


DSP 2.1 *Board*

Installation GUIDE	
 LASERVALL Sources and Laser Systems	
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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:

Laservall Spa declines all responsibility for any use of its machine other than the intended one

System requirements for DSP 2 and relative software Smartist 4

- 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:

DSP2.1 board cannot be installed on system equipped with Windows 9X/ME operative systems

Software installation

The drivers of the board are contained in the provided CD. DSP board can be installed only on the here below listed operative systems:

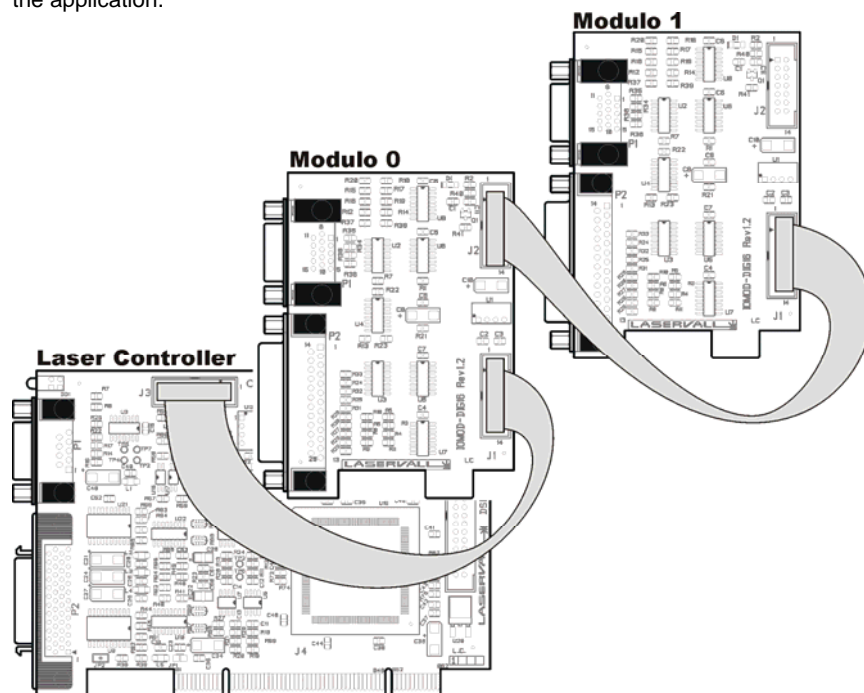
- Windows NT 4.0 with service pack 4 or superior
- Windows 2000
- Windows XP Home
- Windows XP Professional
- Windows Vista

Start your PC. Insert the CD. Install Smartist Software.

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 Laservall's boards



NOTE:

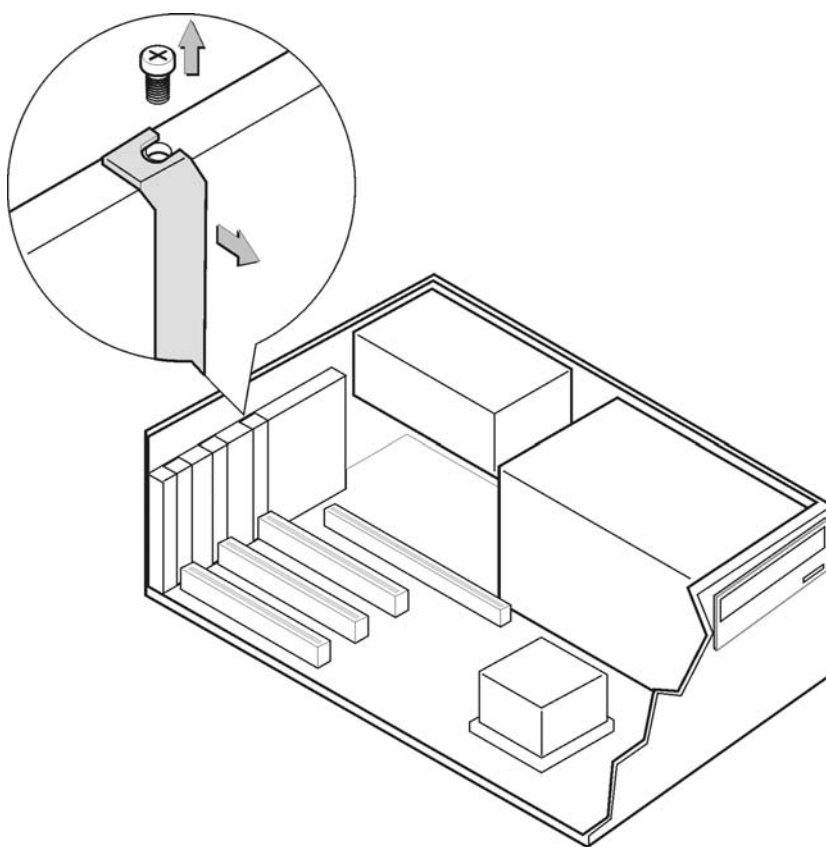
The PCI bus empty slots must be two at least, one is for the DSP boards and the other is for I/O. Whenever an additional I/O module should be installed, foresee the relative slots.



