DSP 2 Board









Installation GUIDE

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Marking Systems

Electrolytic Etching Laser Marking Needle/Scribe Marking Identification Systems Custom Systems

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Table Of Contents

Table Of Contents	3
Foreword	
System requirements for DSP 2 and relative software Creator Pro IV	
Board hardware installation	4
Laser Control Board	4
Board Assembling	5
I/O Module	7
Driver's installation	8
Windows NT	8
Windows 2000	
Windows XP	
DSP 2 Board diagnostic tool	9
Principle of Operation	
Data Transfer	
Spooler Commands	
Size of the Image Field	
Compensation of Field Distorsion	
Using an F-Theta Objective	
Laser Control	
External Control Signal	
I/O timings	
DSP Connections	
Characteristics of connecting Cables	
DSP boards connectors	18
Status LEDS	18
Connector 1	
Pin Out configuration with single scan head	
Pin Out configuration with double scan head	
Connector 2	
Connector 3	
Connector 4	
DSP2 – DAC2 digital galvo control specifications	
Galvo Head Control	
DSP2 pinout	
DAC2 pinout	
DSPani Interface Functions	24





Foreword

This is the DSP 2 laser control board installation guide.

Staff responsible for operating the machine, in addition to being professionally trained in their duties, must also read the manuals, paying particular attention to the safety rules and to the sections that deal with their own specific responsibilities. The manual has been drawn up according to the requirements set out in directive CEE 89/392 and its subsequent amendments and additions. It comprises:



NOTE:

ÖSTLING GmbH declines all responsibility for any use of its machine other than the intended one

System requirements for DSP 2 and relative software Creator Pro IV

For Microsoft Windows™: 300 MHz Intel Pentium ® processor or equivalent (433 MHz recommended) with Windows NT4 or subsequent version (including Windows 2000 and XP), 64 MB RAM (128 MB recommended), 40 MB space available on hard disk, color monitor which supports 800 x 600 resolution and CD-ROM drive.



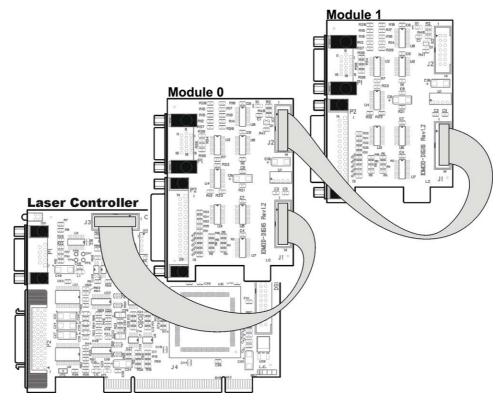
NOTE:

DSP2 board cannot be installed on system equipped with Windows 9X/ME operative systems

Board hardware installation

Laser Control Board

The electronics which control the laser system and the related I/O signals is composed of a board with DSP controller (laser controller) which is inserted in a PCI slot of a standard PC. Up to four expansion boards can be connected to this board to control I/O signals. The following figure represents a connection. Module 0 is always present, in addition to the I/O/ signals set by the application, it also controls the mechanical axes; the subsequent modules are optional and control the I/O signals set by the application.





Board Assembling

- Ensure the PC main switch is in OFF position
- Disconnect PC power supply plug
- · Remove screws or holders holding the PC cover
- · Remove carefully the PC cover to access the motherboard
- Locate the two housing on PCI bus where to place the ÖSTLING's boards



NOTE:

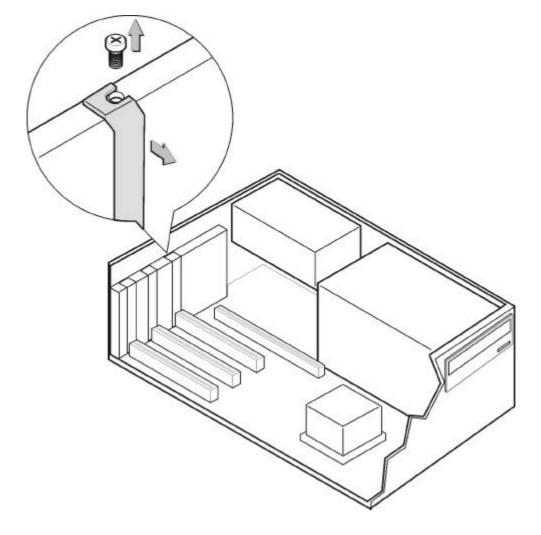
The PCI bus empty slots must be two at least, one is for the DSP boards and the other is for I/O. Whenever an additional I/O module should be installed, foreseen the relative slots.

