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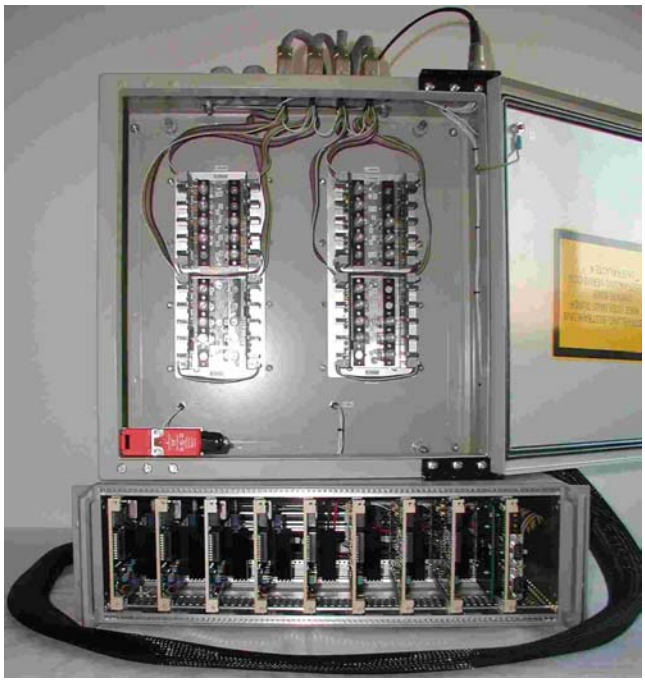
LASO (LAser SOldering station)

Operation Instructions
&
Service Manual



Version: 4.0

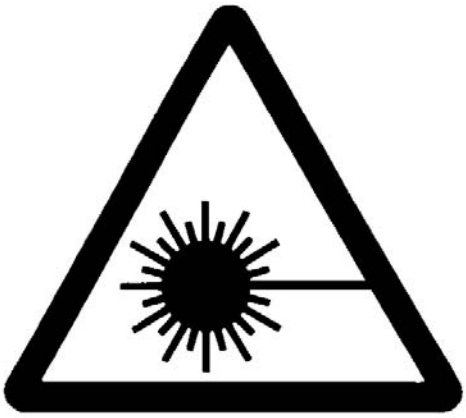
A System Overview

1. Safety Information

LASO is a **laser class IV** Product according IEC 60825-1.
Each of the mounted semiconductor Lasers emits highly concentrated invisible infrared light, which can be **hazardous to the human eye and skin**.

Safety precautions according to IEC 60825-1 have to be made.

LASO ist ein Produkt der **Laser-Klasse IV** nach IEC 60825-1.
Jeder der eingebauten Halbleiterlaser sendet stark gebündeltes, nicht sichtbares Laserlicht, welches für **Augen und Haut gefährlich** werden kann. Entsprechende Sicherheitsvorkehrungen analog zu IEC 60825-1 sind zu treffen.



Attention ! Invisible infrared laser light!

Laser Class IV

2. Introduction

LASO was developed for soldering small chips in automatic bond process. It uses an array of high power semiconductor lasers, each of them with 1-2 W optical output power. Realised applications are for example the soldering of semiconductor-lasers chips onto a silicon wafer or the soldering of a glass prism onto a glass spacon.
LASO uses glass fibbers bundles for the energy transport.

Advantages:

- Revised adhesive power in relation to bondings
- After the soldering the device can not move
- No process step is necessary for the apply of adhesive paste
- Fine adjustment of the light power in comparison to an Nd-YAG-Laser

BAUER Engineering GmbH offers furthermore the customer the guidance and support in the development of the soldering process with his devices.

LASO is a modular system. One laser control unit can supply up to 20 lasers. Overall we can built-on up to 8 of these units. The output power is adjustable for each unit separate. This allows a various scale of the optical power from 5 W to 160W. At the time the applications require 10 W to 60 W.

Possible settings:

- Laser current for adjustment of the optical power
- Pulls width from 1ms up to 60s
- Control limits for the temperatures of the power electronic and the lasers
- Shut-off of any laser to measure separate lasers or bypass defect lasers

Further Features:

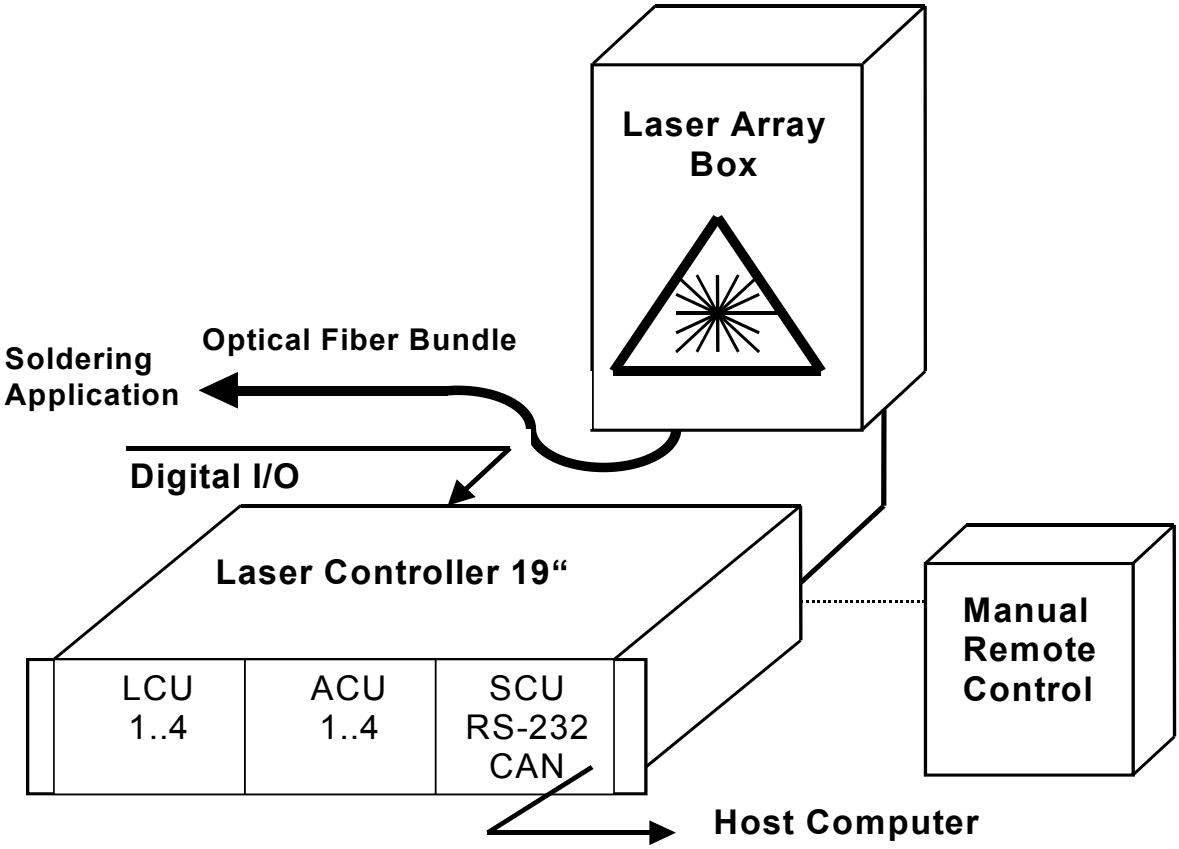
- Safety-Interlock on the Laser-Array-Case

- Key switch in Safety-Interlock-Circuit
- Connection for extern Safety-Interlock
- Manual Remote Control
- Data records on chip card storable and reloadable
- The power units can be added in 2 groups, which can be triggered in separate times
- Triggering by data communication or digital I/O

3. Hardware Description

3.1 General Arrangement

LASO consists of the following components:



Laser Controller

The Laser Control Case is delivered as a 19´´- rack with 3 Height-Units. It include interfaces (RS232, CAN, digital I/O) to control-PC and modular Laser-Control-Units (for power electronic) and Array-Control-Units (for temperature control). For applications with more over 4 LCU it is possible to connect a other rack with 3 Height-Units for up to 4 LCU´s.

Laser Array Box

In a separate box there are the High-Power-Semiconductor-Lasers, which are controlled and cooled. The cooling system consists of peltier elements and

ventilators, so no water connection is necessary. The connection to the Laser Control Case is made by cable in free convert length.

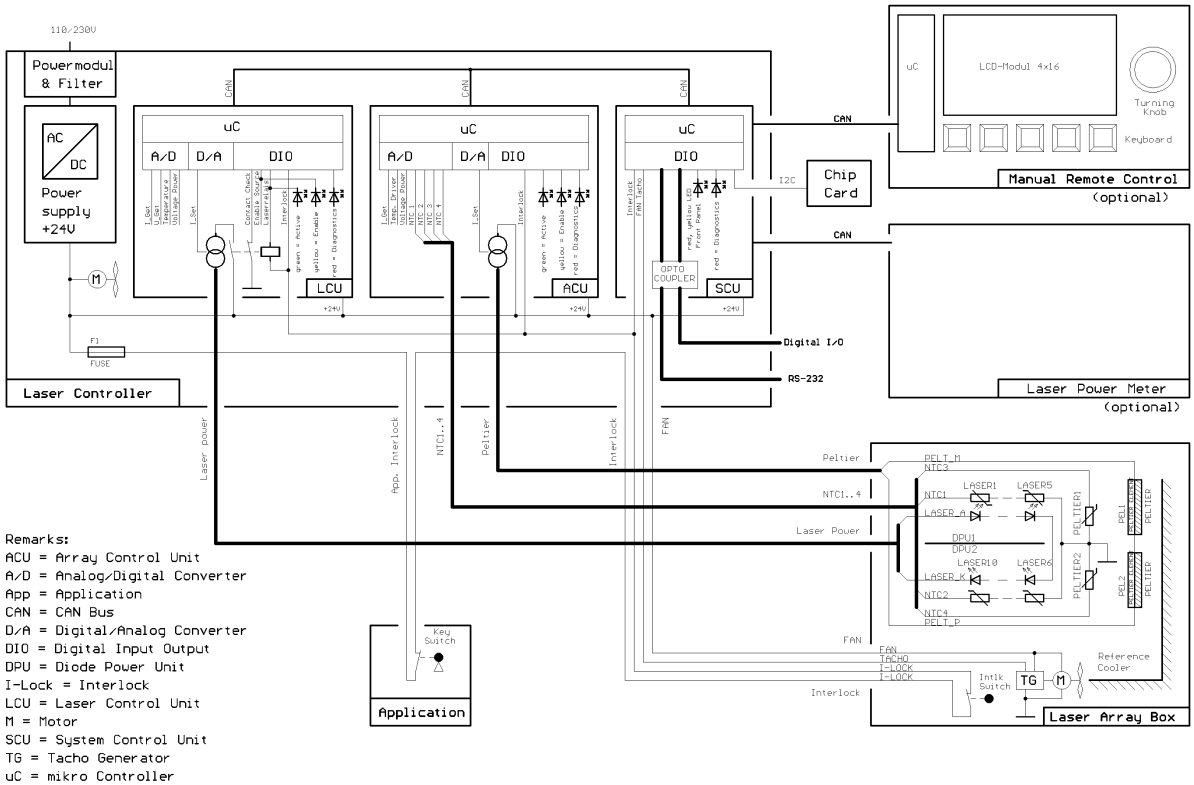
Optical Fibre Bundle

The laser power is delivered with a optical fibre bundle to the soldering position. The optical fibre bundle is application-specific made. Each optical fibre is connected to one laser of the array. A split-up in separate bundles is possible. The optical fibre bundle can moved with a bond head. The coupling of the light power can be direct or with a camera/microscope – optic.

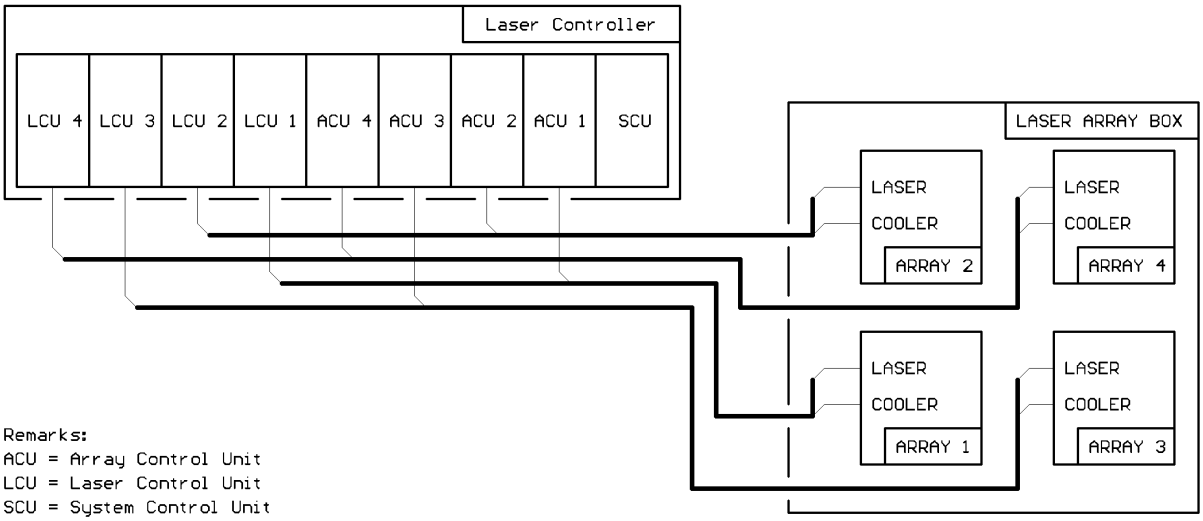
Digital I/O

The control of LASO can happen with a PC with interfaces (RS232 or CAN) or with a digital I/O Port. This offers a connection to a SPS or a Manual Remote Control.