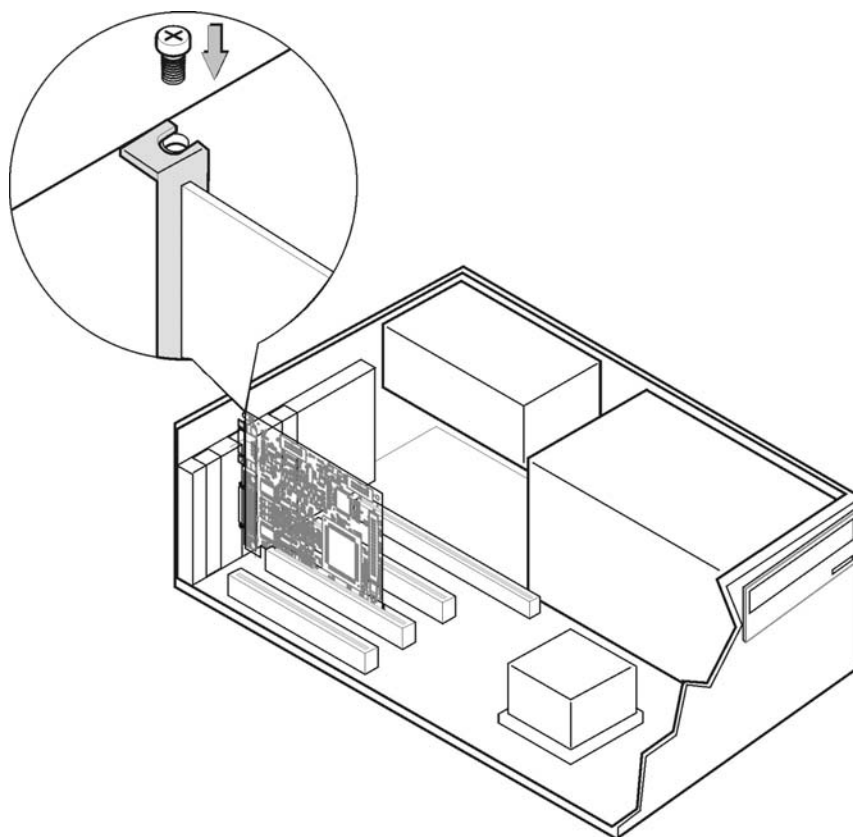
NOTE:

DSP2.1 Board must be installed on PCI bus only

- Remove the metal cover from the chosen PCI slot as shown in the figure below. Often the metal plate cap is replaced by a plate stripe. If this is the case, remove it smoothly doing some rotations forwards and backwards until it will be removed.