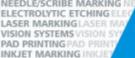


NOTE:

DSP2 Board must be installed on PCI bus only

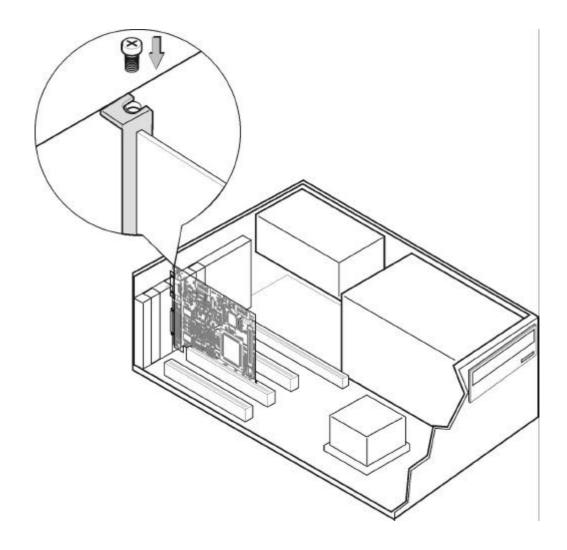
• Remove the metal cover from the chosen PCI slot as shown in the figure below.







- Holding the DSP 2 board with two hand, align the board PCI connector with the PCI slot on the motherboard
- Press the board gently into the PCI slot
- Fix the board with the screw as shows in the figure below





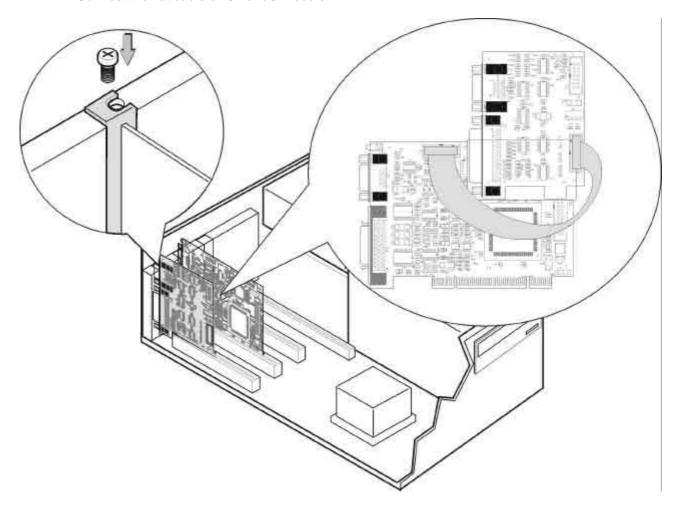
WARNING!

Wrong board connection can hind the PC functioning and also damage the inner hardware.



I/O Module

- · Connect the flat cable on J3 DSP 2 board
- Remove the metal cover from the chosen PCI slot
- Holding the I/O module with two hand, align the board PCI connector with the PCI slot on the motherboard
- Fix the board with the screw as shows in the figure below
- Connect the flat cable on J1 of I/O module



· Close the PC replacing its cover





Driver's installation

The DSP 2 board driver are stored in the CD attached. Driver installation can change on the different operative systems supported.

DSP 2 board can be installed on the following operative systems:

- Windows NT 4.0 con service pack 4 or Higher
- Windows 2000
- Windows XP Home
- Windows XP Professional

Windows NT

Power on the PC, inset the attached CD in the CD reader, browse the CD attached and open the folder "X:\Drivers\WinNT4". Select the file "dsp.inf" open the menu with the right mouse button and select "install".

Continue to follow the program instructions until installation is complete.

Windows 2000

Power on the PC. The operative system will detect a new hardware and will ask for the updated driver, insert the attached CD in the CD reader, browse the CD attached and select the folder "X:\Drivers\Win2K". Continue to follow the program instructions until installation is complete.

Windows XP

Power on the PC. The operative system will detect a new hardware and will ask for the updated driver, insert the attached CD in the CD reader, browse the CD attached and select the folder "X:\Drivers\WinXp". Continue to follow the program instructions until installation is complete.



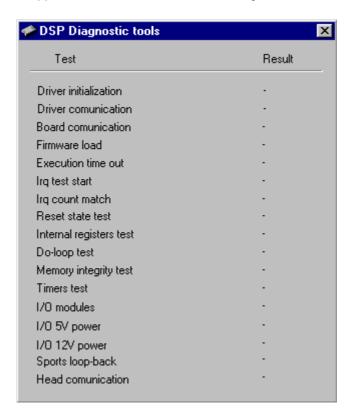


DSP 2 Board diagnostic tool

In Creator Pro IV is available a diagnostic program able to test all the DSP 2 main functions. To enter the diagnostic program proceed as follow:

Start > Programs > Lasonall Creator 4 > DSP Diagnostic

The following window will appear with the result of the inner diagnostic.