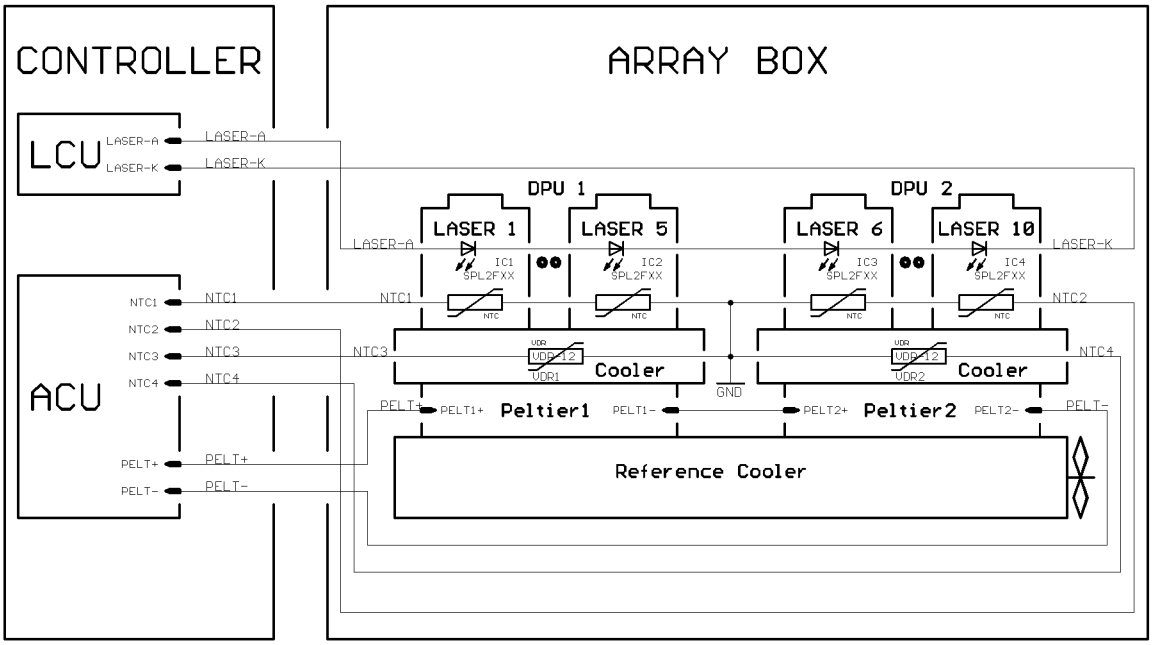
3.2 Block Diagram



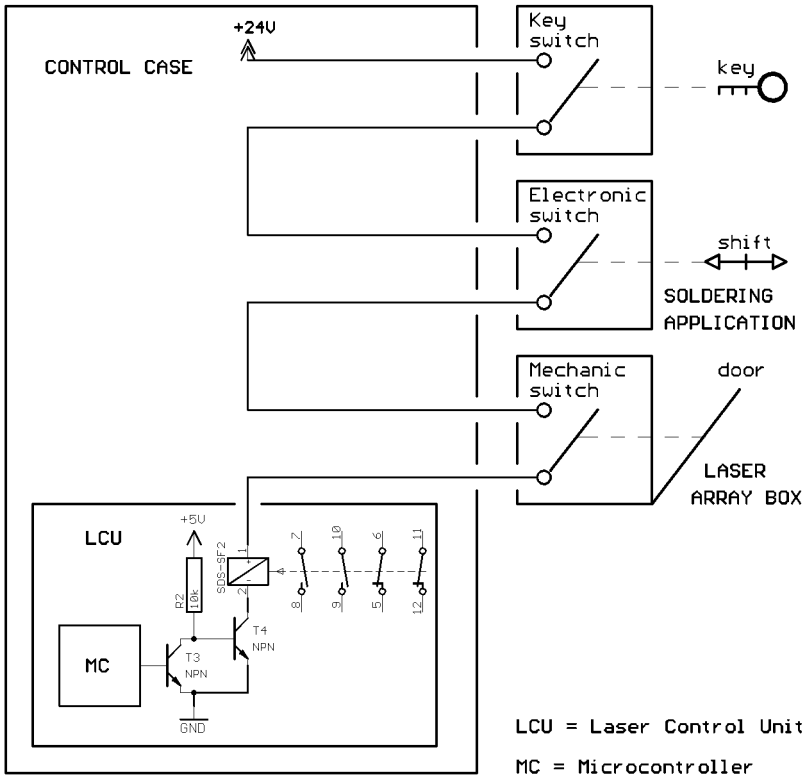
3.3 Allocation ACU / LCU to Arrays



3.4 Cooling Diagram

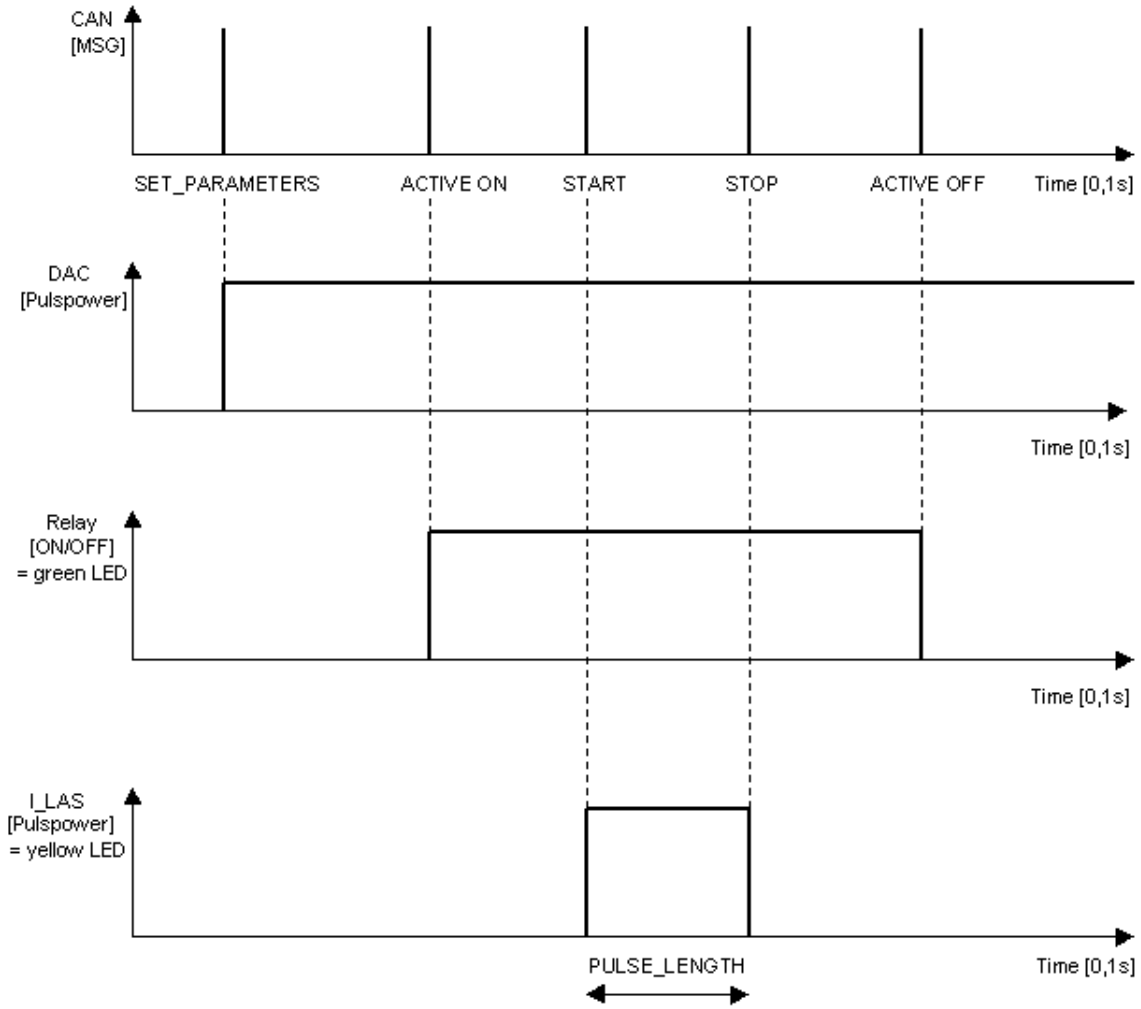


3.5 Safety Interlock

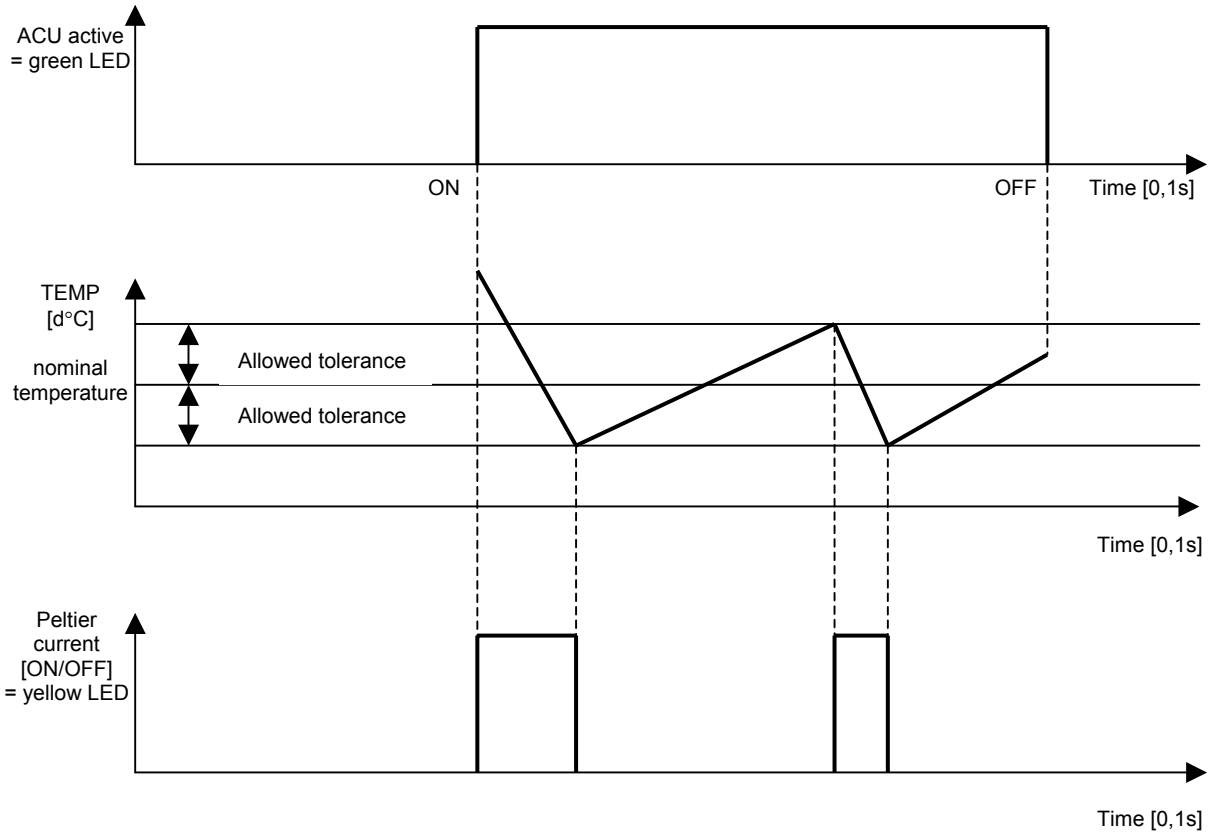


3.7 Timing Diagrams

3.7.1 LCU Timing



3.7.2 ACU Timing



4. Technical Data

Each LASO- System is special configurated depending on the customer requirements. For that reason the technical data are application and customer specific. We attach a specific datasheet and a final test protocol by delivery of each system.

