OPC**".

The ESR can be read directly with the command "***ESR?**". This read command clears the ESR. The content of the ESR can not be set.

The bits are active high.

3.9.2 Standard event status enable register (ESE)

The bits of the ESE are used to select which bits of the ESR shall influence bit 5 (ESB) of the Status Byte Register (STB). The 8 bits of the ESE are connected by logical "AND" with the according 8 bits of the ESR. These 8 results are connected by logical "OR" so that any "hit" leads to a logical 1 of bit 5 (ESB) of the STB. As any bit of the STB can assert an SRQ every event (bit of the ESR) can be used to assert an SRQ.

3.9.3 Status byte register (STB)

The bits of this register are showing the status of the LDC 3065.

RQS	RQS: Request service message: Shows that this device has asserted SRQ (read via serial poll).
MSS	Master summary status: Shows that this device requests a service (read via "***STB?**").
MAV	(message available) This bit is high after a query request as a result "waits" in the output queue to be fetched. It is low if the output queue is empty.
DES	(device error status) This bit is high after a device error occured. Which device errors shall set this bit is defined with the EDE.
EAV	(error available) This bit is high as long as there are errors in the error queue.
FIN	(command finished) This bit is high after a command has finnished and all bits of the STB have been set.

The STB can be read directly with the command "***STB?**". The content of the STB can not be set. The bits are active high.

All bits exept bit 6 of the STB can be used to assert a service request (SRQ) (Please refer to 3.9.5). Alternatively the SRQ can be recognized using the command "***STB?**" (Please refer to 3.9.6) or by serial poll (Please refer to 3.9.7).

3.9.4 Service request enable register (SRE)

The bits of the SRE are used to select, which bits of the STB shall assert an SRQ.
Bit 0, 1, 2, 3, 4, 5 and 7 of the STB are combined by logical "AND" with the according 7 bits of the SRE. These 7 results are combined by logical "OR" so that any "hit" leads to a logical 1 in bit 6 of the STB and asserts an SRQ.

3.9.5 Reading the STB by detecting SRQ

If an SRQ is asserted (see 3.9.4) bit 6 of the STB is set to logical 1, so that the controller can detect by auto serial polling, which device asserted the SRQ.

3.9.6 Reading the STB by *STB? command

If the controller does not "listen" to SRQs at all, the service request can be detected by reading the status byte with the command "`*STB?`".

If bit 6 is logical 1, a service request was asserted.

3.9.7 Reading the STB by serial poll

If the controller does not support auto serial poll the service request can also be detected via manual serial poll.

If bit 6 is logical 1 a service request was asserted.

3.9.8 Device error condition register (DEC)

The bits of this register show the errors, that occure during operation (operation errors). The bits are active high.

If the error disappears, the bits are reset to low.

For an LDC 3065 bits 0 ... 3 and 8 are used:

(0) Over temperature	Internal temperature too high. Wait until the LDC 3065 has cooled down. Maintain proper air flow.
(1) Open circuit	Cable to the laser diode has opened. Compliance voltage not high enough
(2) Interlock open	Interlock line is open.
(3) Current limit	The current limit is reached and the protection circuit is active now. Noise and drift specs are not valid any more.
(8) Power supply error	Internal powersupply error.

The DEC can be read but not set. Reading does not clear the DEC.

3.9.9 Device error event register (DEE)

The bits of this register hold the errors, that occured during operation (operation errors). So each bits of the DEC sets the according bit of the DEE.

The DEE can be read but not set. Reading cleares the DEE.

3.9.10 Device error event enable register (EDE)

The bits of the EDE are used to select, which bits of the DEE shall influence bit 3 (DES) of the STB. The 8 bits of the EDE are related by logical "AND" to the according 8 bits of the DEE. These 8 results are combined by logical "OR" so that any "hit" leads to a logical 1 in bit 3 (DES) of the STB. As any bit of the STB can assert an SRQ, every error (bit of the DEE) can be used to assert an SRQ.

3.10 Hints for setting up control programs

The following flowcharts show the communication sequences between a control computer and a LDC 3065 using the IEEE488 interface. Use this sequences to ensure a fast and secure communication.