- 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

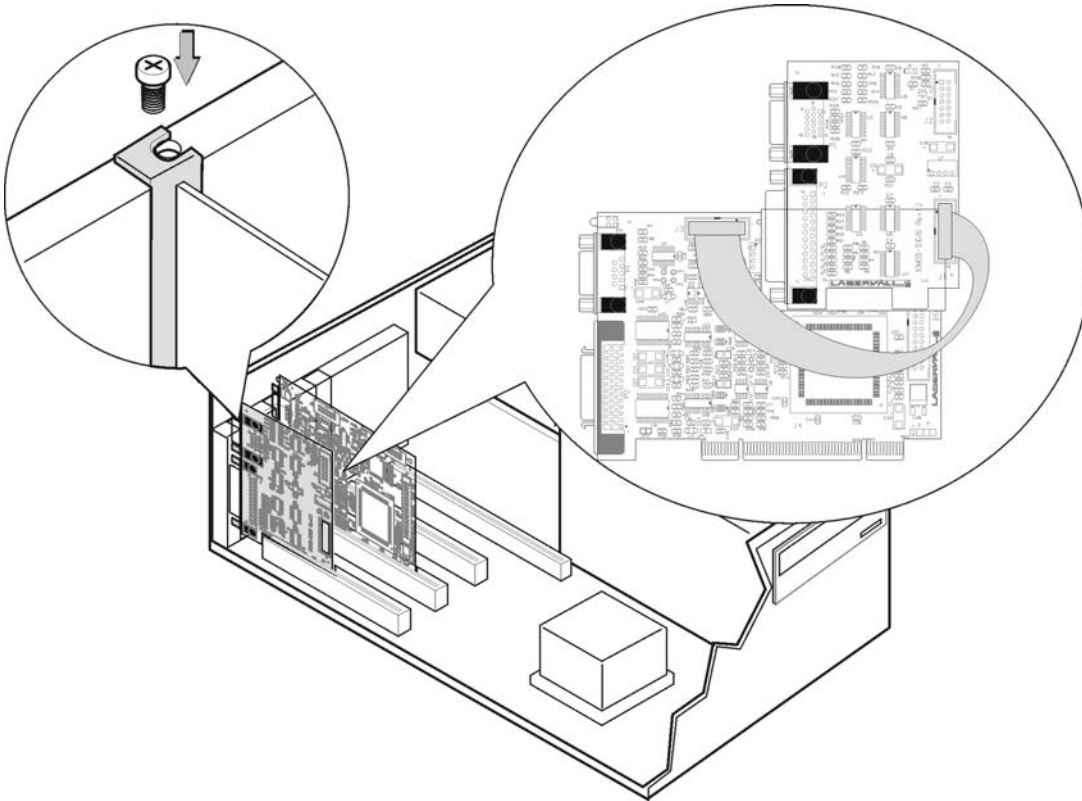


WARNING!

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. Often the metal plate cap is replaced by a plate stripe. If this is the case, remove it smoothly doing some rotations forwards and backwards until it will be removed.
- Grab with your left hand the left superior part of the metal plate of the board and grab the right part with the other hand
- Align the connector of the board to the one of the mother board and press smoothly, avoiding lateral movements, until the board will be fixed in its lodging.
- Fix the metal plate of the board with the screw that you have removed before.
- Connect the flat cable on J1 of I/O module



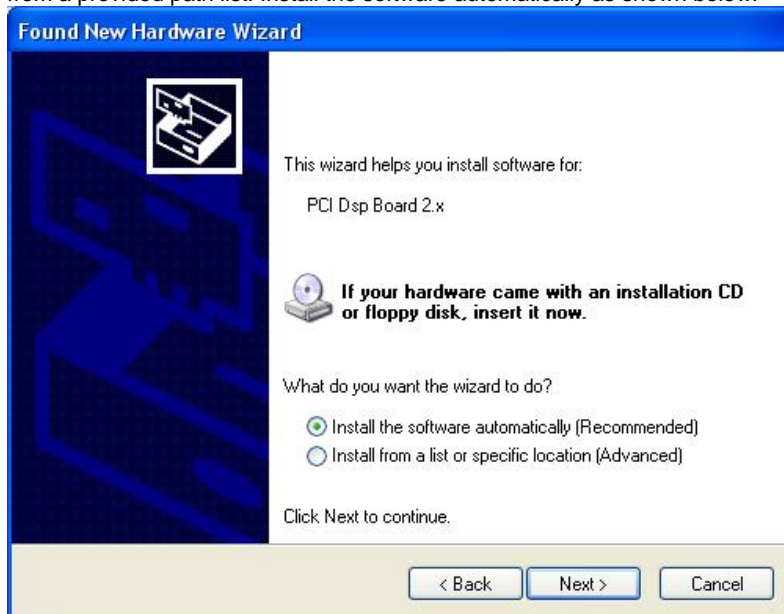
- Close the PC putting on its cover

Driver Installation

At system start the new Hardware is detected. The following pop-up will appear:



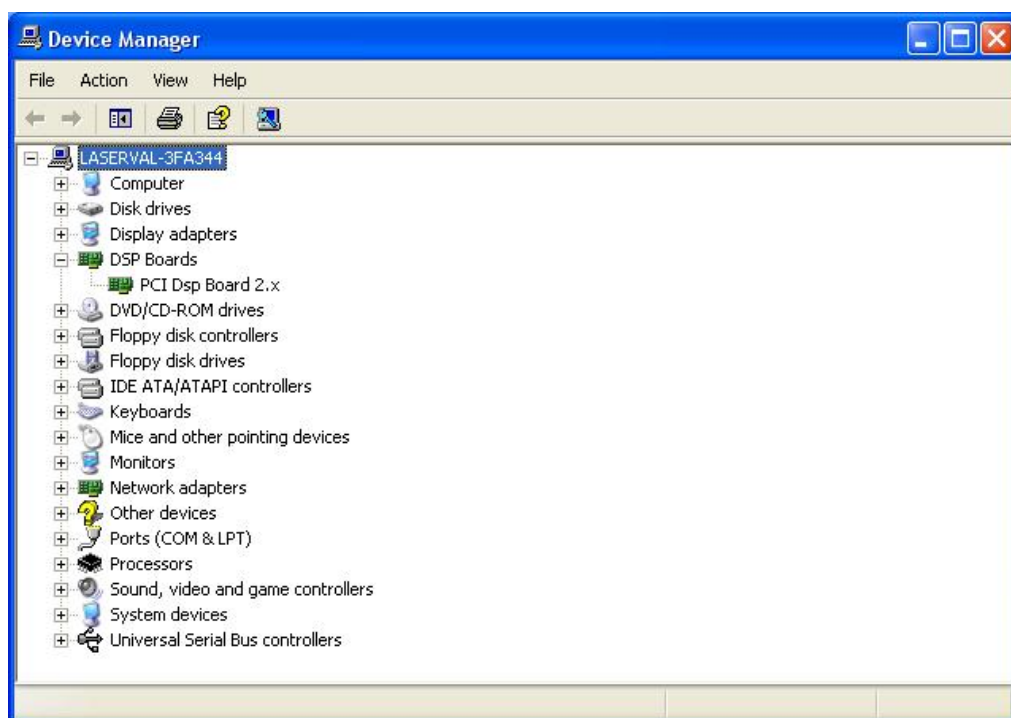
If you select no as shown above, it will be asked if the research should take place automatically or from a provided path list. Install the software automatically as shown below:



Once the installation completes, you get the result in a window like the one below:



Verify the presence of the new hardware in the window "Gestione periferiche" (Peripherals Management):

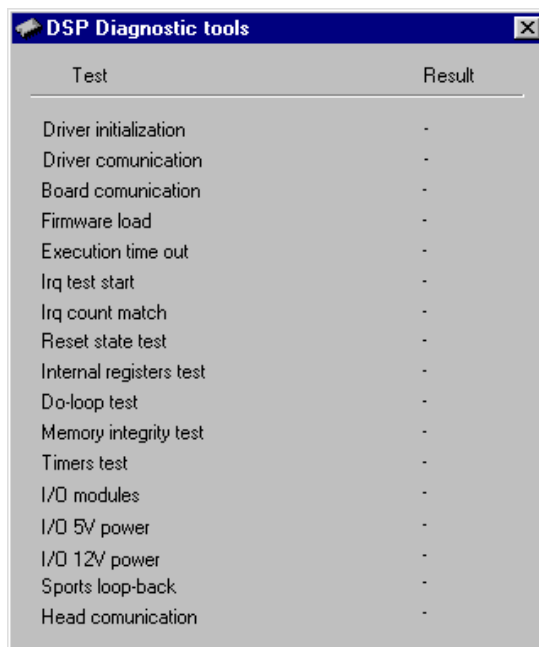


DSP 2 Board diagnostic tool

In Smartist 4 is available a diagnostic program able to test all the DSP 2 main functions.
To enter the diagnostic program proceed as follow:

Start > Programs > Smartist4 > DSP Diagnostic

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



Test	Result
Driver initialization	-
Driver comunication	-
Board comunication	-
Firmware load	-
Execution time out	-
Irq test start	-
Irq count match	-
Reset state test	-
Internal registers test	-
Do-loop test	-
Memory integrity test	-
Timers test	-
I/O modules	-
I/O 5V power	-
I/O 12V power	-
Sports loop-back	-
Head comunication	-

The result can assume the following value

Passed: test correctly executed

Failed: Test failed

Driver initialization

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 scan head. If the test fail, verify the hardware connection between DSP 2 boards – DAC converter – scan head

DSP 1 to DSP 2 upgrading

- Remove the DSP 1 card from the ISA bus
- Install the DSP 2 board on PCI Bus, as described in the previous chapter
- If required, fix the adapter cable (optional) to convert the DB15 of the I/O module to the old DB9
- Install the DSP 2 driver, as described in the previous chapter

Principle of Operation

Data Transfer

The commands transferred to the scan head by DSP board 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.