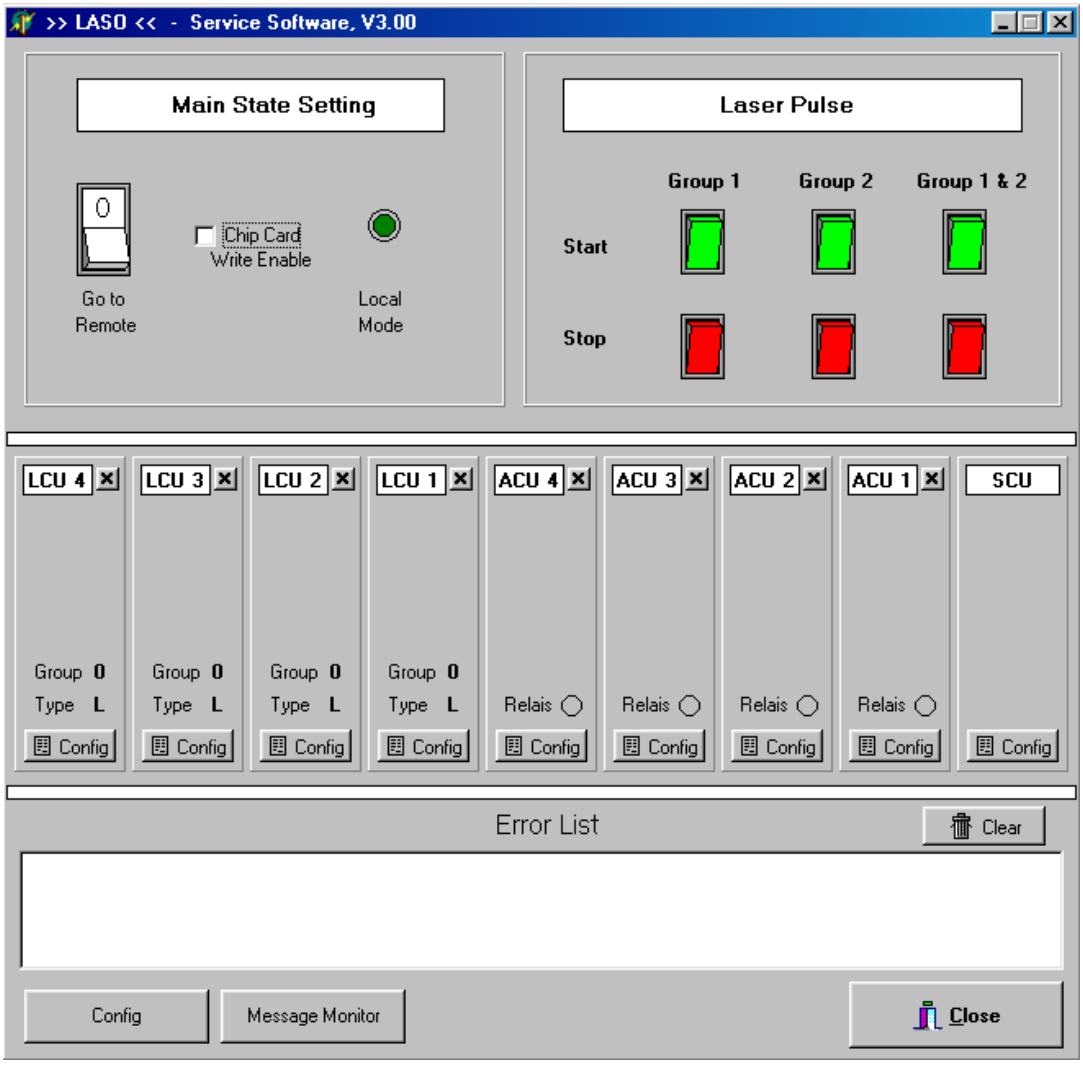
B Service Software

1. Introduction

The service program for the project LASO performs first of all the setting and reading of all the parameters in the LASO system and searching of any failure, which is findable per software. The control of the device in an application is provided by the user software, or is controlled from digital inputs. The system parameters can be loaded from the chip card.

The software can communicate with the device per CAN-Bus or serial interface RS232. It can be also set in the system parameters.

2. Main Form



The design of the main form responds to the control case of the device. There are mostly 9 units: 4 Laser Control Units (LCU), 4 Array Control Units (ACU) and one System Control Unit (SCU). In case of then full casting, which is limited from the system to 8 LCUs, 8 ACUs and 1 SCU, the main form can also be expanded.

In the upper section there is the Main State Setting and Laser Pulse Buttons. Thereunder are nine (ev. 17) slots, which can be allocated to its unit or stand free. Under the slots there are buttons for configuration setting, monitoring of the communication and closing of the program.

2.1 Main State Setting

The device can take two basic states: Local Mode and Remote Mode.
In the Local Mode the device ignores all the commands from the PC, except the commands for main state setting. All the settings, asks or commands, are accepted only in the Remote Mode. A click on the switch button changes the main state according to the label below the button. The actual main state is indicate by the pilot light with its label beside the button.

A special command ‘go to remote with chip card write enabled‘ is sent after the click on the pertinent switch button on the right.

2.2 Laser Pulse Buttons

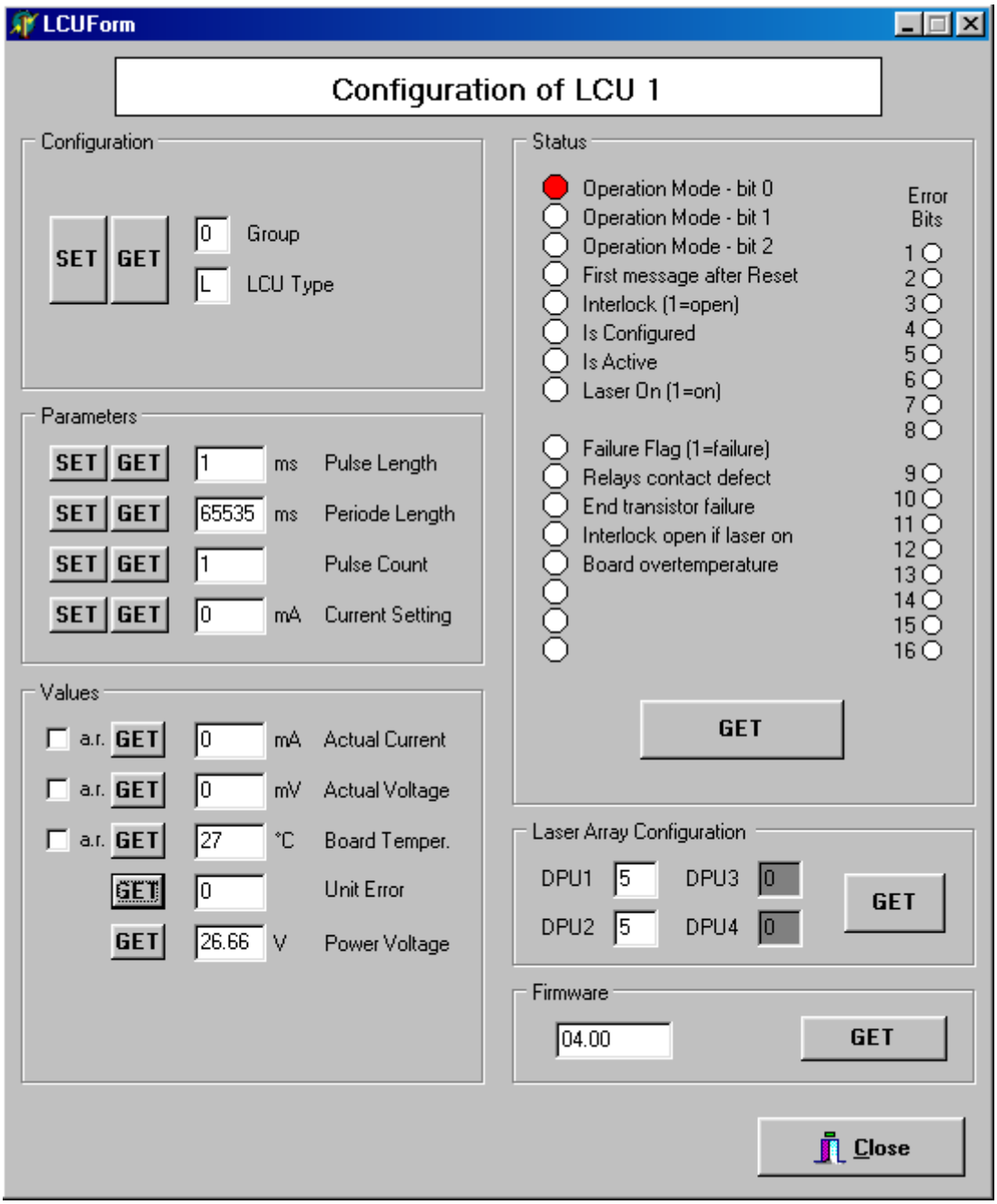
All the Laser Control Units can be situated into two different groups: group 1 or 2. If the group number of the LCU is not set (group number zero), the LCU is not activated and the relevant lasers can‘t emit any pulses.

The green buttons start the laser pulse of the relevant group. The third button activates or deactivates both groups. The length of the pulses depends on the setting of the parameter ‘pulse length‘. If the pulse length is long enough, the puls can be stopped before time, when the relevant stop button with red colour is pressed. Normally the stop button isn’t needed.

2.3 Unit Slots

If the unit slot is not allocated, a click on the empty slot activates the allocation. If a unit is already allocated, a click on the close button (the button up right on the unit, with a cross, like a window system button) will free the unit slot. The System Control Unit must be allways present, so it has no close button. The button with the label ‘config‘ on the unit invokes the settings form.

3. Laser Control Unit



The LCU disposes of a many parameters, which can be set or read in the settings form.

Read / write parameters:

Group	group number of the LCU
	integer 0, 1 or 2 (0 = not active)
	edited in the edit field

LCU Type	type of the LCU characters: 'L' = Low, 'M' = Medium, 'H' = High or 'X' = eXtremely high power edited in the edit field
Pulse Length	length of the laser pulse integer 0 .. 65000 ms edited in the edit field
Period Length	length of the laser period integer 0 .. 65000 ms edited in the edit field
Pulse Count	Number of laser pulses integer 0 .. 99 edited in the edit field
Current Setting	laser current during the pulse integer 0 .. 3000 mA edited in the edit field

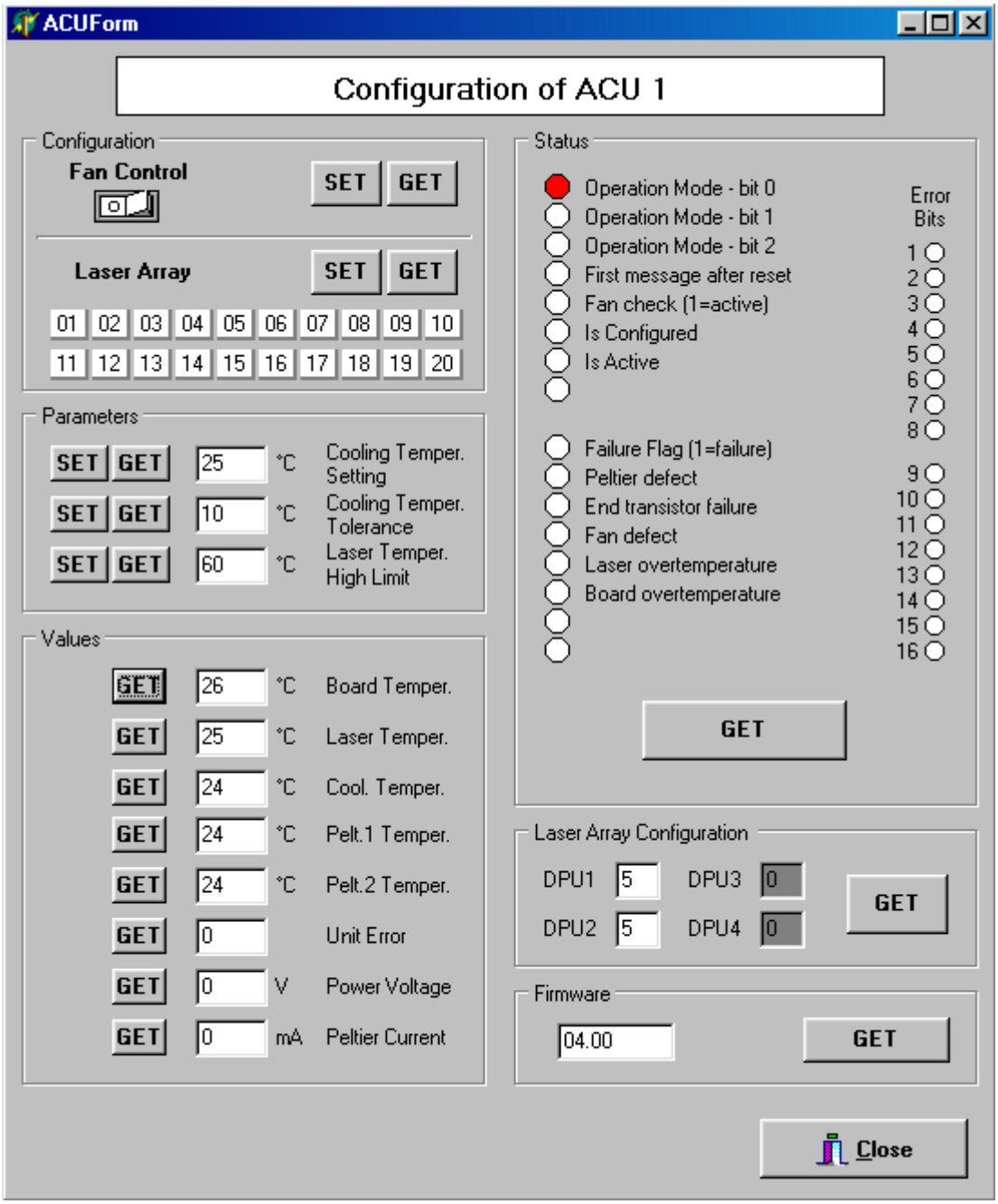
Read only parameters:

Actual Current	actual laser current integer 0 .. xxx mA shown in the edit field
Actual Voltage	actual laser voltage integer 0 .. xxx V shown in the edit field
Board Temperature	actual temperature of the current controller on the LCU board integer 0 .. xxx °C shown in the edit field
Unit Error	last error number of the LCU shown in the edit field integer (error number table)
Power Voltage	actual power voltage

	integer 0 .. xxx V shown in the edit field
Status	actual status of the LCU 2 bytes shown in the 2 x 8 pilot lights
Laser Array Configuration	configuration of the arrays DPU1..4 integer 0 .. 5 shown in the edit field
Firmware Version	firmware version of the LCU software String in the format NN.NN shown in the edit field

A click on the SET button sends the setting message, and if there is no communication error the value contained in the edit field will be set in the relevant LCU. A click on the GET button sends the read message and if there is no communication error the value appears in the edit field or pilot lights.