The result can assume the following value

Passed: test correctly executed

Failed: Test failed





Driver initialisation

It perform a diagnostic routine on the DSP driver

Driver Communication

Receive a get info with the DSP parameters

Board Communication

When failed, there's a communication problem between DSP driver and DSP board

Firmware load

It test the correct firmware's loading on the board by the driver

Execution Time out

Time out occurred during the test routine execution.

Irq test start

This test consist in a sequence of 10 interrupt request from the system

Irq count match

Verify the number of interrupt executed (=10)

Reset state test

Notify the reset status to DSP microprocessor

Internal register test

Verify the DSP register with write/read command

Do-loop test

Execute four hardware loops

Memory integrity test

Execute write/read cycle in order to test the memory integrity

Timers test

Verify the correct functioning of the five internal timers

I/O modules

Reply with the numbers of I/O modules installed. When the reply is zero, the test fail, verify the correct I/O module hardware installation.

I/O 5V power

Verify the 5V presence on DSP board.

I/O 12V power

Verify the 12V presence on DSP board.

Sports loop-back

Verify the correct functioning of the serial communication devices on DSP processor with RX/TX commands

Head communication

Verify the data exchange between the DSP processor and the galvo head. If the test fail, verify the hardware connection between DSP 2 boards - DAC converter - Galvo head



Principle of Operation

Data Transfer

The commands transferred to the scan head by DSP are commands for scanning straight line segments (vectors and polygons).

Each path to be marked by the scan head has to be divided in small line segments by the user. For the input of the commands for scanning these line segments, the so-called commands spooler, are provided (see chapter "DSPapi Functions".)

The commands spooler is transmitted by the PC to the DSP where a double circular buffer is available for the storage of this data. After a start signal, the data is transferred digitally to the scan head in real time. The digital set position of the mirrors on the galvanometer scanners transferred to the scan head by DSP are converted to analogue values by the remote D/A board directly plugged on the head.

Spooler Commands

The driver of the DSP offers a set of functions to create and fill the marking spooler with commands for scan head, laser control and stepper motors control. Some of them are explained in detail hereafter. The argument of a vector command is always the end point of the vector to be scanned. The start point is identical whit the end of the preceding vector. Closing the spooler whit the appropriate function causes the laser focus positioning at the centre of the image field, i.e. at the point 0,0.

Move_to spooler command

A move_to command effects a fast movement of the mirrors, e.g. the laser focus "jumps" from the start to the end of the vector. The laser is turned off during a move to.

The jumping speed has to be defined by the dspSetJumpSpeed(...) function.

Scan_to spooler command

A scan_to command leads the laser focus to mark along a vector with constant velocity. At the beginning of the scan_to command the laser is tuned on if necessary (only if it was off).

The marking speed has to be defined by the dspSetScanSpeed(...) function or by the set_scan_speed spooler command. Usually the marking speed is lower than the jumping speed.

Each vector executed by the scan head after a move to or scan to command is divided in micro steps by the DSP. This division is necessary as the galvanometer scanners are controlled via analogue regulator circuits.

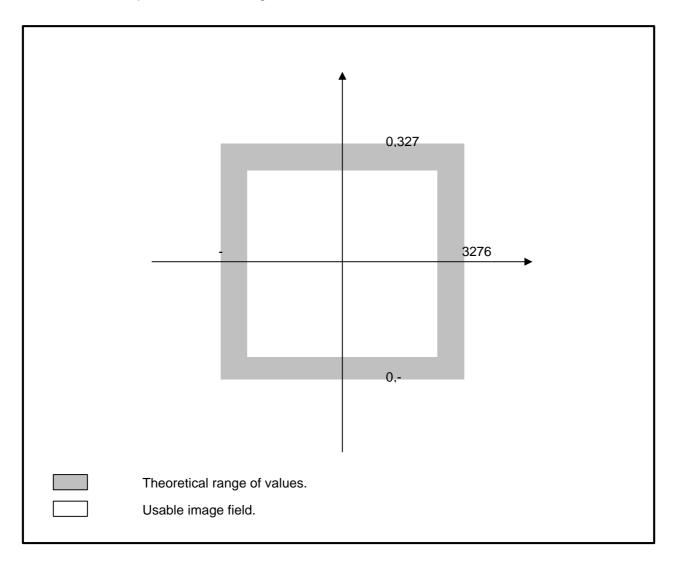
The step frequency is programmed by dspSetScanSpeed(...) function or set_scan_speed spooler command to minimize the step size. The shortest possible output interval is about 3µs (3.2µs on DSP and 2.8µs on DSP2 board) that means a maximum rate of about 300K coordinates/s (312.5K on DSP and 375K on DSP2) at the maximum resolution (step size = 1).