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, data are 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 DSP driver 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 with the end of the preceding vector. Closing the spooler with the appropriate function causes the laser focus positioning at the centre of the image field.

- **Move_to spooler command**

A move_to command effects a fast movement of the mirrors. 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).

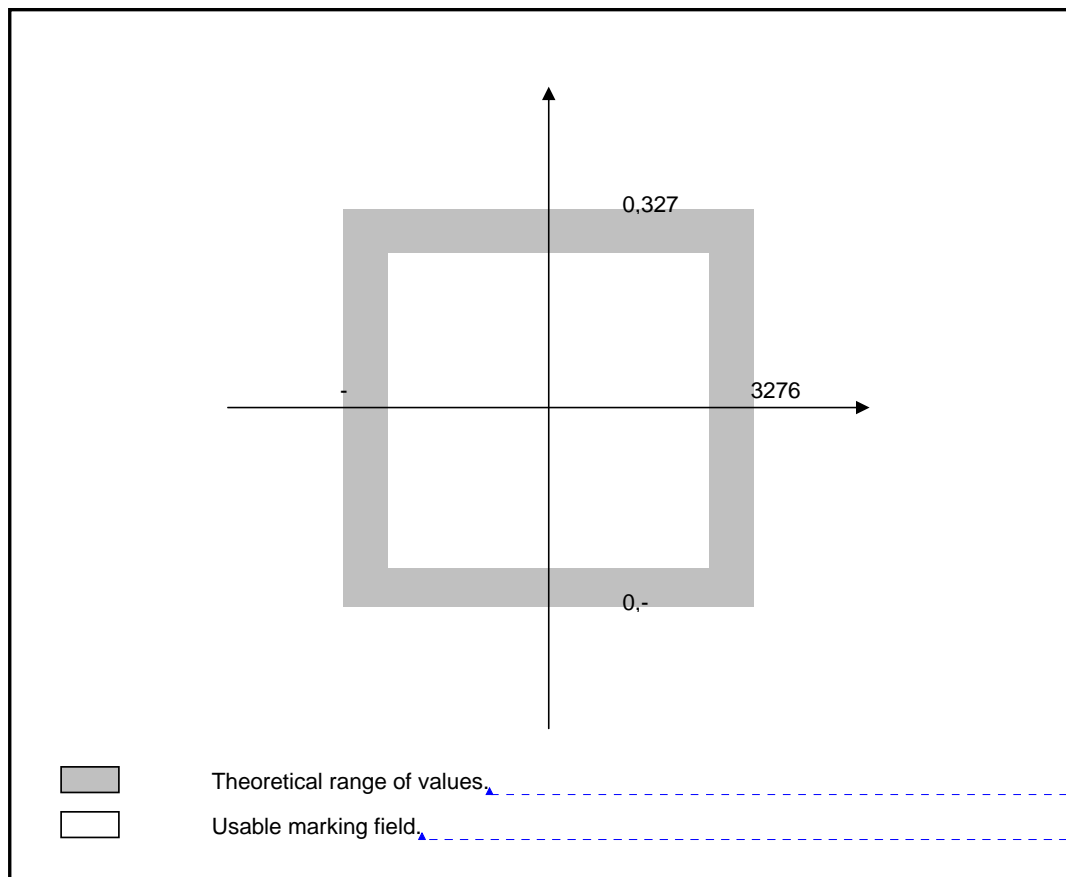
The marking speed has to be defined by the dspSetScanSpeed(...). Usually the marking speed is lower than the jumping speed.

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 shortest possible output interval is about 3µs (3.2µs on DSP1 and 2.8µs on DSP2.1 board) that means a maximum rate of about 300K coordinates/s (312.5K on DSP1 and 375K on DSP2.1) at the maximum resolution (step size = 1).

Size of the marking Field

The dimensions of the usable marking 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 field. The theoretical values for the x and y coordinate of points inside the image field are between -32768 and $+32767$.



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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 Distorsion

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 (**Figure 1**).