4. Array Control Unit



The ACU parameters can also be set, or read in the relevant settings form.

Read / write Parameters:

Active	active property of the ACU off = not active, on = active set using switch button
Laser Array	array of the 20 laser relais

they can be switched on or off with switch button array
green colour of the button = on, white colour = off
on means laser is shorted.

Cooling Temperature Setting required temperature on the laser cooler
integer 0 .. 99 °C
edited in the edit field

Cooling Temperature Tolerance bounds for the cooling overtemperature warning
integer 0 .. 99 °C
edited in the edit field

Laser Temperature High Limit upper limit for the laser overtemperature warning
integer 0 .. 99 °C
edited in the edit field

Read only parameters:

Board Temperature actual temperature on the current controller on the ACU board
integer 0 .. 99 °C
shown in the edit field

Laser Temperature average value of the actual temperature of all laser packages
integer 0 .. 99 °C
shown in the edit field

Cooling Temperature average value of both Peltier elements temperature
integer 0 .. 99 °C
shown in the edit field

Peltier 1 Temperature actual temperature of Peltier element 1
integer 0 .. 99 °C
shown in the edit field

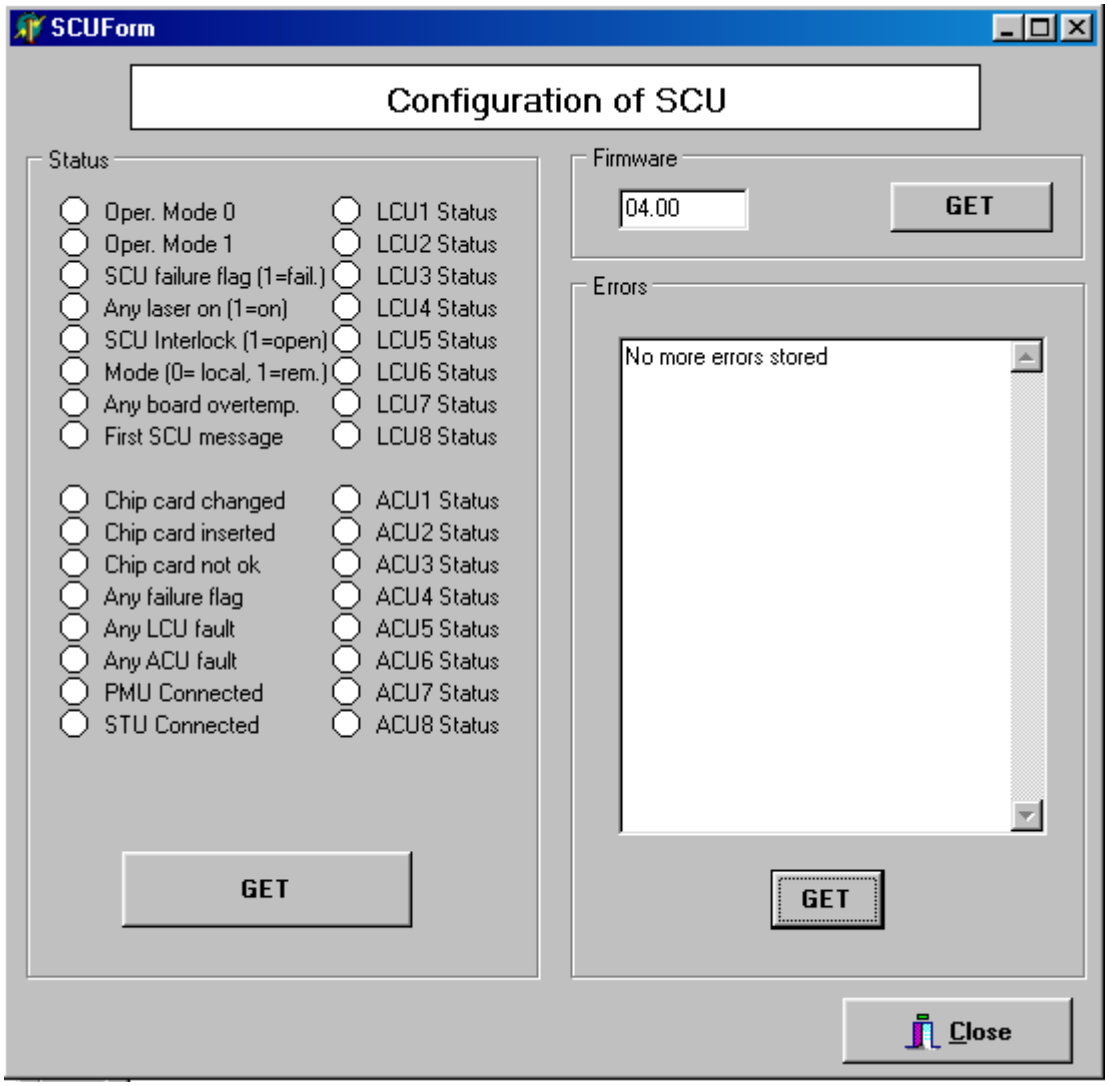
Peltier 2 Temperature actual temperature of the Peltier element 2
integer 0 .. 99 °C
shown in the edit field

Unit Error last error number of the ACU
shown in the edit field

	integer (error number table)
Power Voltage	actual power voltage integer 0 .. xxx V shown in the edit field
Peltier Current	actual laser current integer 0 .. xxx mA shown in the edit field
Status	actual status of the ACU 2 bytes shown in the 2 x 8 pilot lights
Laser Array Configuration	configuration of the arrays DPU1..4 integer 0 .. 5 shown in the edit field
Firmware Version	firmware version of the ACU software String in the format NN.NN shown in the edit field

A click on the SET button sends the setting message, and if there is no LCU error free sets the value contained in the edit field in the relevant ACU. A click on the GET button sends the read message and if there is no communication error the value appears in the edit field or pilot lights.

5. System Control Unit



The SCU has no parameter to set. The unit sends only answers on the status, firmware or last error requests.

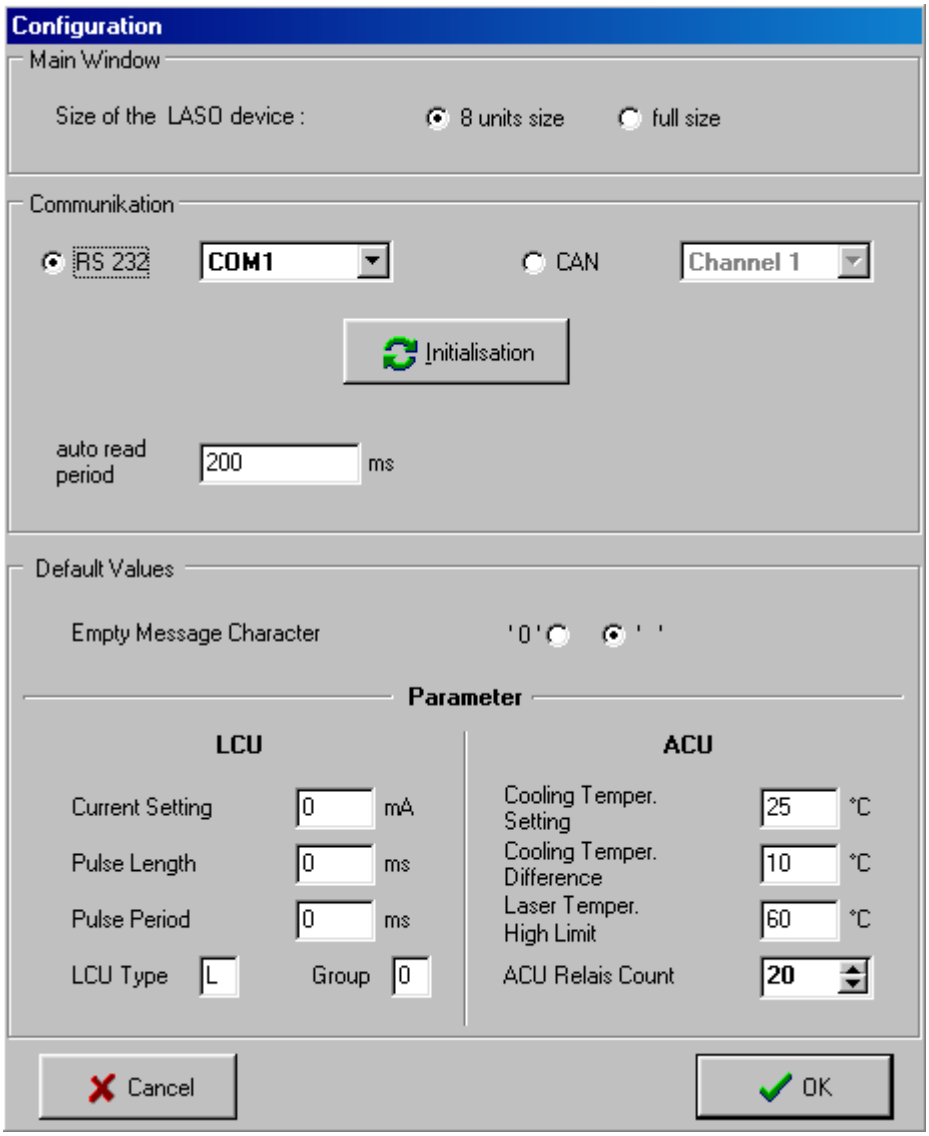
Parameters read only:

Status	actual status of the SCU 4 bytes shown in the 4 x 8 pilot lights
Firmware Version	firmware version of the SCU software String in the format NN.NN shown in the edit field
Last Stored Error	last error number stored in the SCU error buffer shown in the memo box

shown as rows with an error account

A click on the GET button sends the read message and if there is no communication error free appears the value in the edit field, pilot-lights or memo box.

C6. Configuration Form



The configuration setting pertains to the application size, the kind of communication interface and default values of the some units parameters. The set values are stored when the application closes and on the newly application start the values will be loaded again.

The application size can be 8 LCU/ACU units or 16 (full allocation) LCU/ACU units, so the overall units count can be 9 or 17 inclusive SCU.