Size of the Image Field

The dimensions of the usable image field are determined by the size of the scan angle and the focal length of the objective. For the indication of the coordinates 16 bit with sign are available for each axis. The origin of coordinates is in the centre of the image field. The theoretical values for the x and y coordinate of points inside the image field are between -32768 and + 32767.



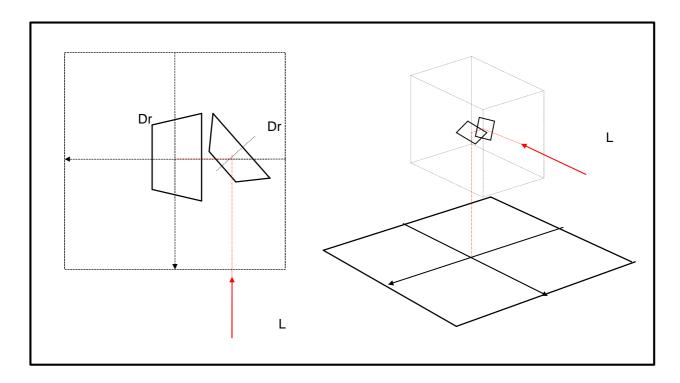
The interval defining the practicable x and y coordinates is shorter than the theoretical range of values. As there is no field correction outside the usable image field, the maximum values for the coordinates of points inside should not be exceeded.





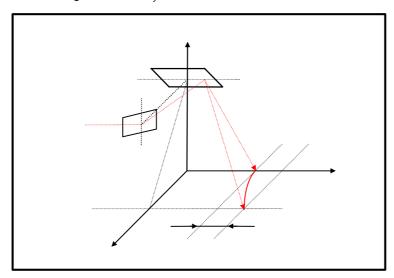
Compensation of Field Distortion

The scanning head used for laser engraving employs electrical drives to set the angular position of two mirrors and deflect the beam along the two directions X and Y. A simplified diagram is shown below.



The deflection of the laser beam results in three effects:

1. The arrangement of the mirrors leads to a certain distortion of the image field. This is caused by the distance between mirror Y and the image field depending on the size of scan angles of mirror Y and mirror X. A bigger scan angle leads to a longer distance. The picture projected on the engraving surface by the two mirrors is deformed due to the different length of the optical paths for the different angles. Observe the next diagram. The point on the plane does not follow a straight line parallel to the x axis as angle J_x varies but it rather flows a trajectory which is similar to a parabola distancing the hypothetical line according to the two angles J_x and J_v .







- 2. There is no direct proportionality between the scan angle and the image height; the image height is proportional to the tangent of the scan angle. Therefore, there is no proportionality between the angular velocity of the deflecting system and the marking speed on the image field.
- 3. If the deflected laser beam is focused by an ordinary lens, the focus lies on a sphere. A varied spot size in a plane target field results.

The co-ordinates of the projected point can be computed with the following formula:

$$\begin{cases} x = f \cdot \tan(\boldsymbol{J}_{x}) \\ y = (d+h) \cdot \tan(\boldsymbol{J}_{y}) = \left[d + f \cdot \sqrt{1 + \tan^{2}(\boldsymbol{J}_{x})}\right] \cdot \tan(\boldsymbol{J}_{y}) = \left(d + \frac{f}{\cos(\boldsymbol{J}_{x})}\right) \cdot \tan(\boldsymbol{J}_{y}) \cong f \cdot \frac{\tan(\boldsymbol{J}_{y})}{\cos(\boldsymbol{J}_{x})} \end{cases}$$

The error - i.e. the discrepancy between the real y and the ideal value according to variations of $J_{_{
m Y}}$ is:

$$\Delta y = f \cdot \frac{\tan(\boldsymbol{J}_y)}{\cos(\boldsymbol{J}_x)} - f \cdot \tan(\boldsymbol{J}_y) = f \cdot \tan(\boldsymbol{J}_y) \cdot \left(\frac{1}{\cos(\boldsymbol{J}_x)} - 1\right)$$

As a result, the angular correction to be applied to $m{J}_{_{\mathrm{V}}}$ for compensating this distortion is:

$$\Delta \boldsymbol{J}_{y} = \tan^{-1} \left(\frac{\Delta y}{f} \right) = \tan^{-1} \left[\tan(\boldsymbol{J}_{y}) \cdot \left(\frac{1}{\cos(\boldsymbol{J}_{x})} - 1 \right) \right]$$

Using an F-Theta Objective

By focusing the deflected laser beam with an F-Theta objective, two of the three effects can be avoided:

A direct proportionality between scan angle and image height is obtained and the focus lies on a plane

However, the F-Theta objective causes a barrel-shaped distortion of the image field.