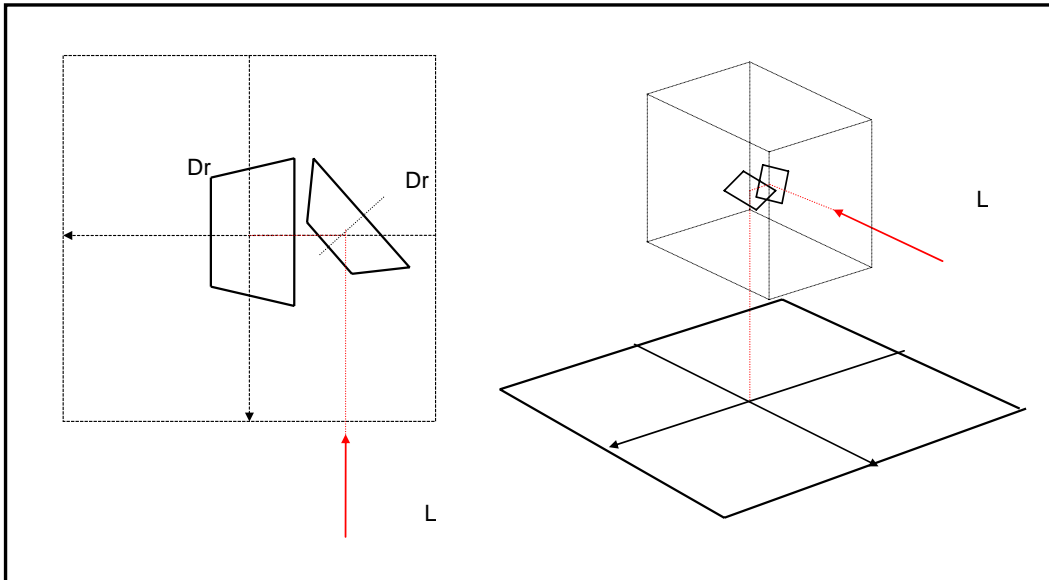


Figure 1: Scan Head

Distortions

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 (**Figure 2**). The point on the plane does not follow a straight line parallel to the x axis as angle ϑ_x varies but it rather flows a trajectory which is similar to a parabola distancing the hypothetical line according to the two angles ϑ_x and ϑ_y .

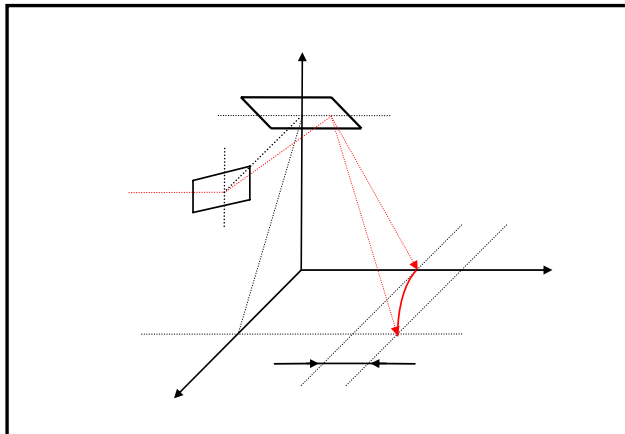


Figure 2: Field Projection

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

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

The error - i.e. the discrepancy between the real y and the ideal value according to variations of ϑ_x - is:

$$\Delta y = f \cdot \frac{\tan(\vartheta_y)}{\cos(\vartheta_x)} - f \cdot \tan(\vartheta_y) = f \cdot \tan(\vartheta_y) \cdot \left(\frac{1}{\cos(\vartheta_x)} - 1 \right)$$

As a result, the angular correction to be applied to ϑ_y for compensating this distortion is:

$$\Delta \vartheta_y = \tan^{-1} \left(\frac{\Delta y}{f} \right) = \tan^{-1} \left[\tan(\vartheta_y) \cdot \left(\frac{1}{\cos(\vartheta_x)} - 1 \right) \right]$$

Barrel distortion

The applied objectives for the scanner heads (for example: RODENSTOCK f-theta objective), beside giving the focus on the working plane, apply a deformation called *Barrel*, which eliminates the dependency from the tangent

