aLIGO Laser Electronic

Interlock Concept

LIGO-T1000005-v2

neoLASE

1 Interlock Concept

The PSL safety concept is based on Beckhoffs 'Safety over EtherCAT protocol'. This allows an easy integration of safety relevant signals and components at different locations.

1.1 Safety over EtherCAT

The concept benefits from the decentralized topology of the Beckhoff terminals to collect/distribute inputs/outputs via the standard EtherCAT bus system. The I/Os are linked to an intelligent logic terminal that exclusively deals with the safety logic. Further information about this can be found in the following document:

http://download.beckhoff.com/download/press/2007/english/Industrial_Ethernet_Book_092007.pdf

The 'Safety over EtherCAT protocol' is specified to meet the safety standards of IEC 61508 SIL 3 and EN 954 Cat. 4.

1.2 Safety relevant input devices

An overview of the safety devices and all components connect to the system can be found in Figure 1 PSL control overview with safety devices.

The **interlock box IL** collects the status of the following interlock-relevant components (Fig.1, red symbols). For proper function all contacts must be closed (wire break safe):

- LDR facilities interlock (external interlock input)
- LDR emergency pushbutton
- LDR safety key lock
- TEC power supplies (TEC1+TEC2 needs to be switched ON)
- Frontend diode temperature (the temperature of each diode must be below 40°C)
- DB1-4 diode temperature (the temperature of each diode must be below 40°C)
- Chiller flow (flow of both chillers need to be between 5 and 40 l/min)

In addition the **control box CB** collects the status of the following safety-relevant components:

- LAE emergency pushbutton mounted in proximity to the laser table
- LVEA facilities interlock
- LVEA safety key lock

1.3 Safety relevant output devices

If one of the above mentioned inputs will open the following subsystems will be shut down or their outputs will be set to zero (Fig.1, green symbols).

- NPRO interlock (will switch off the NPRO output)
- Frontend interlock (will switch off diode power supply output)
- Oscillator diode power supply interlock (will switch off diode power supply output)
- TEC power supply interlock (will switch off TEC power supply output)
- Chillers remote control (will switch off the chillers)

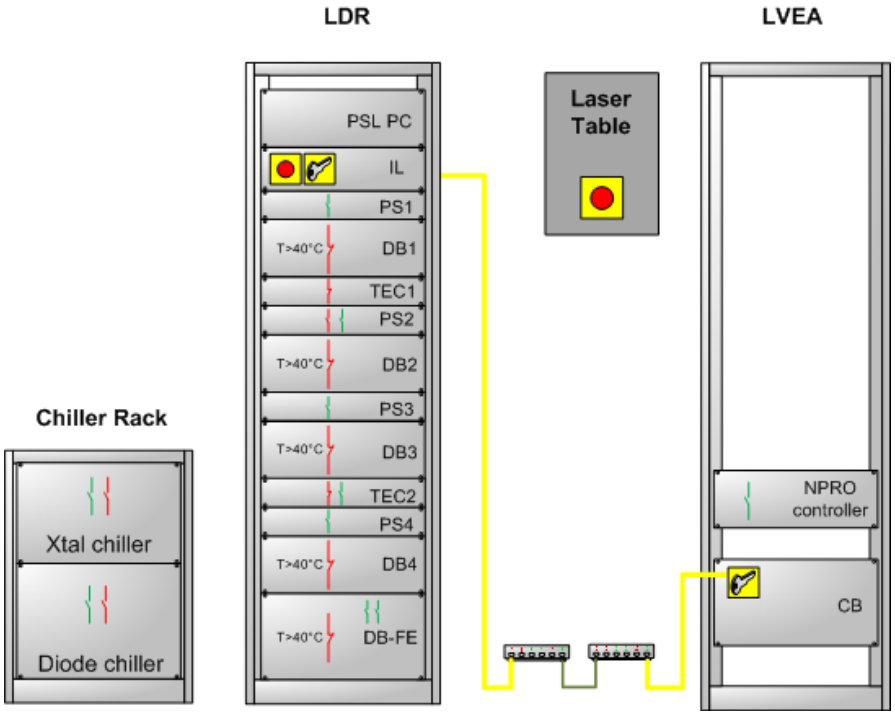

Figure 1 PSL control overview with safety devices

1.4 Functionality

The mentioned interlock inputs are connected to the input terminals (Beckhoff TwinSafe EL1904). During normal operation all inputs are supposed to be closed and an output terminal (Beckhoff TwinSafe EL2904) will actuate a safety relay (DOLD LG5929.60). This relay will close the hardware interlock inputs of safety relevant or light emitting subsystems.