Both distortion – the original distortion described before and the barrel-shaped distortion caused by F-Theta objective - are superimposed. The result is a so-called pillow-barrel-shaped distortion of the image field.

You can use the dspSetDefaultCorrection(...) function to compute a correction grid according to the formulas above. To set a custom correction grid, use the dspSetCorrection(...) function instead.

The image field is superimposed with this correction grid and x,y coordinates pairs are corrected by interpolation between the available precise coordinate values of the nearest grid points. Then the corrected values are transferred to the scan head. The correction algorithm is executed for each micro step.

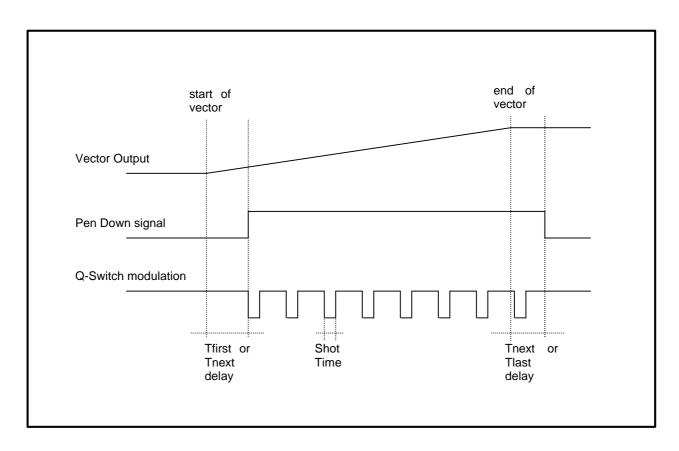


Laser Control

The DSP board is able to drive one Q-switched laser source. For controlling a YAG laser, three signals are provided: a high active "Pen Down" signal, a low active Q-Switch modulation signal and a 12 bit analogue (from 0 to 10V) "Power Level" signal. Frequency and pulse length of the Q-switch modulation signal can be programmed by using set_shot_frequency and set_shot_time spooler commands.

As an alternative, you can set up a default value for the pulse duration by using SetDefaultShotTime(...) function.

The set value of the laser power can be programmed by the set_laser_power spooler command. If you want to set the current power level you can use the dspSetPower(...) function but the only way to fix the power level during spooler execution is the use the set laser power spooler command.



External Control Signal

To start or stop the current spooler execution externally, two opto-isolated inputs are provided (see "Connections" chapter). The start of the current spooler execution is possible only upon software acknoledge. In fact, if the DSP board detects a valid external input signal, the DSPapi software module queries the user program to perform the desired action (the simplest action is to call dspStartExecution() function). This purpose is useful to make some dynamic spooler update just before to start the execution.

In addition, external system can monitor the laser system status with four open-collector outputs:

Laser Ready: The spooler is full and software is ready to start.

Laser Busy: The current spooler is executing (marking in progress).

Laser End: The current spooler execution is terminated.

This signal is active when the DSP firmware is running correctly by Laser Run:

calling dspInitDSP() function.

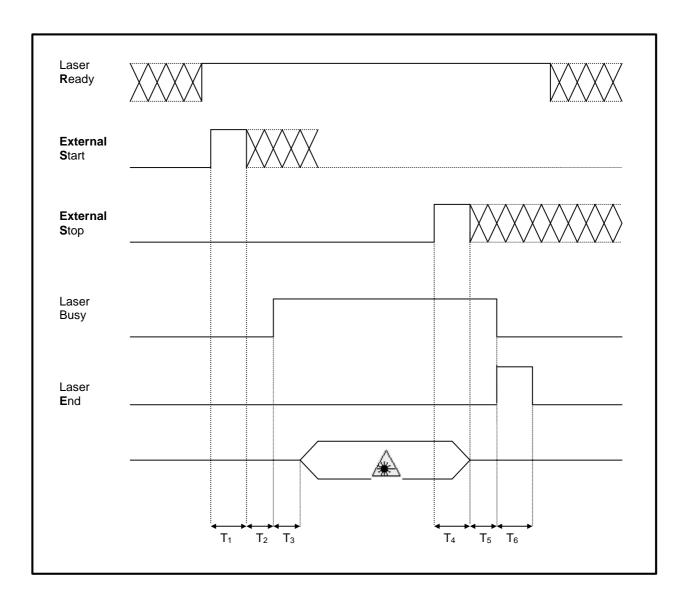
15





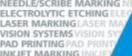
I/O timings

The following diagram illustrates the possible timings and parameterisation of these signals.