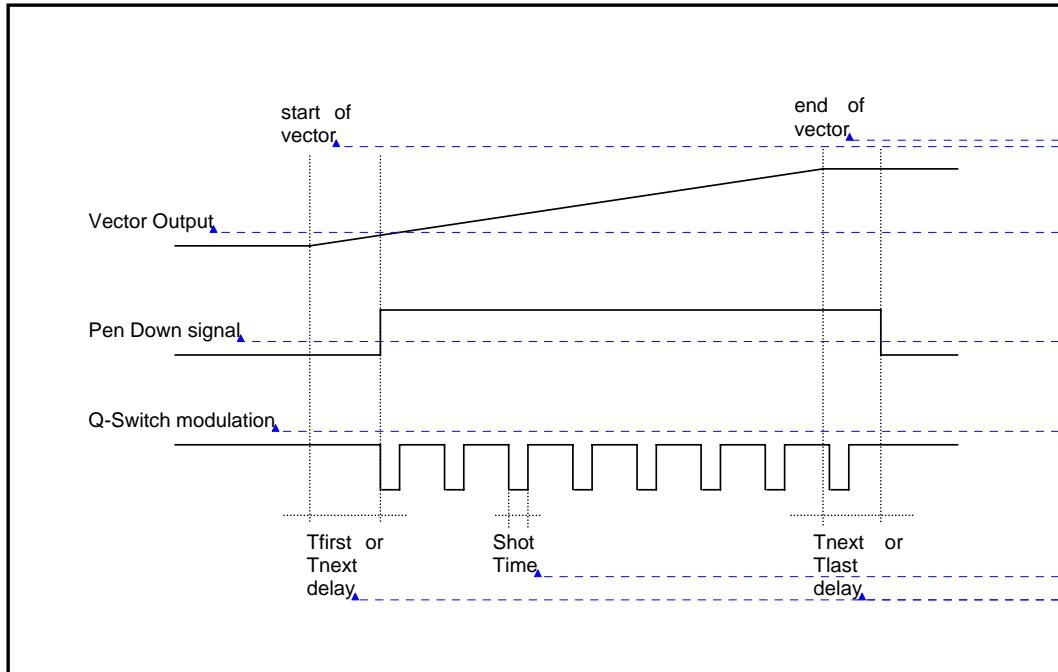
$$y = h \cdot \vartheta_y$$

The use of this kind of objectives should simplify the job of the software, eliminating the distortions of the tangent.

Laser Control

The DSP board is able to drive one Q-switched laser source. For this control three signals are used:

- a "pen Down" signal, active high
- a Q-switch modulation signal, active low
- a "power level" analogue signal (0 – 10 V) generated from a 12 bit value



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External Control Signal

To start or stop the current spooler execution externally, two opto-isolated inputs are provided.

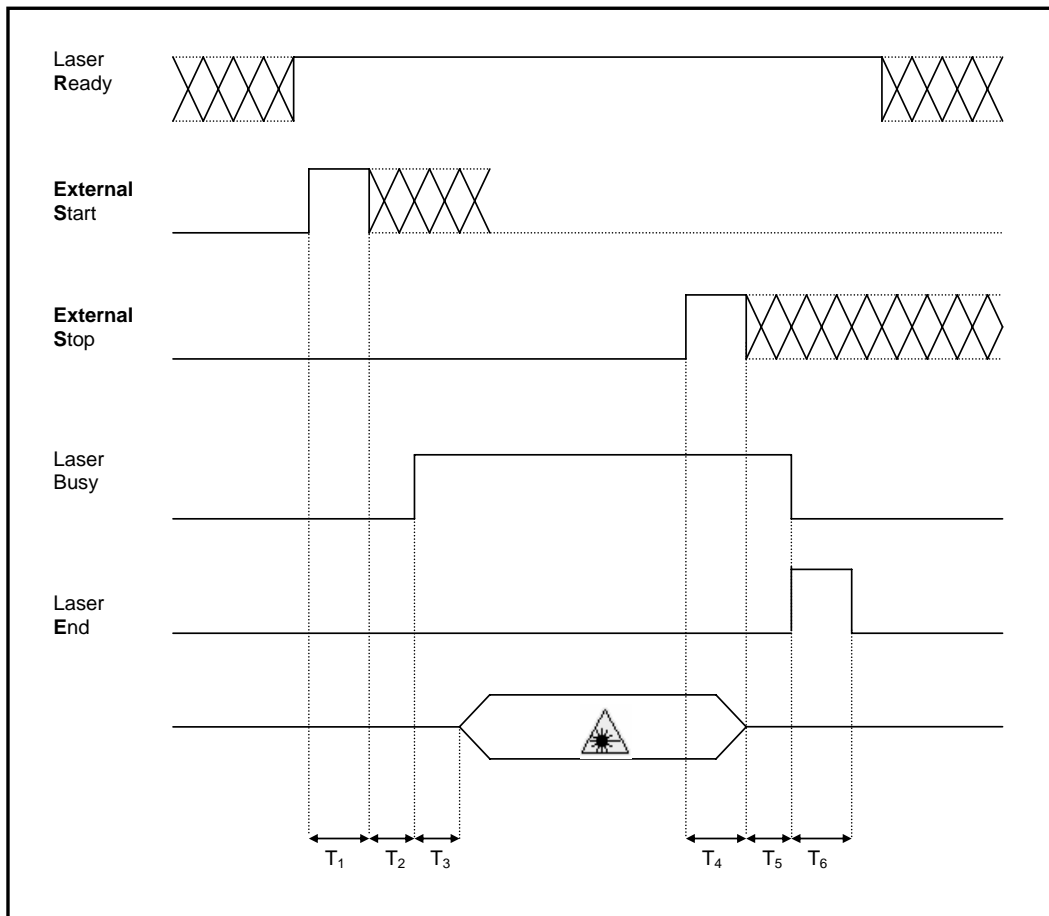
The start signal is subdue a software confirmation. The DSP board detects a valid external input signal, the DSPapi software module queries the user program to perform the desired action. This behaviour is useful to make some dynamic spooler updates just before the execution starts.