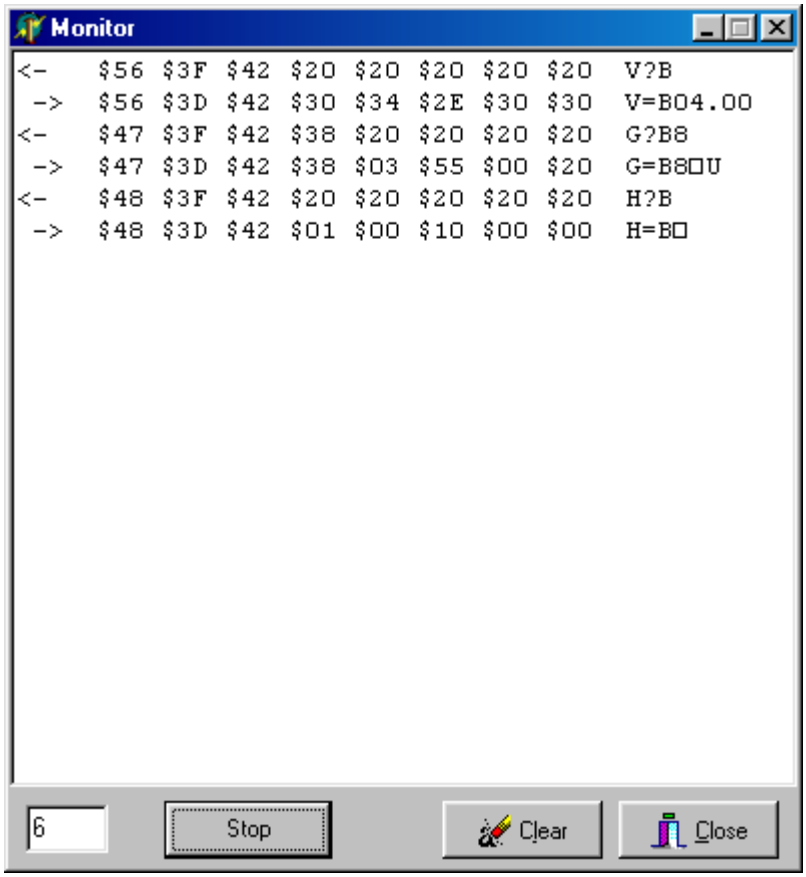
The communication proceeds either per CAN interface or serial interface RS232. In case of CAN interface the PC must dispose of the CAN card with the corresponding software driver. The user can choose between CAN channel 1 or 2, which means

with the two connectors on the CAN interface board. If the serial interface is used, the user has to choose COM number (from 1 to 4).
If the communication interface has been changed, the interface must be initialized, otherwise the communication will not work!

All the units parameters are initialized on the application start with its default value. Some of these default values can be preset. Otherwise the parameter will be set to zero. The configuration form contains the presetting of the values:

Empty Message Character	empty characters in the question-messages zero character (ASCII $30) or spare character (ASCII $20)
Current Setting	current setting on the laser pulse of all LCUs 0 .. 3000 mA
Pulse Length	length of the laser pulse of all LCUs 0 .. 65 000 ms
Group	group number of all LCU 0, 1 or 2
LCU Type	type of all LCUs ‘L‘, ‘M‘, ‘H‘ or ‘X‘
Cooling Temperature Setting	required temperature on the laser cooler of all ACUs 0 .. 99 °C
Cooling Temperature Tolerance	bounds for the cooling overtemperature warning 0 .. 99 °C
Laser Temperature High Limit	upper limit for the laser overtemperature warning 0 .. 99 °C
ACU Relais Count	size of the relais array on all ACUs 1 .. 20

7. Message Monitor



All the received and transmitted messages can be monitored with the message monitor. It is a simple text box, where the content of the message appears in a form of a byte string. Before the byte string there is an arrow (‘<-‘ or ‘->‘), that shows the message direction: message with the arrow left was transmitted, with the arrow right was received.

The button ‘Start‘ resp. ‘Stop‘ can unblock resp. block the monitoring. The button ‘Clear‘ erases the whole content of the text box. ‘Close‘ will close the window.

C Operating Manual

1. General Description

For controlling the laser soldering unit an external device like a PC or a handheld terminal can be connected to the SCU unit placed in the Laser Control Case.

1.1 Communication

1.1.1 RS-232 Interface

The serial communication port is accessed via the „RS-232“ connector at the rear panel of the Control Case. The port is set to these parameters:
9600 baud, 8 data bits, 1 stop bit, odd parity, no handshake

1.1.2 CAN-Interface

The CAN-interface complies to ISO/DIS 11898 standard. The CAN connector is accessed via the “CAN 1” or “CAN 2” connector at the front panel of the Laser Control Case. The interface is set to these parameters:
100kBit/sec

1.2 Power On Defaults

During power on reset the LASO system is initialised to a defined, save default state. The default configuration is:

- control unit in local mode
- no LCU is active (all set to ‘low power type’ and inactive),
- pulse time is set to 1ms
- pulse period is set to 2ms
- number of generated laser pulses is set to 1
- LCU current is set to 0 mA

- no ACU active
- no ACU fan control switched on
- array cooling temperature set to 25 °C
- array cooling tolerance set to 5°C
- maximum laser temperature set to 60°C
- laser switch relais all deactivated

In case of an inserted, valid chip card the default configuration is overwritten by chip card data. The system is configured according to the valid data.

2. Remote Commands

The terminal (PC or service terminal) can configure and control the LASO system by sending remote commands (RC) to the LASO SCU via CAN or RS-232. The SCU does all necessary communication with the LCU und ACU units in the LASO system.

2.1 Data Format and Timing

A remote command is defined as follows

command ‚A' .. ‚Z'	operator ‚:', ‚?', ='	data 1 .. 6 bytes

Command:
For each remote command a different capital letter is reserved. Keep in mind that the remote commands are case sensitive.

Operator:
The operator determines whether the selected command/value

- has to be written (':', followed by data)
- has to be read ('?', without data)
- is an answer on a read command ('=', with data).

Data:

This field is filled with data formatted according to the command. Only integer values are allowed. In commands that addresses LCUs or ACUs the first data byte always specifies the selected unit.

Remote Command Format:

All RCs are 8 bytes long. Not used data bytes are filled with spaces (ASCII 0x20).
Data values have to be filled in with leeding zeros.
No command confirmation is provided.
Multiple commands are not allowed to be in a command line.

Timing and Error Handling for RS 232 communication:

No minimal interbyte time exists.
A receiver has to control the serial communication on timeout. After an exeeding interbyte time of 1s all bytes of the corrupted command are becoming invalid and a pending command request has to be repeated.
The SCU has to start with a requested answer within a time of 3 seconds. Otherwise the command request has to be repeated.

Timing and Error Handling for CAN communication:

The SCU has to start with a requested answer within a time of 3 seconds. Otherwise the command request has to be repeated.

CAN communication:

For the CAN communication a CAN message is of the format:

From →	To	Identifier	RTR	DLC	Data
PC	SCU	0x3A0	0	8	see RC definition
SCU	PC	0x348	0	8	see RC definition
Service Terminal	SCU	0x390	0	8	see RC definition
SCU	Service Terminal	0x348	0	8	see RC definition

2.2 Remote Command Survey

In all commands refering to one or more units the byte after the operator determines the address of the selected unit.

‘A’	all LCUs
‘B’	LCU 1
‘C’	LCU 2
‘D’	LCU 3
‘E’	LCU 4
‘F’	LCU 5
‘G’	LCU 6
‘H’	LCU 7
‘I’	LCU 8
‘J’	SCU
‘K’	ACU 1
‘L’	ACU 2
‘M’	ACU 3
‘N’	ACU 4
‘O’	ACU 5
‘P’	ACU 6
‘Q’	ACU 7
‘R’	ACU 8
‘S’	STU
‘T’	PMU

All communication is initiated by the Master (PC or service terminal), the SCU always acts as Slave.

2.2.1 Unit Configuration and Parameters

The components of a LASO system can be configured by

1. inserting a chip card with configuration and parameter data
2. sending the LCU and ACU configuration remote commands any time.

A LCU and the corresponding ACU with the laser array can be switched to active or inactive state by one single remote command. Furthermore several laser arrays can

be logically combined in 2 groups which makes it possible that a laser pulse for group 1 or 2 is started or stopped.

The configuration setting for a LCU and ACU can be made by the command:

'C:B1M '	LCU 1 is active, belongs to group 1 and is of medium power type; ACU 1 is active

For changing operating parameters for LCUs and ACUs the LASO system supports multiple commands:

LCU Parameters:

The LCU controls the value and the length of a laser pulse.

The *current* value in mA, the *pulse length* value in ms and the the *pulse period length* value in ms can be changed by the user. Also the *amount of laser pulses* can be configured.

'I:A01000'	laser current setting for all LCUs is 1000mA
'Z:C00500'	laser pulse length setting for LCU 2 is 500ms
'O:C01000'	laser pulse period length setting for LCU 2 is 1000ms
'P:B1 '	LCU 1 generates one laser pulse

ACU Parameters:

The ACU controls the laser cooler temperature. It should be choosen to be in the safe temperature range. Practically a current is controlled which flows into the peltier part. The value of the current corresponds to the temperature difference between a laser cooler and a reference cooler. A two point control is defined by the *nominal temperature* and the *allowed tolerance temperature*.

Additionally the ACU controls the *maximum laser temperature*.

'B:K130 '	set the nominal temperature for cooler for all ACUs to 30°C (here 'K' is dummy unit number, '1' is selector for nominal temperature for the laser array cooler)
'B:K205 '	set the tolerance for the cooler for all ACUs to 5°C (here 'K' is dummy unit number, '2' is selector for allowed tolerance for the laser array cooler)

‘B:K350 ’	set maximum laser temperature for all ACUs to 50°C (here ‘K’ is dummy unit number, ‘3’ is selector for max. laser temperature)

LASO also supports the possibility of switching a certain laser on or off.
For this a laser, deactivated by the “Switch ACU Relais”-command, is shortened by hardware.

‘F:7FFFF$00 ’	laser array 7: laser 1 .. 20 on/off according to bitmask (xx$x: fill in no ASCII bytes but hexadecimal coded bytes!)

Each ACU also can be configured to control a fan of the laser array. If the feature fan control is active the ACU sends an error number if the fan signal is missing.

‘D:M1 ’	ACU 3 fan control is active

Parameters are not taken over during an ongoing laser pulse.

2.2.2 Reading Unit Parameters and Measured Values

All unit configuration data and parameters can be requested directly from the corresponding unit.

‘C?B ’	read LCU 1 configuration data
‘D?L ’	read ACU 2 fan control setting
‘I?I ’	read current setting value from LCU 8
‘Z?C ’	read pulse time setting value from LCU 2
‘O?C ’	read pulse period time setting value from LCU 2
‘P?B ’	read number of generated pulses from LCU 1
‘B?K3 ’	read maximum laser temperature from ACU 1
‘F?4 ’	read shortened laser of laser array 4

Furthermore there exists many commands for reading measured values from LASO units.

‘A?D ’	read measured laser current from LCU 3

‘U?E ’	read measured laser array voltage from LCU 4
‘G?R4 ’	read peltier 1 temperature from ACU 8

2.2.3 Controlling Operation

Local Mode / Remote Mode:

The LASO system may operate as standalone device or controlled by PC. To specify this operation mode the LASO SCU distinguishes between local (=standalone) and remote (=PC) mode.

For changing the SCU operation mode use the commands like this

‘R:1 ’	set remote mode with writing parameters to chip card enabled
‘L: ’	set local mode

Initiating a laser pulse or stop a laser pulse by a RC like this

‘T:1 ’	start laser pulse for group 1
‘S:3 ’	stop laser pulse, both groups

2.2.4 Miscellaneous Commands

For controlling the whole system it is important to know the status of the LASO units. Get additional information by using the “get status” command

‘H?J ’	get status of SCU

For service purposes a RC for reading the firmware version code of each unit is available

‘V?K ’	get ACU 1 firmware version

The LASO SCU manages a volatile LIFO buffer for 16 failure entries. Each detected failure is stored as a failure code which can be read out by a RC

‘E? ’	get last stored failure entry and delete it afterwards

In communication the LASO SCU acts as a Slave. So the SCU can not report detected errors by itself but it can answer to a detected faulty remote command with a “command error”-command

‘Y=4 ’	wrong command operator detected

2.3 Remote Command Reference

Some RC are defined with more than one possible operator. For read commands (operator = ‘?’) the answer from the SCU (operator = ‘=’) is nearly of the same format as the write command (operator = ‘:’)

2.3.1 Unit Configuration and Parameters

C:<u><group><type>	**LCU/ACU configuration**
Function:	Configure or reconfigure a LCU unit and the corresponding ACU unit.
Notes:	A LCU always accepts this command except a laser pulse being active. When LASO is in remote mode with the feature “writing parameters to chip card” enabled the configuration is also written to chip card. Addressing a LCU and setting it to group 1 or 2 the corresponding ACU is set to active too, e.g. when setting LCU 1 (‘B’) to group 2 ACU 1 (‘K’) is automatically set to active. Operator ‘=’ is possible (answer belongs to LCU unit).
Parameters: <u>	‘B’ .. ‘I’: address of selected unit
<group>	‘0’: LCU set to inactive state / ACU inactive ‘1’: LCU belongs to group 1 / ACU active ‘2’: LCU belongs to group 2 / ACU active

	<type>	‘L’: low power type
		‘M’: medium power type
		‘H’: high power type
		‘X’: extremely high power type
Examples:		C:C1M

D:<u><switch>		**ACU fan control**
Function:		Switch ACU fan control on or off.
Notes:		An ACU always accepts this command except a laser pulse being active. When LASO is in remote mode with the feature “writing parameters to chip card” enabled the configuration is also written to chip card. Operator ‘=’ is possible.
Parameters:	<u>	‘K’ .. ‘R’: address of selected unit
	<switch>	‘0’: switch off fan control
		‘1’: switch on fan control
Examples:		D:D1