Flowchart for writing device commands

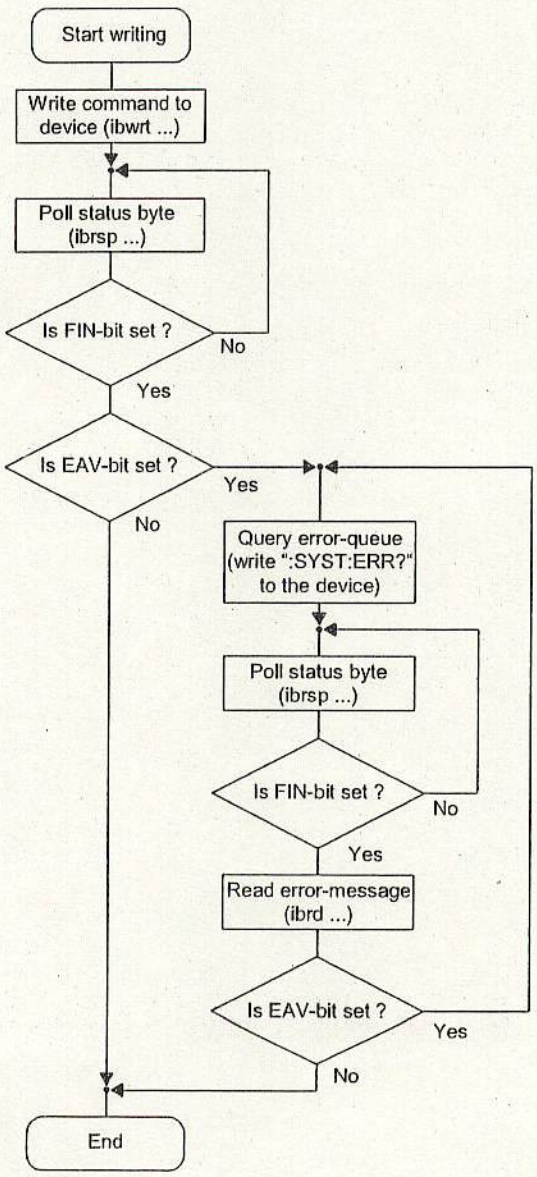


Figure 6 Writing device commands

Flowchart for querying device messages

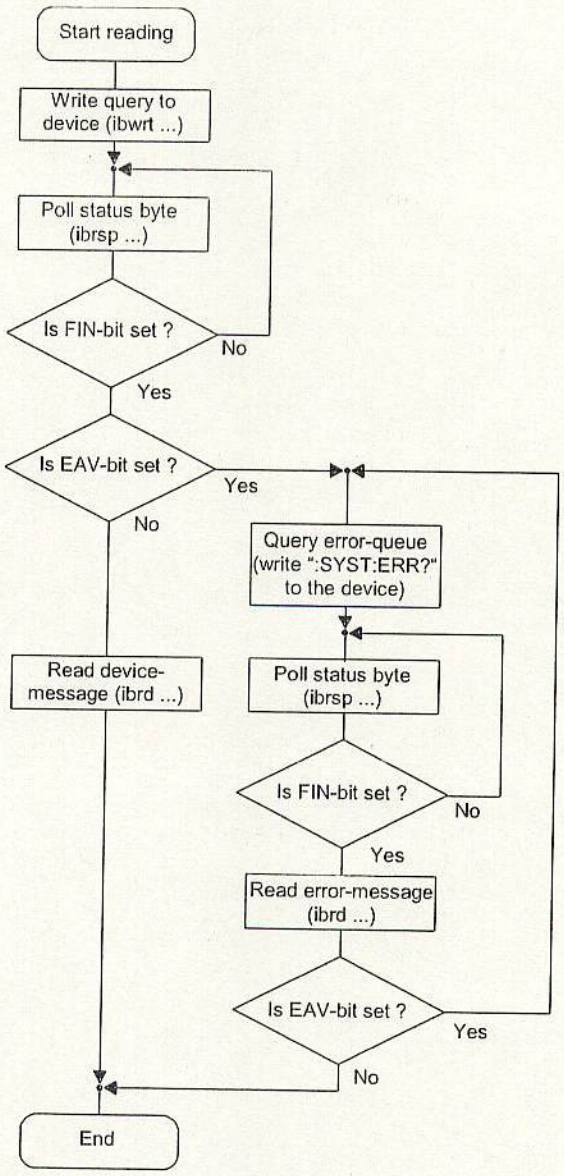


Figure 7 Querying device messages

NOTE

During the test phase of control programs all program messages schould be transmitted separately. Each command should be followed by a status request (response message) so that possible errors are read out directly after the command causing them.