The time intervals in the diagram can all be programmed by a resolution of 1 ms.

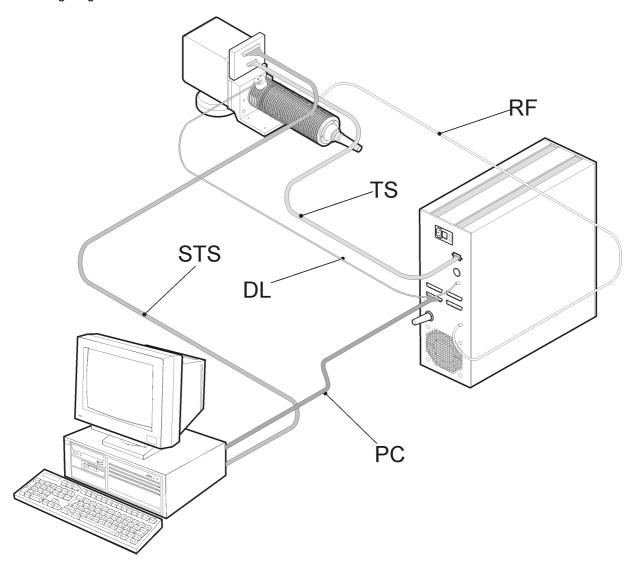
- T_1 : Start Time – For setting the minimum acceptable time for the start engraving signal.
- T_2 : Start Delay – For delaying engraving start.
- T_3 : Busy Advance – For advancing the Laser Busy signal with respect to laser emission.
- T_4 : Stop Time – For setting the minimum time for the stop engraving signal.
- T_5 : End Delay – For delaying the Laser End signal with respect to laser emission.
- T_6 : End Time – For setting the Laser End activation time.





DSP Connections

The connectors for latching up the DSP board to the laser engraving system are illustrated in the following diagram.



Characteristics of connecting Cables

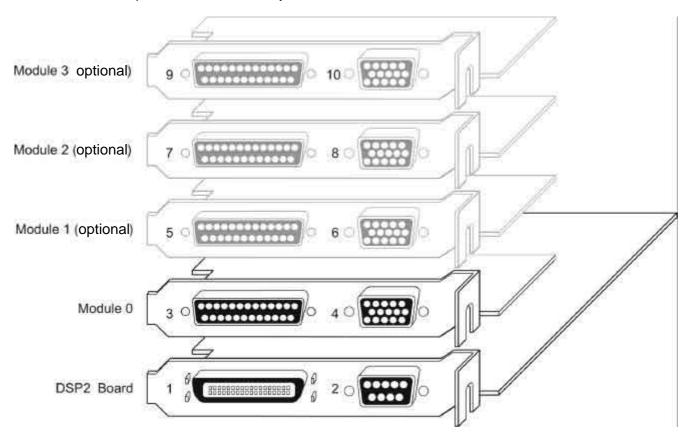
- **STS** Twisted pairs cable between Connector DB 25 F on the DSP1 Card or Mini Delta Ribbon 50 F on the DSP2 card and the 25 pin F Canon connector on the Scanner Head.
- PC Canon 9 pin M plug-to-plug cable between laser rack and DB 9 F connector on the DSP1 or DSP2 Card.





DSP boards connectors

The electronics which control the laser system and the related I/O signals is composed of a board with DSP controller (laser controller) which is inserted in a PCI slot of a standard PC. Up to four expansion boards can be connected to this board to control I/O signals. The following figure shows all the available connectors. Module 0 is always present both on DSP1 and DSP2 boards, the subsequent modules are optional and available only with DSP2 board.



Status LEDS

On DSP 2 card are installed two status led (red and green) with the following meaning:

Description	Red LED status	Green LED Status
PC start-up	Random Blink	
Engraving software On (Creator Pro) Status OK		Blinking
DSP 2 failure (run diagnostic problem for additional information	ON	
Scan head communication problem	Random Blink	