I:<u><value>		**LCU Current Setting**
Function:		Sets the nominal laser current in mA.
Notes:		A LCU always accepts this command except a laser pulse being active. When LASO is in remote mode with the feature “writing parameters to chip card” enabled the setting is also written to chip card. Operator ‘=’ is possible.
Parameters:	<u>	‘A’: all LCUs (not for operator ‘=’)
		‘B’ .. ‘I’: address of selected unit
	<value>	0 .. 30000
Examples:		I:A01000
		I :D00500

Z:<u><value>	**LCU Pulse Time Setting**

Function:		Sets the nominal laser pulse time in ms.
Notes:		A LCU always accepts this command except a laser pulse being active. When LASO is in remote mode with the feature “writing parameters to chip card” enabled the setting is also written to chip card. If a laser pulse is started and the value pulse time setting is bigger than the value pulse period setting the pulse period value is automatically set to the maximum value. Operator ‘=’ is possible.
Parameters:	<u>	‘A’: all LCUs (not for operator ‘=’) ‘B’ .. ‘I’: address of selected unit
	<value>	0: continuous mode till stop command received 1 .. 65000
Examples:		Z:A00500 Z:B00000

O:<u><value>	**LCU Pulse Period Setting**
Function:	Sets the nominal laser pulse period time in ms.
Notes:	A LCU always accepts this command except a laser pulse being active. When LASO is in remote mode with the feature “writing parameters to chip card” enabled the setting is also written to chip card. If a laser pulse is started and the value pulse time setting is bigger than the value pulse period setting the pulse period value is automatically set to the maximum value. Operator ‘=’ is possible.
Parameters: <u>	‘A’: all LCUs (not for operator ‘=’) ‘B’ .. ‘I’: address of selected unit
<value>	1 .. 65000

Examples: Z:A00500
Z:B00000

P:<u><value>	**LCU Pulse Count Setting**
Function:	Sets the number of generated laser pulses.
Notes:	A LCU always accepts this command except a laser pulse being active. When LASO is in remote mode with the feature “writing parameters to chip card” enabled the setting is also written to chip card. Operator ‘=’ is possible.
Parameters: <u>	‘A’: all LCUs (not for operator ‘=’) ‘B’ .. ‘I’: address of selected unit
<value>	01..99
Examples:	P:A01 P:B99

B:<u><identifier><value>	**ACU Temperature Setting**
Function:	Sets the nominal temperature for the laser array cooler, the allowed tolerance for the laser array cooler and the maximum laser temperature. All values in °C.
Notes:	This command always concerns to all ACUs. When LASO is in remote mode with the feature “writing parameters to chip card” enabled the setting is also written to chip card. Operator ‘=’ is possible.
Parameters: <u>	‘K’ .. ‘R’: dummy value for address of selected unit! Operator ‘=’: address of selected unit
<identifier>	‘1’: nominal temperature for the laser array cooler ‘2’: allowed tolerance for the laser array cooler ‘3’: maximum laser temperature
<value>	0 .. 99

Examples: B:K125
B:K205
B:K350

F:<laser array> <value1><value2><value3>		**ACU Switch Relais**
Function:		Assigns shortened laser for a laser array.
Notes:		value1 – value3: hexadecimal bytes.
		Bitmasks for shortened lasers.
		1 = laser shortened
		Operator '=' is possible.
Parameters:	<laser array>	'1' .. '8': selected laser array
	<value1>	bit 0: laser 1
		.
		.
		bit7: laser 8
	<value2>	bit 0: laser 9
		.
		.
		bit7: laser 16
	<value3>	bit 0: laser 17
		.
		.
		bit3: laser 20
		else: not defined
Examples:		F:1$01$0F$08
		F:8FFFF$00

2.3.2 Reading Unit Parameters and Measured Values

Some RC are defined with more than one possible operator. For read commands (operator = '?') the answer from the SCU (operator = '=') is nearly of the same format as the write command (operator = ':').

For answers of the RC ‘C’, ‘D’, ’I’, ‘Z’, ‘B’ and ‘F’ please see *Unit Configuration and Parameters*.

C?<u>	**LCU configuration**
Function:	Read configuration of LCU unit.
Notes:	A LCU always accepts this command except a laser pulse being active.
Parameters: <u>	‘B’ .. ‘I’: address of selected unit
Examples:	C?C

D?<u>	**ACU fan control**
Function:	Read fan control configuration of ACU unit.
Notes:	none
Parameters: <u>	‘K’ .. ‘R’: address of selected unit
Examples:	D?L

D=<u><switch>	**ACU fan control**
Function:	Answer for ACU unit fan control configuration.
Notes:	Only sent by SCU after request D?<u>
Parameters: <u>	‘K’ .. ‘R’: address of selected unit
<switch>	‘0’: ACU fan control switched off
	‘1’: ACU fan control switched on
Examples:	D=R0

I?<u>	**LCU Current Setting**
Function:	Request nominal laser current in mA.
Notes:	A LCU always accepts this command except a laser pulse is being active.
Parameters: <u>	‘B’ .. ‘I’: address of selected unit
Examples:	I ?D

Z?<u>	**LCU Pulse Time Setting**
Function:	Request nominal laser pulse time in ms.

Notes:	A LCU always accepts this command except a laser pulse is being active:
Parameters: <u>	'B' .. 'I': address of selected unit
Examples:	Z?B

O?<u>	**LCU Pulse Period Setting**
Function:	Request nominal laser pulse period time in ms.
Notes:	A LCU always accepts this command except a laser pulse is being active:
Parameters: <u>	'B' .. 'I': address of selected unit
Examples:	Z?B

P?<u>	**LCU Pulse Count Setting**
Function:	Request number of generated laser pulses.
Notes:	A LCU always accepts this command except a laser pulse is being active:
Parameters: <u>	'B' .. 'I': address of selected unit
Examples:	P?D

B?<u><identifier>	**ACU Temperature Setting**
Function:	Read the nominal temperature for the laser array cooler, the allowed tolerance for the laser array cooler or the maximum laser temperature.
Notes:	none
Parameters: <u>	'K' .. 'R': address of selected unit!
<identifier>	'1': read nominal temperature for the laser array cooler '2': read allowed tolerance for the laser array cooler '3': read maximum laser temperature
Examples:	B?K1 B?M2 B?R3

F?<laser array>	**ACU Switch Relais**

Function:		Read assigned shortened laser to a laser array.
Notes:		none
Parameters:	<laser array>	'1' .. '8': selected laser array
Examples:		F?1

A?<u>	**LCU Read Current**
Function:	Request measured laser current of LCU.
Notes:	none
Parameters: <u>	'B' .. 'I': address of selected unit
Examples:	A?D

A=<u><value>	**LCU Read Current**
Function:	Measured laser current of LCU in mA.
Notes:	Only sent by SCU after request **A?<u>.**
Parameters: <u>	'B' .. 'I': address of selected unit
<value>	0 .. 30000
Examples:	A=D01000

U?<u>	**LCU Read Voltage**
Function:	Request measured laser voltage of LCU.
Notes:	none
Parameters: <u>	'B' .. 'I': address of selected unit
Examples:	U?E

U=<u><value>	**LCU Read Voltage**
Function:	Measured laser voltage of LCU in mV.
Notes:	Only sent by SCU after request **U?<u>.**
Parameters: <u>	'B' .. 'I': address of selected unit
<value>	0 .. 99000
Examples:	U=E09000

G?<u><identifier>	**Read Temperature**

Function:		Request board temperature, laser temperature, ACU temperature, ACU peltier 1 temperature or ACU peltier 2 temperature.
Notes:		Identifier ‘2’ .. ‘5’ only for units ‘K’ .. ‘R’ (ACUs)
Parameters:	<u>	‘B’ .. ‘I’, ‘K’ .. ‘T’: address of selected unit
	<identifier>	‘1’: board temperature ‘2’: laser temperature ‘3’: ACU temperature ‘4’: ACU peltier 1 temperature ‘5’: ACU peltier 2 temperature
Examples:		G?L2 G ?B1

G=<u><identifier> <value>	**Read Temperature**
Function:	Measured board temperature, laser temperature, ACU temperature, ACU peltier 1 temperature or ACU peltier 2 temperature in °C.
Notes:	Only sent by SCU after request **G?<u><identifier>.** Identifier ‘2’ .. ‘5’ only for units ‘K’ .. ‘R’ (ACUs).
Parameters: <u>	‘B’ .. ‘I’, ‘K’ .. ‘T’: address of selected unit
<identifier>	‘1’: board temperature ‘2’: laser temperature ‘3’: ACU temperature ‘4’: ACU peltier 1 temperature ‘5’: ACU peltier 2 temperature
<value>	0 .. 99
Examples:	G=L255

2.3.3 Controlling Operation

R:<switch>	**Goto Remote Mode with writing protection enabled/disabled**

Function:	Sets the LASO system into remote mode. The feature ‘writing parameters to chip card’ could be enabled or disabled.
Notes:	none
Parameters: <switch>	‘0’: writing parameters to chip card disabled ‘1’: writing parameters to chip card enabled
Examples:	R:0

L:	**Goto Local Mode**
Function:	Sets the LASO system into local mode.
Notes:	none
Parameters:	
Examples:	L:

T:<group>	**Start Laser Pulse**
Function:	Start laser pulse for LCU group.
Notes:	none
Parameters: <group>	‘1’: start laser pulse for LCU group 1 ‘2’: start laser pulse for LCU group 2 ‘3’: start laser pulse for LCU group 1 and 2
Examples:	T:3

S:<group>	**Stop Laser Pulse**
Function:	Stop laser pulse for LCU group.
Notes:	none
Parameters: <group>	‘1’: stop laser pulse for LCU group 1 ‘2’: stop laser pulse for LCU group 2 ‘3’: stop laser pulse for LCU group 1 and 2
Examples:	S:3

2.3.4 Miscellaneous Commands

H?<u>	**Get Status**
Function:	Request present unit status.

Notes:	none
Parameters: <u>	'B' .. 'T': address of selected unit
Examples:	H?J

H=<u><value1><value2><value3><value4><value5>	**Get Status**
Function:	Contains present unit status.
Notes:	Only sent by SCU after request **H?<u>.** value 1 .. value 5: hexadecimal bytes.
Parameters: <u>	'B' .. 'T': address of selected unit
<value1>	hexadecimal bytes,
.	see *Appendix B, Unit Status Information*
.	
<value5>	
Examples:	H=J$00$02$00$00$01

V?<u>	**Get Version**
Function:	Read version code.
Notes:	none
Parameters: <u>	'B' .. 'T': address of selected unit
Examples:	V?C

V=<u><version>	**Get Version**
Function:	Contains version code.
Notes:	Only sent by SCU after **U?<u>.**
Parameters: <u>	'B' .. 'I': address of selected unit 'ss.ff'
<version>	ss: system version code, has to fit with system version code of other units ff: firmware version code
Examples:	V=C01.01

E?	**Get Error**

Function:	Read last detected error.
Notes:	none
Parameters:	none
Examples:	E?

E=<error>	**Get Error**
Function:	Contains last detected error and erases the error out of error buffer.
Notes:	Only sent by SCU after E**?.**
Parameters: <error>	0: no more error entries 1 .. 99: see *Appendix A: Failure Codes*
Examples:	E=00

Y=<code>	**Command Error**
Function:	SCU answer on a detected communication/command error.
Notes:	Only sent by SCU.
Parameters: <code>	‘1’: wrong parity bit ‘2’: receive buffer overflow ‘3’: wrong/undefined command ‘4’: wrong/undefined operator ‘5’: wrong command length (<> 8 bytes) ‘6’: wrong/undefined data
Examples:	Y=3

3. LASO System Programming

3.1 Quick Start

1. Connect the communication cable, either RS 232 or CAN.Use a null-modem cable and connect it with connector “RS 232” for serial communication or connect a prepared CAN cable to the connector “CAN 1” or “CAN 2”.

2. Remove an inserted chip card. Turn the power on. After power on, all parameters are set to default values. The LEDs on the front panel flashes for a short moment. After this all LEDs are turned off for 3s (startup phase). Afterwards the LED “I-Lock open” could be on (according to status of interlock switch).

3. Set system parameters and configuration by a chip card or by PC.

4. Use the Service-Software for setting parameters (see Chapter B)

3.2 Startup Phase

After power on the LASO system performs a selftest and the system will be initialized. Therefore in the first 3 seconds after power on

- the LEDs are turned off (after a short flash at the beginning)
- no communication is possible
- the SCU sends no cyclic status message on CAN
- active units are not controlled on a cyclic status message on CAN

Afterwards the LEDs are turned on according the corresponding status, communication is possible and normal LASO operation has started.

3.3 Local/Remote

The LASO system may operate as standalone device or controlled by PC. To specify this operation mode the LASO SCU distinguishes between local (=standalone) and remote (=PC) mode.
In local mode (default value after power on) start and stop laser pulse commands are accepted by a hardware trigger signal or by a remote command. In remote mode the whole function of the system should be controlled by the PC. Therefore an unintentionally “start laser pulse”- hardware trigger signal is refused and a failure entry is made. Changing the parameters by inserting an other chip card is just supported if the SCU is in local mode.

