Product description laser control and safety system.

Drawings: **Laser system construction guide**
System interconnection SLCU13DN
FIRESTAR interconnection SLCU13DN

A laser control system is used to implement all security relevant aspects. Installation is simple and system cost is reduced.
This system is designed for laser units controlled by pulse width modulation (PWM).
Alternately this system can be used for pulse triggered systems (YAG etc.)

System consists of following components:

1. Shutter (ELS11-A10 --- ELS11-A18)
2. Shutter / laser safety control unit (SLCU13DN)

1. Shutter ELS11-A10): Aperture 10 mm **ELS11-A18**: Aperture 18mm
The beam shutter has no power limit, because closing shutter cuts PWM to laser.
A: mounts directly to the beam exit of SYNRAD lasers
Additional base mount for other laser units.
B: operates in horizontal and vertical position.
C: equipped with 3 HAL sensors, one sensor signals shutter open, 2 sensors signal shutter closed.
D: sensor outputs source 24V/200mA each and are overload and short circuit protected.
E: when the shutter is closed and laser is active, laser beam is deviated to a heat dump. If temperature increases above 65 Celsius, laser is shut down.
F: shutter and coil are energized by 24V DC. A booster circuit energizes shutter coil for about 500ms with full power i.e. a current of 720 mA flows through the shutter coil. After 500 ms the current is reduced to 110 mA holding the shutter open and reducing coil heating.
G: Power consumption: Shutter 24VDC: open 200mA, closed 20mA
H: Two shutter versions are available:
Shutter ELS11-A10 dimension: 88 * 78 * 40.5 mm;
Aperture 10 mm; Shutter closing time: 10ms +/- 1ms
Shutter ELS11-A18 dimension 125.5 * 87 * 46.5 mm;
Shutter aperture 18 mm; Shutter closing time: 10 ms +/- 1ms

2. Shutter / laser control unit (SLCU13DN): DIN rail unit 45mm wide

A: continous monitoring of shutter functions; malfunction of shutter is signalled by shutter fault output = LOW --- shutter is closed
B: all outputs are 24V DC current limited and short circuit protected.
C: all inputs are 24V tolerant
D: PLC (SPS) inputs/outputs (+24V/GND)
E: PWM drive ON/OFF by PLC/SPS
F: Laser enable by PLC / SPS control
G: 2 emergency-off contacts with cross-wire and short detection, contacts are galvanically isolated by optocouplers
H: Reset button for emergency-off (F-STOP) and system faults
I: 2 interlock contacts with cross-wire and short detection, contacts are galvanically isolated by optocouplers.
K: Cage clamp connections for easy and fast implementation removable cage clamp connectors
L: direct connection to all SYNRAD lasers and other laser units
M: gated PWM (pulse width modulation) pass through. PWM is inhibited by shutter fault, laser not ready, shutter closed, interlock open and laser overtemperature.
N: cooler monitoring input (switch closed to GND = fault) cooler fault output. Fault condition will disable laser!
O: LED indicators for function monitoring
P: power consumption: 24VDC / app. 100mA

Monitoring leds:

Green = |+5V OK| = on = 24V / internal 5VDC ok
Green = |SHUCLOS|= on = shutter is closed
Orange= |SHUOPEN|= on = shutter is open
Red = |SHUFLT|= on = shutter fault
Blue = |LA-ENB|= on = Enable signal to laser on (+5V)
Red = |COOLFLT|= on = cooler fault
White = |%PWM|=on = PWM out (intensity = % power)
Green = |EMERG-OFF|= on = NC contact is closed
Yellow= |EMERG-OFF|= on = NO contact is closed
Green = |INTERLOCK|= on = NO contact is closed
Yellow= |INTERLOCK|= on = NC contact is closed
Orange= |LA-RDY|= on = Laser is ready

Jumpers:

Mode 1: On = Laser Enable OFF by emergency-off and door open
Off = Laser Enable OFF by emergency off only.
Mode 2: On = Security relays open if shutter temperatur > 65 C,
Shutter fault and external contact faults (emergency, doors)
and emergency operated and/or doors (interlock) open.
Off = same as above but interlock unaffected.

General notes:

Closing time of mechanical shutter is about 10 ms. When PWM pass through mode is used (recommended), laser drive is removed in about 1ms by interlock or other malfunctions. Shutter uses HAL-Sensors to signal shutter end position. Shutter closed is detected by 2 HAL-Sensors. Failure of one sensor causes a laser shut down. Similar, if mechanical travel from open to close or close to open takes longer than 200ms, laser is shut down.

System design and security considerations:

Please view drawing: **System interconnection diagram:**
SLCU13 is powered by a external 24VDC supply. External supply should deliver at least 1.5 A!
If an emergeny situation arises, laser is closed by emergency-stop button, shutter malfunction, PLC control or water cooling failures.
Shutter closes, PWM to laser is removed and laser is disabled. If recommended PWM pass through mode is used, no shutter dump heatup can occur since laser beam is disabled i.e. PWM is removed and laser is in tickle mode.

There is one failure condition which above system setup can only solve by an external relay. If internal electronics of laser fail in such way, that unit continues to output a laser beam despite all controls are disabled and PWM is removed! In this case the closed shutter will overheat.

SHUOVT: (recommended) connect relay coil to connector RELAY 1 / 2.
If above described failure occurs, beam dump of shutter unit heats up above 65 Centigrade. 24VDC from relay coil is removed and therefore AC input to main laser power supply is interrupted.

Security considerations on interlock and emergency stop detection.

For reasons of security it is mandatory in laser systems, that interlock(s) and emergency-stop circuits are constructed as a dual channel system (2 contacts per function).
For optimum security surveillance of interlock switches and emergency-stop switches for cross-wire shorts and ground shorts must be done. If F-STOP is returned to normal a system reset is required (reset button)!

FAULT conditions:
FAULT Led on (red):
1. Shutter malfunction
2. External interlock contacts failure
3. Emergency Stop switch failure and F-STOP activated.

Shuttern closes by: (green led)
1. Interlock (door) open
2. Fault led on
3. Shutter temperaturer above 65 centigrades
4. Laser not ready
5. Emergency off button operated
6. SLCU13DN enable input low
7. Laser power measurement input low

Laser enable output low (blue led off)
1. Cooler fault (red cooler led on)
2. Emergency off button operated
3. Interlock (door open; only with mode1 jumper on!)
4. FAULT Led on
5. Laser not ready (orange laser ready led off)
6. SLCU13DN enable input low

PWM output off (% PWM led white off)
1. Cooler fault (red cooler led on)
2. Emergency off button operated
3. Interlock (door) open
4. FAULT led on
5. LASER not ready (orange laser ready led off)
6. SLCU13DN enable input low

Important Note: Version APEX LASER V2 or higher
For additional security a system cold start requires a fault reset (fault reset button)!

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