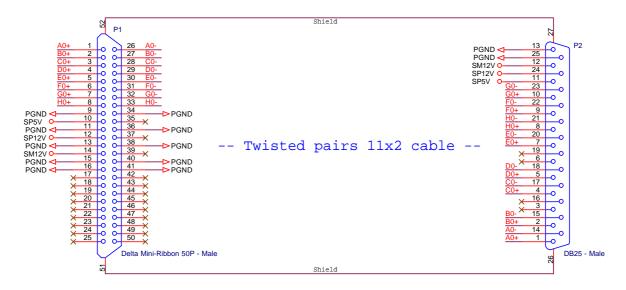


Connector 1

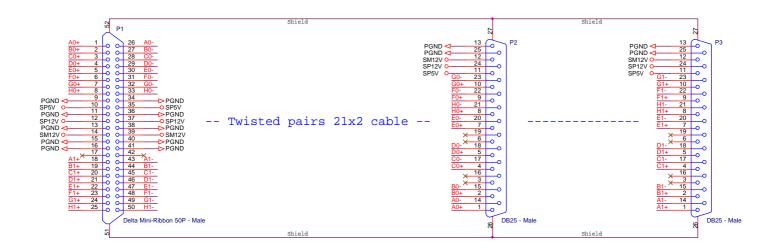
DB 25 pin female on DSP1 or Mini Delta Ribbon 50 pin female on DSP2 - Digital scanner head connection between DSP board and Digital To Analogue converter.

The wire can be up to 10 metres long. The recommended standard provided with the board is 3 metres.

Pin Out configuration with single scan head



Pin Out configuration with double scan head





Connector 2

DB 9 pin female – Laser source controller. The signals related to this connector are all TTL compatible outputs. They are active when the logical level is up.

Pin out	
1:	Current Level (0 - 10V +/- 1%).
2:	Pen Down. Active during laser emission.
3:	GND.
6:	Q-Switch Modulation (logic level down = Q-switch open).
7:	+5V service (500mA).
8:	+12V service (500mA).
9:	Running. Signalling that the DSP is ready for laser management and that the previous signals are valid.

Connector 3

DB 25 pin male – Axis drive connector. The DSP board can generate the signals for controlling three independent axis driven by stepper motors. All the generated signals are open-collector. They are active when conducting (output to GND) and not active in high impedance. All inputs are opto-isolated and require a voltage in the range from 10 to 30 V.

1:	+12V 500mA	14:	+5V 500mA.
2:	Step Y.	15:	Step X.
3:	Step Z.	16:	Dir Z.
4:	Break X.	17:	Dir Y.
5:	Break Y.	18:	Dir X.
6:	Break Z.	19:	Input8.
7:	Zero X.	20:	Input4.
8:	Zero Y.	21:	Input2.
9:	Zero Z.	22:	Input1.
10:	Disable X.	23:	N.C.
11:	Disable Y.	24:	N.C.
12:	Disable Z.	25:	GND.
13:	GND.		

The signals are described below:

Step: Out - Axis drive step signal (Clock).
Dir: Out - Axis drive direction signal.

Break: Out - Electromechanical brake release signal (if fitted). Active during drive motion.

Zero: In – Mechanical zero sensor. The axis reference mechanical zero search is stopped

when this signal is activated (positive voltage).

Disable: In – Axis disable signal. When active, the corresponding step signal remains in the

status prior to activation.

Inputs,4,2,1: Inputs for signalling system faults. They form a four bit number allowing to signal up

to 15 different error statuses plus OK (0000).



Connector 4

DB 9 pin male on DSP1 and Height Density DB 15 pin on DSP2 board – Controls/Laser status. The output signals of this connectors are open-collector. They are active when conducting (output to GND) and not active when disabled (high impedance). All inputs are opto-isolated and require a voltage in the range from 10 to 30V to be activated.

DSP1 - Pin out 1: Out – Laser End. Active at end of engraving. 2: Out – Laser Busy. Active during engraving. 3: Out – Laser Ready. Active when the system is ready. 4: In – External Start. When activated start the engraving process. 5: In – External Stop. When activated stop the engraving process. 6: +12V 500mA. 7: Out – Laser Running. Active when DSP is running. 8: +5V 500mA GND. 9: **DSP2 - Pin out** Out – Laser End. Active at end of engraving. 2: Out – Laser Busy. Active during engraving. 3: Out – Laser Ready. Active when the system is ready. 4: In – External Start. When activated start the engraving process. 5: In – External Stop. When activated stop the engraving process. 6: N.C. 7: N.C. 8: N.C. 9: +12V 500mA. 10: Out – Laser Running. Active when DSP is running. 11: N.C. 12: GND. 13: N.C. N.C. 14: 15: N.C.



DSP2 – DAC2 digital galvo control specifications

Galvo Head Control

The DSP2 board incorporates two complete double channel synchronous serial ports for digital control of up two galvo-heads. Each port is able to transmit and receive a couple of 16bit words independently. Sports signal are differential and need twisted-pairs cable to work properly. Sports meets the EIA-485 standard.