Function	**Local Mode (default mode)**	**Remote Mode**
Set configuration and parameters	by chip card or by PC	by PC
Get configuration and parameters	by service terminal	by PC or service terminal
Start/stop laser pulse	by start/stop laser pulse signal, by service terminal or by PC	by PC (else: refused and error entry)

3.4 Refuse Start/Stop Laser Pulse Signals

Starting a laser pulse may only be possible if there is no danger for any person and also for LASO device. Therefore a few criterias lead to the cancelation of a “start laser pulse” signal respectively command.

Criterias which cancel a “start laser pulse” action:

- interlock switch open
- faulty remote command ‘T’
- start signal by hardware or by service terminal while SCU is in remote mode (leads to a fault entry)
- any fan failure.

Also a protection against an unintentionally stop signal is given:

- a stop signal by hardware or by service terminal doesn’t stop a laser pulse when the SCU is in remote mode but leads to a fault entry.

3.5 Setting System Parameters and Configuration

System Parameters and Configuration can be set and changed in different ways:

- via PC or service terminal in a running system
- via chip card at every time (except being in remote mode).

3.5.1 Temporary Settings

When controlling the LASO system by a PC-software or if new parameters should be tested unit parameters can be set temporarily.
For this

1. bring LASO system into local mode or into remote mode *without* the parameter “writing parameters to chip card”
2. change configuration or parameters by using remote commands, e.g. “LCU Configuration” ‘C:C1M ’

All changed settings are not stored to chip card so **after power down these settings are erased**.

3.5.2 Non Volatile Setting

When the system should start with a special parameter set or if the parameter set should be changed on the fly a chip card can be inserted.

On the chip card the following parameters are stored:

- LCU 1 .. 8 group
- LCU 1 .. 8 type
- LCU 1 .. 8 laser current
- LCU 1 .. 8 pulse time
- LCU 1 .. 8 pulse period time
- LCU 1 .. 8 number of generated pulses
- ACU temperature for the laser array cooler
- ACU tolerance for the laser array cooler
- ACU maximum laser temperature
- ACU 1 .. 8 active/inactive
- ACU 1 .. 8 fan control on/off
- shortened laser to a laser array 1 .. 8

For programming parameters to the chip card

1. bring LASO system to remote mode *with* the parameter “writing parameters to chip card”
2. change configuration or parameters by using remote commands, e.g. “LCU Configuration” ‘C:C1M ’ – now every parameter is stored to chip card

or

use the external chip card programmer box.

Being in local mode a new/changed chip card is read and the parameters are distributed to LASO units.

Being in remote mode a new/changed chip card is not read and the parameters are not distributed to LASO units. **Only when bringing LASO from remote to local mode the new chip card parameters are distributed**.

3.6 Failure Buffer

LASO supports various selftest mechanisms for effective fault detection. The failure buffer is organized as a LIFO (last in first out) ring buffer and holds the 16 latest fault numbers (in maximum). Using the RC “Get Error” the latest fault is sent and is also erased automatically.
A list of all defined fault numbers is attached in Appendix A.

When controlling the LASO system by PC perform a cyclic check of the SCU status information, especially of the flag “Any Fault”(see Appendix B). If the flag is set use the RC “Get Error” for detailed information, but be aware that although a read fault is erased out of the fault buffer the fault could be still active(cycle time of detection)!

3.7 Program Example

Here a brief program example is given for a LASO system with 2 LCUs and 2 ACUs.

R:0	// set LASO into remote mode for protection against hardware or
	// service terminal signals – writing parameters to chip card is
	// disabled

I:B00100	// set LCU 1 laser current temporarily to 100mA
I:C00200	// set LCU 2 laser current temporarily to 200mA
Z:B00500	// set LCU 1 and LCU 2 pulse time temporarily to 500ms
Z:C00500	
O:B01000	// set LCU 1 and LCU 2 pulse period time temporarily to
O:C01000	1000ms
P:B1	// set LCU 1 and LCU 2 to generating a single laser pulse
P:C1	
B:K135	// set ACU parameters temporarily-
B:K205	// nominal temperature for laser array coller to 35°C
B:K350	// allowed tolerance for the laser array cooler to 5°C

	// maximum laser temperature to 50°C
F:1$00$00$00	// set ACU switch relais 1 and 2 settings temporarily-
F:2$00$00$00	// no laser is shortened
	// ($00=hexadecimal value instead of ASCII!)
D:B1	// switch on ACU 1 fan control temporarily
D:C0	// switch off ACU 2 fan control temporarily
C:B1L	// set LCU 1 configuration temporarily to group 1 and type L
	// set ACU 1 to active
C:C2M	// set LCU 2 configuration temporarily to group 2 and type L
	// set ACU 2 to active
H?J	// request SCU status information
if (<value2,bit3> ==	// check SCU status information on any failure
1) then exit	
T:3	// start a laser pulse for both groups

Store all the parameters to chip card:

R:1	// set LASO into remote mode with writing parameters to chip card is enabled
I:B00100	// set LCU 1 laser current to 100mA
I:C00200	// set LCU 2 laser current to 200mA
Z:B00500	// set LCU 1 and LCU 2 pulse time to 500ms
Z:C00500	
O:B01000	// set LCU 1 and LCU 2 pulse period time to 1000ms
O:C01000	
P:B1	// set LCU 1 and LCU 2 to generating a single laser pulse
P:C1	
B:K135	// set ACU parameters -
B:K205	// nominal temperature for laser array coller to 35°C
B:K350	// allowed tolerance for the laser array cooler to 5°C
	// maximum laser temperature to 50°C
F:1$00$00$00	// set ACU switch relais 1 and 2 settings -

F:2$00$00$00 // no laser is shortened
// ($00=hexadecimal value instead of ASCII!)
D:B1 // switch on ACU 1 fan control
D:C0 // switch off ACU 2 fan control
C:B1L // set LCU 1 configuration to group 1 and type L
// set ACU 1 to active
C:C2M // set LCU 2 configuration to group 2 and type L
// set ACU 2 to active

3.8 Digital Start and Stop Signals

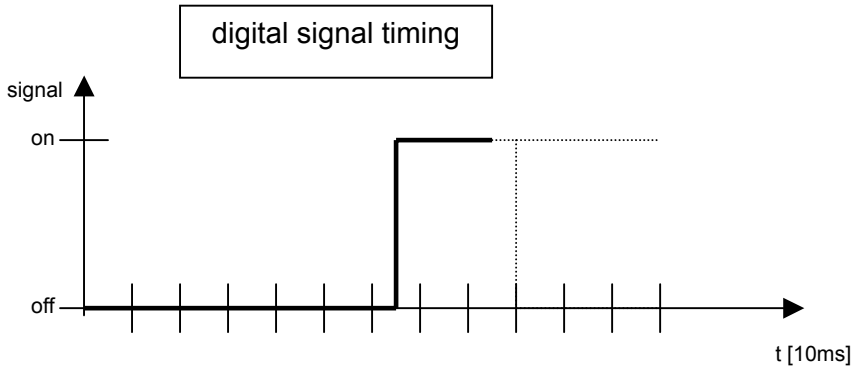
Laser pulses can be started and stopped via

a) remote commands and/or
b) digital input signals.

Input signals could be generated by an external device, e.g. a maintenance device or SPS control unit, which is connected to the 'Digital Control' connector at the rear panel of the Laser control case.
The signals are only accepted if the LASO system is in local mode.
6 digital signals are defined for the following functions:

- start group 1
- start group 2
- start group 1 + 2
- stop group 1
- stop group 2
- stop group 1 + 2

Because of safety reasons a defined signal timing has to be fulfilled



D Appendix

1. Failure Codes

The column ‘Status Information’ only concerns to the status of the LED 1-4 at the frontpanel.
A status information causes the LED 4 being turned on and a fault number being sent (answering RC “Get Error”) for the duration of the event.
E.g. a chip card communication problem is detected – the LED 4 is on and the RC “Get Error” is answered with the fault number 0x4F as long as the problem exists.

‘Status Information’ active fault numbers are prior to other fault numbers, i.e. LED 4 is controlled by these events as long as they are present. Also these fault numbers are sent on a RC “Get Error”.

Kind of Fault	**Fault Number, dec.**	**Fault Number, hex**	**Only Status Information**	**Cycle Time of Detection**
no faults stored	0	0		
Overtemperature LCU 1	1	1		2,5 s
Overtemperature LCU 2	2	2		2,5 s
Overtemperature LCU 3	3	3		2,5 s
Overtemperature LCU 4	4	4		2,5 s
Overtemperature LCU 5	5	5		2,5 s
Overtemperature LCU 6	6	6		2,5 s
Overtemperature LCU 7	7	7		2,5 s
Overtemperature LCU 8	8	8		2,5 s
Amplifier LCU 1	9	9		2,5 s
Amplifier LCU 2	10	0A		2,5 s
Amplifier LCU 3	11	0B		2,5 s
Amplifier LCU 4	12	0C		2,5 s
Amplifier LCU 5	13	0D		2,5 s
Amplifier LCU 6	14	0E		2,5 s
Amplifier LCU 7	15	0F		2,5 s
Amplifier LCU 8	16	10		2,5 s
Overtemperature Laserarray 1	17	11		2,5 s
Overtemperature Laserarray 2	18	12		2,5 s

Overtemperature Laserarray 3	19	13		2,5 s
Overtemperature Laserarray 4	20	14		2,5 s
Overtemperature Laserarray 5	21	15		2,5 s
Overtemperature Laserarray 6	22	16		2,5 s
Overtemperature Laserarray 7	23	17		2,5 s
Overtemperature Laserarray 8	24	18		2,5 s
Peltier 1 defective	25	19		2,5 s
Peltier 2 defective	26	1A		2,5 s
Peltier 3 defective	27	1B		2,5 s
Peltier 4 defective	28	1C		2,5 s
Peltier 5 defective	29	1D		2,5 s
Peltier 6 defective	30	1E		2,5 s
Peltier 7 defective	31	1F		2,5 s
Peltier 8 defective	32	20		2,5 s
LCU 1 failure	33	21		2,5 s
LCU 2 failure	34	22		2,5 s
LCU 3 failure	35	23		2,5 s
LCU 4 failure	36	24		2,5 s
LCU 5 failure	37	25		2,5 s
LCU 6 failure	38	26		2,5 s
LCU 7 failure	39	27		2,5 s
LCU 8 failure	40	28		2,5 s
ACU 1 failure	41	29		2,5 s
ACU 2 failure	42	2A		2,5 s
ACU 3 failure	43	2B		2,5 s
ACU 4 failure	44	2C		2,5 s
ACU 5 failure	45	2D		2,5 s
ACU 6 failure	46	2E		2,5 s
ACU 7 failure	47	2F		2,5 s
ACU 8 failure	48	30		2,5 s
LCU 1 internal	49	31		2,5 s
LCU 2 internal	50	32		2,5 s
LCU 3 internal	51	33		2,5 s
LCU 4 internal	52	34		2,5 s
LCU 5 internal	53	35		2,5 s
LCU 6 internal	54	36		2,5 s
LCU 7 internal	55	37		2,5 s
LCU 8 internal	56	38		2,5 s
ACU 1 internal	57	39		2,5 s

ACU 2 internal	58	3A		2,5 s
ACU 3 internal	59	3B		2,5 s
ACU 4 internal	60	3C		2,5 s
ACU 5 internal	61	3D		2,5 s
ACU 6 internal	62	3E		2,5 s
ACU 7 internal	63	3F		2,5 s
ACU 8 internal	64	40		2,5 s
Overtemperature ACU 1	65	41		2,5 s
Overtemperature ACU 2	66	42		2,5 s
Overtemperature ACU 3	67	43		2,5 s
Overtemperature ACU 4	68	44		2,5 s
Overtemperature ACU 5	69	45		2,5 s
Overtemperature ACU 6	70	46		2,5 s
Overtemperature ACU 7	71	47		2,5 s
Overtemperature ACU 8	72	48		2,5 s
Interlock open during laser pulse	73	49		0.. 2,5 s
LCU Safety relais defective	74	4A		0.. 2,5 s
Unit not initialized	75	4B		0.. 2,5 s
Fan 1 failure	76	4C		2,5 s
Fan 2 failure	77	4D		2,5 s
Fan 3 failure	78	4E		2,5 s
Fan 4 failure	79	4F		2,5 s
Fan 5 failure	80	50		2,5 s
Fan 6 failure	81	51		2,5 s
Fan 7 failure	82	52		2,5 s
Fan 8 failure	83	53		2,5 s
Wrong system version code	84	54		0.. 2,5 s
Chip Card fault	85	55	X	
Unit not in local mode	86	56	X	
not defined	87	57		