NOTE

The producer of the interface card of the control computer will provide communication functions for both directions between PC and LDC 3065 for all common software packages. These will be embedded into the programming text and accomplish the data transfer between control computer and LDC 3065. We recommend to build these write and read back commands into separate functions and then use these functions for the data transfer.

In these functions a globally to set flag should be requested that determines whether the write or read back communication is to be read out together with talker and listener address at IEEE488 systems additionally into a data file or on the printer. When communication problems occur at the bus or in case of error messages that cannot be explained the evaluation of the data transfer between the LDC 3065 and the control computer will then be possible without much effort.

This also applies when programming the RS232C interface

4 Service and Maintenance

4.1 Selecting the line voltage

The line voltage can not be selected!

The LDC 3065 can be operated in a line voltage range between 90 V ... 260 V with 50/60 Hz.

4.2 Exchanging the line fuse

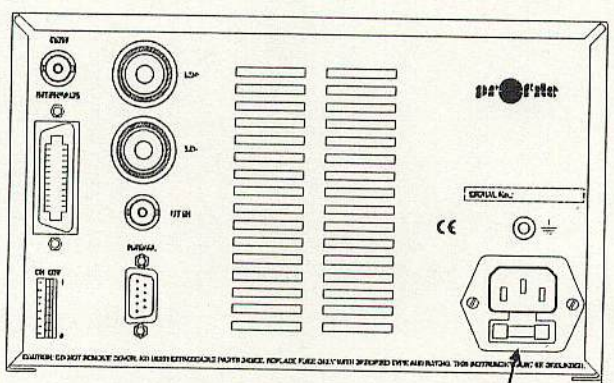
If the line fuse should have blown due to line disturbances or other influences from the outside it can be exchanged at the rear without opening the unit.

Attention

To avoid fire hazard only the appropriate fuse is to be used:

6,3 AT

Rear view of the LDC 3065



mains plug with fuse and spare fuse

Figure 8 Mains fuse exchange

- Switch the LDC 3065 off and remove the mains cable from the mains jack.

- Remove the cover of the fuse holder by means of a screwdriver. A small drawer will open up. If available first the replacement fuse is visible. The active fuse is located at the rear part of the drawer.

- Remove the fuse holder completely and exchange the defective fuse. We would recommend to check at the same time if a replacement fuse is provided and if this fuse is still useable.

- Put the fuse holder back until is has snapped in.

- Execute a function test of the LDC 3065 by switching it on. In case the LDC 3065 could not be switched on despite the correct fuse being inserted please contact your supplier or *Profile*.

4.3 Maintenance and repair

The LDC 3065 does not need any regular maintenance by the user. The chassis may be cleaned with a soft humid cloth and a mild detergent.

To maintain the specifications for a long period of time we would recommend to have the unit re-calibrated by *Profile* every second year.

The LDC 3065 does not possess any components to be repaired by the user. If any disturbances in function should occur please contact our *Profile* technical hotline before sending the device to *Profile* (Germany) for repair.

4.4 Troubleshooting

In case that your LDC 3065 system shows malfunction please check the following items:

- System does not work at all (no display on the mainframe):
  - Mainframe LDC 3065 connected properly to the mains?
    - Connect the LDC3000B to the power line using the supplied three wire power cord with grounded safety plug.
  - Mainframe turned on?
    - Turn on your LDC 3065 with the key mains-switch.
  - Control the fuse at the rear panel of the LDC 3065 mainframe.
    - If blown replace the fuse by the correct type

- You don't get the desired laser output power
  - Is the interlock closed?
    - Control the resistance between the interlock pins of the connector jack not to be more than 430 Ω.
      (refer to section 1.8.3, "Using the interlock input" on page 15)
  - Is the emergency switch armed?
    - Turne the safety switch to the right untill it locks out.
  - Do you have turned on the laser output?
    - Enter all necessary parameters and push the "LD ON" key or use the command `:LASER ON`

- Is the hardware limit $I_{LD\ LIM}$ set to 0?
  - Adjust the hardware limit $I_{LD\ LIM}$ by means of the potentiometer on the front panel to an appropriate value.