In case of an error or safety shut down the relay contacts will open and ensures that the laser diode current from the different power supplies (PS1-4 and DB-FE) as well as the NPRO is turned off. Thus, no light can be emitted from the lasers. In addition the chillers and the TEC power supplies are turned off. To restart the laser the user needs to reset the system manually.

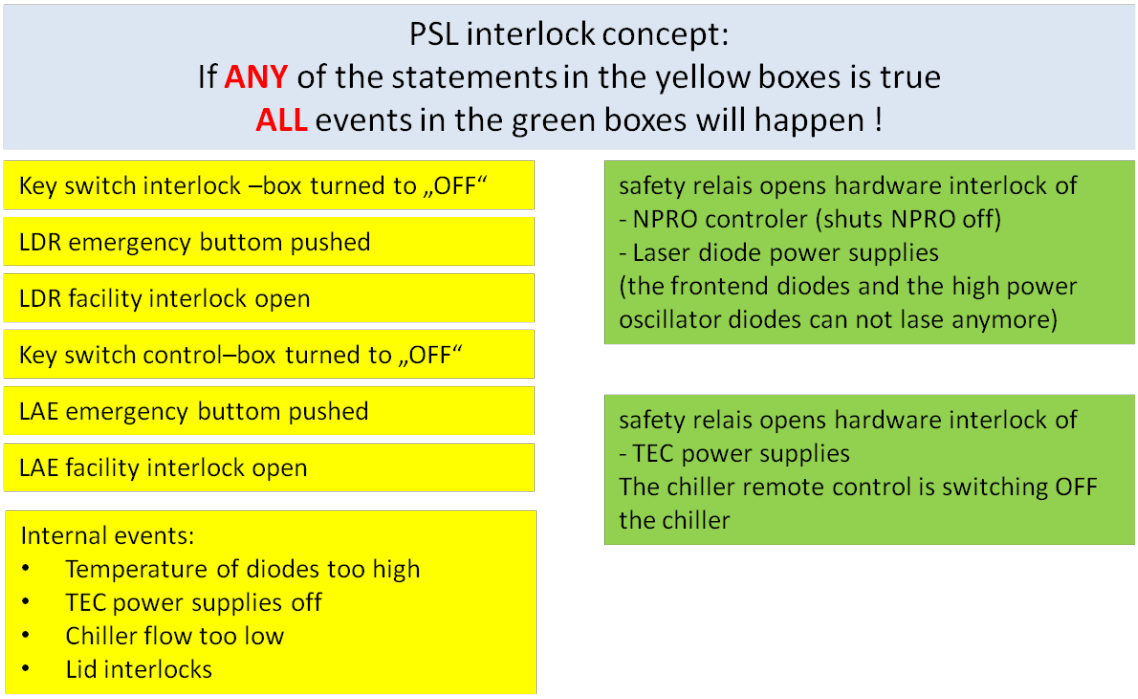

Figure 2 PSL interlock concept

1.5 Test procedure

Switch ON all components and RESET all errors. After Reset the interlock relay should be switched ON, ATTENTION this allows Laser operation. Check the interlock events and make sure that they will be displayed on the control screen (corresponding interlock and main interlock indicator).

		Status checked:
Check key lock switch (IL)		☐
Check push button (IL)		☐
Check Facility interlock (IL)		☐
Check key lock switch (CB)		☐
Check laser pushbutton (LAE)		☐
Check Facility interlock (CB)		☐
Check that in case the main interlock indicator is switched to red the following components will be switched off:		
NPRO	System stopped (LED Interlock)	☐
FE-DB	Laser Diodes stopped	☐
PS1-4	Power Supplies Stopped (RSD, LED)	☐
TEC1-2	Power Supplies Stopped (RSD, LED)	☐
Chiller	Chillers switched off	☐
Check internal system relevant safety signals:		
Check for DB overtemp. signal		
DB1 (open on DB side)		☐
DB2 (open on DB side)		☐
DB3 (open on DB side)		☐
DB4 (open on DB side)		☐
FE-DB (open on DB side)		☐
Check for chiller interlock		
Chiller x-tal (open on chiller side)		☐
Chiller diode (open on chiller side)		☐
TEC (Switch off TEC 1)		☐
TEC (Switch off TEC 2)		☐
Lid Interlock Frontend		☐
Lid Interlock High Power Oscillator		☐

Comments:

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Controller: _____ Date: _____