2. Unit Status Information

SCU		Name	Remarks
<value1>	bit 0	Operation Mode 0	internal information
	bit 1	Operation Mode 1	internal information
	bit 2	SCU Failure Flag (1=failure)	any SCU failure detected
	bit 3	Any Laser on (1=on)	any laser on
	bit 4	Interlock (1=open)	interlock open detected
	bit 5	Local/Remote (1=remote)	local/remote mode
	bit 6	Any Board Overtemperature	any board overtemperature
	bit 7	First Message after Reset	first CAN status message after reset
<value2>	bit 0	New Chip Card	new/changed chip card detected
	bit 1	Chip Card inserted	chip card inserted
	bit 2	Chip Card fault	any chip card fault detected
	bit 3	Any Fault	any fault detected (SCU,LCU,ACU)
	bit 4	Any LCU Fault	any LCU fault detected
	bit 5	Any ACU Fault	any ACU fault detected
	bit 6	PMU connected	PMU connected detected
	bit 7	STU connected	STU connected detected
<value3>	bit 0	LCU 1 Failure	LCU 1 failure (no CAN status message)
	bit 1	LCU 2 Failure	LCU 2 failure (no CAN status message)
	bit 2	LCU 3 Failure	LCU 3 failure (no CAN status message)
	bit 3	LCU 4 Failure	LCU 4 failure (no CAN status message)
	bit 4	LCU 5 Failure	LCU 5 failure (no CAN status message)
	bit 5	LCU 6 Failure	LCU 6 failure (no CAN status message)
	bit 6	LCU 7 Failure	LCU 7 failure (no CAN status message)
	bit 7	LCU 8 Failure	LCU 8 failure (no CAN status message)
<value4>	bit 0	ACU 1 Failure	ACU 1 failure (no CAN status message)
	bit 1	ACU 2 Failure	ACU 2 failure (no CAN status message)
	bit 2	ACU 3 Failure	ACU 3 failure (no CAN status message)
	bit 3	ACU 4 Failure	ACU 4 failure (no CAN status message)
	bit 4	ACU 5 Failure	ACU 5 failure (no CAN status message)
	bit 5	ACU 6 Failure	ACU 6 failure (no CAN status message)
	bit 6	ACU 7 Failure	ACU 7 failure (no CAN status message)
	bit 7	ACU 8 Failure	ACU 8 failure (no CAN status message)

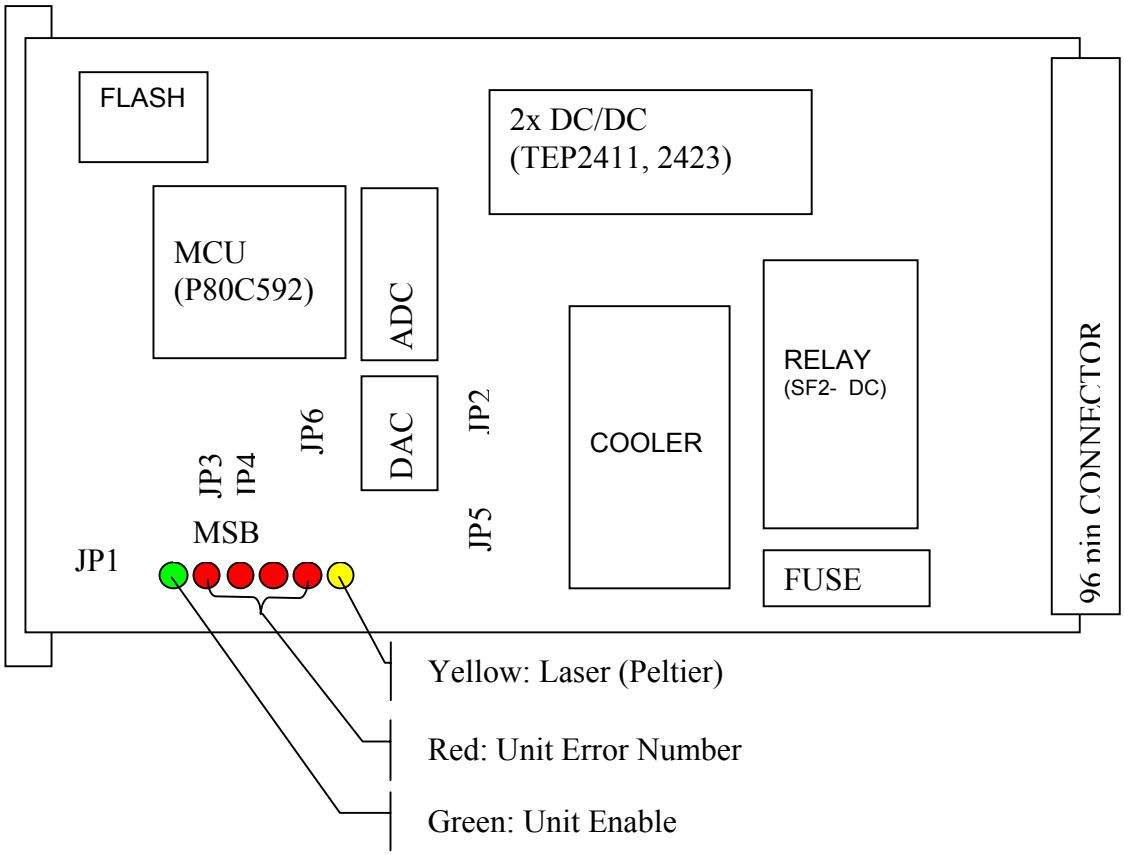
<value5>	byte	System Version Code	system version code in BCD

LCU 1 .. 8		**Name**	**Remarks**
<value1>	bit 0	Operation Mode 0	internal information
	bit 1	Operation Mode 1	internal information
	bit 2	Operation Mode 2	internal information
	bit 3	First Message after Reset	first CAN status message after reset
	bit 4	Interlock (1=open)	interlock open detected
	bit 5	Is Configurated	all parameters set
	bit 6	Is Active	unit is set to ‘active’
	bit 7	Laser on (1=on)	laser on
<value2>	bit 0	Failure Flag (1=failure)	any LCU failure detected
	bit 1	Relais Contact defective	relais contact defective
	bit 2	Amplifier defective	amplifier defective
	bit 3	Interlock open during laser pulse	Interlock open during laser pulse
	bit 4	Board Overtemperature	board overtemperature detected
	bit 5	n. d.	
	bit 6	n. d.	
	bit 7	n. d.	
<value3>	bit 0..3	LCU Group	LCU group (0,1,2)
	bit 4	LCU Type ‘L’	
	bit 5	LCU Type ‘M’	
	bit 6	LCU Type ‘H’	
	bit 7	LCU Type ‘X’	
<value4>	byte	for internal use	
<value5>	byte	for internal use	
<value6>	byte	System version code	BCD: ‘01’..’99’
<value7>	byte	n.d.	

ACU 1 .. 8		**Name**	**Remarks**
<value1>	bit 0	Operation Mode 0	internal information
	bit 1	Operation Mode 1	internal information
	bit 2	Operation Mode 2	internal information
	bit 3	First Message after Reset	first CAN status message after reset
	bit 4	Fan Control	fan control switch (1=on)

	bit 5	Is Configurated	all parameters set
	bit 6	Is Active.	unit is set to ‘active’
	bit 7	n.d.	
<value2>	bit 0	Failure Flag (1=failure)	any ACU failure detected
	bit 1	Peltier Defective	peltier defective detected
	bit 2	n.d.	
	bit 3	Fan Defective	fan defective detected
	bit 4	Laser Overtemperature	laser overtemperature detected
	bit 5	Board Overtemperature	board overtemperature detected
	bit 6	n.d.	
	bit 7	n.d.	
<value3>	byte	n.d.	
<value4>	byte	for internal use	
<value5>	byte	for internal use	
<value6>	byte	System version code	BCD: ‘01’..’99’
<value7>	byte	n.d.	

3. ACU and LCU Diagnostics LED Matrix



ERROR	LED4	LED3	LED2	LED1	F_F	Reset	ACU	F_F	Reset	LCU
							no error			no error
1				X	Y	N	board power voltage failure	Y	N	board power voltage failure
2			X		Y	N	CAN controller failure	Y	N	CAN controller failure
3			X	X	Y	N	wrong board number setting	Y	N	wrong board number setting
4		X			Y	N	I2C failure	Y	N	I2C failure
5		X		X	Y	N	incorrect DPU configuration	Y	N	incorrect DPU configuration
6		X	X		Y	N	incorrect array configuration	Y	N	incorrect array configuration
7		X	X	X	Y	N	peltier power voltage failure	Y	N	laser power voltage failure
8	X				Y	N	end transistor failure	Y	N	relay contact failure
9	X			X	Y	N	peltier 1 or 2 defect	Y	N	end transistor failure
10	X		X		Y	N	FAN failure	Y	N	to lower output impedance
11	X		X	X	Y	N	laser overtemperature	Y	N	Interlock open if laser on
12	X	X			Y	N	board overtemperature	Y	N	board overtemperature
13	X	X		X	Y	Y	SCU status message failure	Y	Y	SCU status message failure
14	X	X	X		Y	Y	SCU status timeout	Y	Y	SCU status timeout
15	X	X	X	X	Y	Y	incorrect system version number	Y	Y	incorrect system version number

APP = application
F_F = FAILURE_FLAG
HW = hardware
N = NO

nu = not used
X = LED ON
Y = YES

3. SCU Diagnostics LED Matrix

The LED matrix (4 red LEDs at the SCU board) offers the possibility of categorize the latest fault entry.

For detailed information for the error code use the “Get Error” RC.

Diagnosis-LED-Matrix	**LED 5**	**LED 6**	**LED 7**	**LED 8**
No failure	0	0	0	0
Any LCU 1-8 fault	**1**	0	0	0
Any ACU 1-8 fault	0	**1**	0	0
Fan failure	**1**	**1**	0	0
Any Interlock fault	0	0	**1**	0
Unit not in local mode	**1**	0	**1**	0
Any Chip Card fault	0	**1**	**1**	0
Unit not initialized	**1**	**1**	**1**	0
LCU 1-8 internal	0	0	0	**1**
ACU 1-8 internal	**1**	0	0	**1**
Wrong system version code	0	**1**	0	**1**
n.d.	1	1	0	1
n.d.	0	0	1	1
n.d.	1	0	1	1
n.d.	0	1	1	1
n.d.	1	1	1	1

4. Frontpanel LEDs

The four LEDs at the frontpanel of the LASO rack are all controlled by the SCU. After power on all LEDs flashes for a short time and then they are off for about 3 seconds (=startup phase). After the startup phase the LEDs are showing the current state of the system:

LED 1 “Laser On”
LED 2 “Overtemp.”
LED 3 “I-Lock open”
LED 4 “Failure”

LED 1 “Laser On”:
The LED is turned on when at least one laser on information is received by a LCU.

LED 2 “Overtemp.”:
The LED is turned on when at least one board overtemperature information is received by a LCU or ACU.

LED 3 “I-Lock open”
The LED is turned on when the interlock open signal is detected by the SCU.

LED 4 “Failure”
The LED is turned on as soon as at least one fault entry is in the fault buffer. It is also turned on for the time of a chip card problem or when a “Unit not in local mode” event happened. The latter information is reset when switching into local mode or the “Get Error” RC is used.

5. CAN and RS232 Pin Assignments

Connector: “CAN 1” and “CAN 2”

LASO front panel Type: DSub9 (m)		Function
1		not used
	6	not used
2		CAN_L
	7	CAN_H
3		GND
	8	not used
4		not used
	9	not used
5		not used

Connector: “RS232 (PC)”

LASO rear panel type: DSub9 (f)		Function
1		not used
	6	not used
2		RxD (in)
	7	not used
3		TxD (out)
	8	not used
4		not used
	9	not used
5		GND

6. Array Current Setting Help Table

Transconductance Etaf = 0,7 W/A

Constant K = -0,25

Number of Lasers		Laser Array Input Current [A]										
		0,50	0,75	1,00	1,25	1,50	1,75	2,00	2,25	2,50	2,75	3,00
Array Optical Output Power [W]	1	0,10	0,28	0,45	0,63	0,80	0,98	1,15	1,33	1,50	1,68	1,85
	2	0,20	0,55	0,90	1,25	1,60	1,95	2,30	2,65	3,00	3,35	3,70
	4	0,40	1,10	1,80	2,50	3,20	3,90	4,60	5,30	6,00	6,70	7,40
	6	0,60	1,65	2,70	3,75	4,80	5,85	6,90	7,95	9,00	10,05	11,10
	8	0,80	2,20	3,60	5,00	6,40	7,80	9,20	10,60	12,00	13,40	14,80
	10	1,00	2,75	4,50	6,25	8,00	9,75	11,50	13,25	15,00	16,75	18,50
	12	1,20	3,30	5,40	7,50	9,60	11,70	13,80	15,90	18,00	20,10	22,20
	14	1,40	3,85	6,30	8,75	11,20	13,65	16,10	18,55	21,00	23,45	25,90
	16	1,60	4,40	7,20	10,00	12,80	15,60	18,40	21,20	24,00	26,80	29,60
	18	1,80	4,95	8,10	11,25	14,40	17,55	20,70	23,85	27,00	30,15	33,30
	20	2,00	5,50	9,00	12,50	16,00	19,50	23,00	26,50	30,00	33,50	37,00