- Is the output power in CP mode or output current in CC mode set to 0? Adjust the output power (or the output current) in the "OPERATION MODE" menu or with the command "`:ILD:SET <NR3>`", `:IMD:SET <NR3>`" or "`:POPT:SET <NR3>`" depending on the operation mode.

- Is the laser diode installed properly?
  - Control the connection cable. Highest quality of the contact (lowest junction resistance) is vital!

- Is the photo diode connected properly?
  - Check the connecting cable (should be shielded twisted pair).

- Is the correct photo diode efficiency set (A/W)?
  - Enter the coefficient with the "CAL" potentiometer or with the command "`:CALPD:SET <NR3>`"

If you don't find the error source by means of the trouble shooting list or if more modules work erratic please first contact the *Profile-Hotline* before sending the whole LDC 3065 system for checkup and repair to *Profile*-Germany.

(Refer to section 5.3, "Addresses" on page 83.)

5 Listings

5.1 List of abbreviations

AC	Alternating Current
ADC	Analog to Digital Converter
AG	Anode Ground
ASCII	American Standard Code for Information Interchange
CC	Constant Current
CG	Cathode Ground
CLR	CleaR
CP	Constant Power
CR	Carriage Return
CRD	Character Response Data
CW	Continuous Wave
DAC	Digital to Analog Converter
DC	Direct Current
DCL	Device Clear
DEC	Device Error Condition Register
DEE	Device Error Event Register
DES	Device Error Summary Bit
DIN	Deutsche Industrie Norm
DIP	Dual In-line Package
EAV	Error Available Bit
EDE	Enable Device Error Event Register
EN	Europa Norm (European Standard)
EOI	End Or Identify
ERR	ERRor
ESE	Standard Event Status Enable Register
ESR	Event Status Register
FIN	Command FINished Bit
GET	Group Execute Trigger
GTL	Go To Local
IEEE	Institute for Electrical and Electronic Engineering
ILD	I (current) Laser Diode
IPD	I (current) Photo Diode

LD	Laser Diode
LDC	Laser Diode Controller
LED	Light Emitting Diode
LF	Line Feed
LLO	Local Lockout
NR1	Numeric Response data of type 1
NR2	Numeric Response data of type 2
NR3	Numeric Response data of type 3
MAV	Message Available Bit
MSS	Master Summary Status
N.C.	Not Connected
OTP	Over TemPerature
PC	Personal Computer
PD	Photo Diode
RF	Radio Frequency
RMS	Root Mean Squared
RQS	ReQuest Service Message
SDC	Selected Device Clear
SEL	SELect
SRE	Service Request Enable Register
SRQ	Service ReQuest
STB	STatus Byte Register
TEC	ThermoElectric Cooler (Peltier Element)
TRG	TRiGger

5.2 List of figures

5.3 Addresses

Europe and other non US countries

(Factory home address)

Fa.
Profile Optische Systeme GmbH
Gaußstrasse 11
D-85757 Karlsfeld
Fed. Rep. of Germany

Tel.: ++49 (0)81 31 / 5956-0
Fax: ++49 (0)81 31 / 5956 99
Email: info@ profile-optsys.com
Internet: http://www.profile-optsys.com/
Technical Hotline: ++49 (0) 8131 5956-11, -55, -0

United States of America

Profile Inc.
87 Hibernia Avenue
Rockaway, NJ 07866, USA

Tel: (+1) 973-664-9385
Fax: (+1) 973-664-9384
E-mail: profile.gl@worldnet.att.net
Internet: http://www.profile-optsys.com

Our company is also represented by several distributors throughout the world.
Please call our Hotline, send an E-mail to ask for your nearest distributor or just visit our homepage **http://www.profile-optsys.com** !