A SPORT receives a couple of serial data on RXDx_X and RXDx_Y inputs and transmits a couple of serial data on TXDx_X and TXDx_Y outputs. The data bits are synchronous to the serial clock RCKx for the receiver and TCKx for the transmitter. Frame synchronization signals RFSx and TFSx are used to indicate a start of a serial data and remains asserted for the length of the serial words.

The transmitter generates:

- TCKx Clock signal active on the rising-edge.
- TFSx Frame synchronization signal active high.
- TXDx X X coordinates 16bit channel.
- TXDx_Y Y coordinates 16bit channel.

The receiver needs:

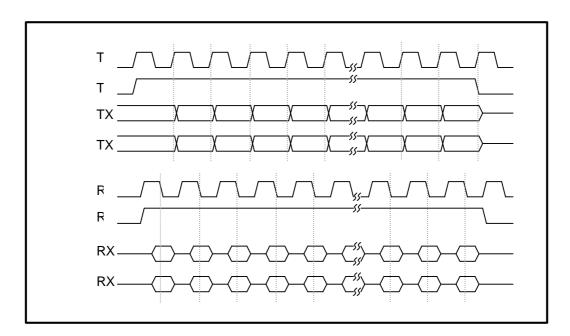
- RCKx Clock signal active on the falling-edge.
- RFSx Frame synchronization signal active high.
- RXDx_X Status flags from the galvo head.
- RXDx_Y Feedback channel containing the exclusive or of the transmitted data.

Note

'x' = 0 for Head0 control signals (e.g. TCK0, TXD0_X).

'x' = 1 for Head1 control signals (e.g. TFS1, RXD1_Y).

The next figure shows the relations between the above signals.



Data bits are sent on TXDx_X and TXDx_Y MSB first on the rising edge of the TCKx. RXDx_X and RXDx_Y are sampled on the falling edge of RCKx and is intended MSB first. TFSx is asserted in the same TCKx cycle as the first bit of a word and RXDx sampling start on the first falling edge of RCKx when RFSx seen to be asserted. Digital to analog conversion, on the DAC2 board, starts on the falling edge of the TFSx signal.



DSP2 pin out

DSP2 board use a Mini Delta-Ribbon connector 50 pins female. The table below shows the entire list of available signals. The following signals are designed to drive two independent galvo heads using DAC2 boards. Connection between DSP2 and DAC2 need to be made using twisted-pairs cable.

Din	Signal	Pin	Signal
Pin 1	Signal		Signal
	TXD0_X+	26	TXD0_X-
2	TFS0+	27	TFS0-
3	TCK0+	28	TCK0-
4	TXD0_Y+	29	TXD0_Y-
5	RXD0_X+	30	RXD0_X-
6 7	RFS0+	31	RFS0-
	RCK0+	32	RCK0-
8	RXD0_Y+	33	RXD0_Y-
9	GND	34	GND
10	+5V	35	+5V
11	GND	36	GND
12	+12V	37	+12V
13	GND	38	GND
14	-12V	39	-12V
15	GND	40	GND
16	GND	41	GND
17	N.C.	42	N.C.
18	TXD1_X+	43	TXD1_X-
19	TFS1+	44	TFS1-
20	TCK1+	45	TCK1-
21	TXD1_Y+	46	TXD1_Y-
22	RXD1_X+	47	RXD1_X-
23	RFS1+	48	RFS1-
24	RCK1+	49	RCK1-
25	RXD1_Y+	50	RXD1_Y-

DAC2 pin out

DAC2 board use a DB connector 25 pins female. The table below shows the entire list of available signals. Each of the signal below can be connected to the corresponding signal on the DSP2 connector using a 11x2 twisted-pair cable.

Pin	Signal	Pin	Signal
1	TXD_X+	13	GND
2	TFS+	14	TXD_X-
3	N.C.	15	TFS-
4	TCK+	16	N.C.
5	TXD_Y+	17	TCK-
6	N.C.	18	TXD_Y-
7	RXD_X+	19	N.C.
8	RXD_Y+	20	RXD_X-
9	RFS+	21	RXD_Y-
10	RCK+	22	RFS-
11	+5V	23	RCK-
12	-12V	24	+12V
		25	GND





DSPapi Interface Functions

The DSPapi module, with the appropriate DSPxxx driver, is the minimal interface to the ÖSTLING DSP board based engraving system. This module is made as a dynamic linked library designed for 32bit Microsoft[®] WindowsTM platforms.

The DSPxxx driver is currently available for the following operating systems:

- Windows[™] NT4 Windows[™] 2000 Windows[™] XP Home and Professional editions

IMPORTANT: WindowsTM 98 and WindowsTM Me are no longer supported.

The following figure shows the block diagram of the marking software using DSPapi.