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.
- **Laser Run:** This signal is active when the DSP firmware is loaded and running correctly.

I/O timings

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

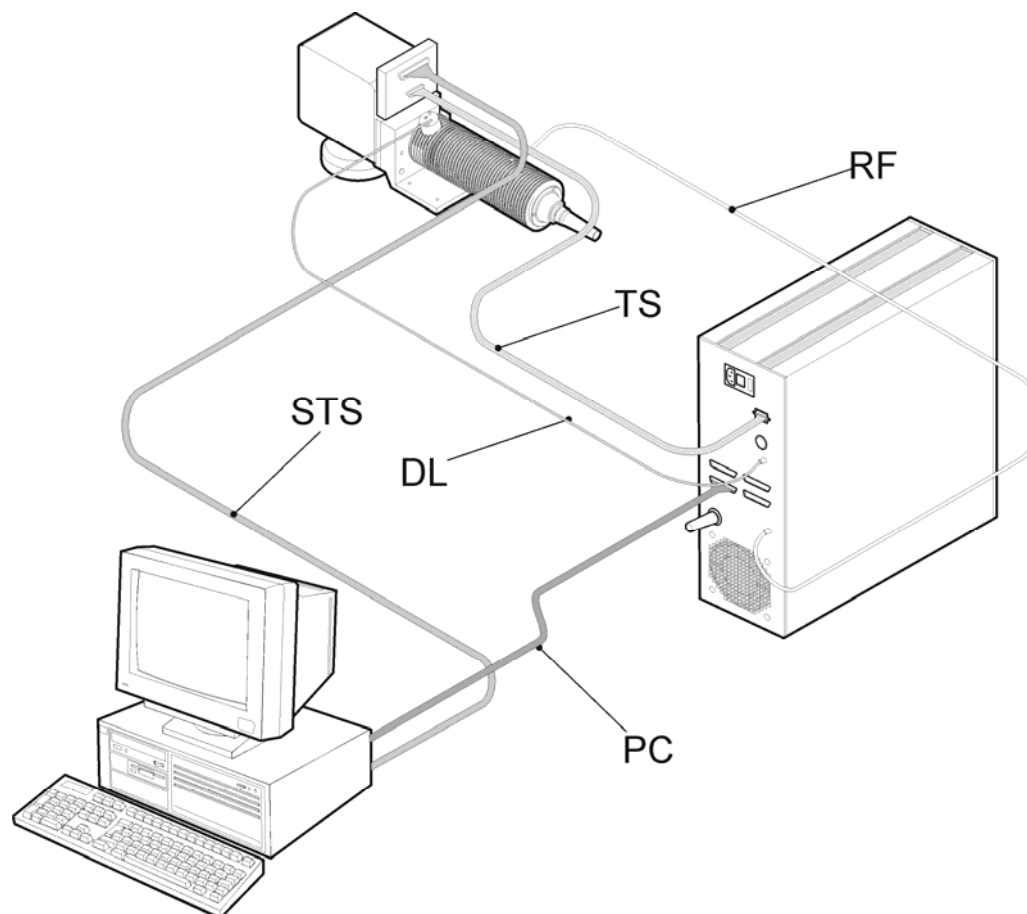


The time intervals in the diagram can all be programmed by a resolution of 1 ms.

- | | |
|-------------------------------|---------------------------------------------------------------------------|
| 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 | – Busy signal corresponding to mark progress.. |
| T ₄ : Stop Time | – The minimum time for stop signal to stop the marking process. |
| 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.

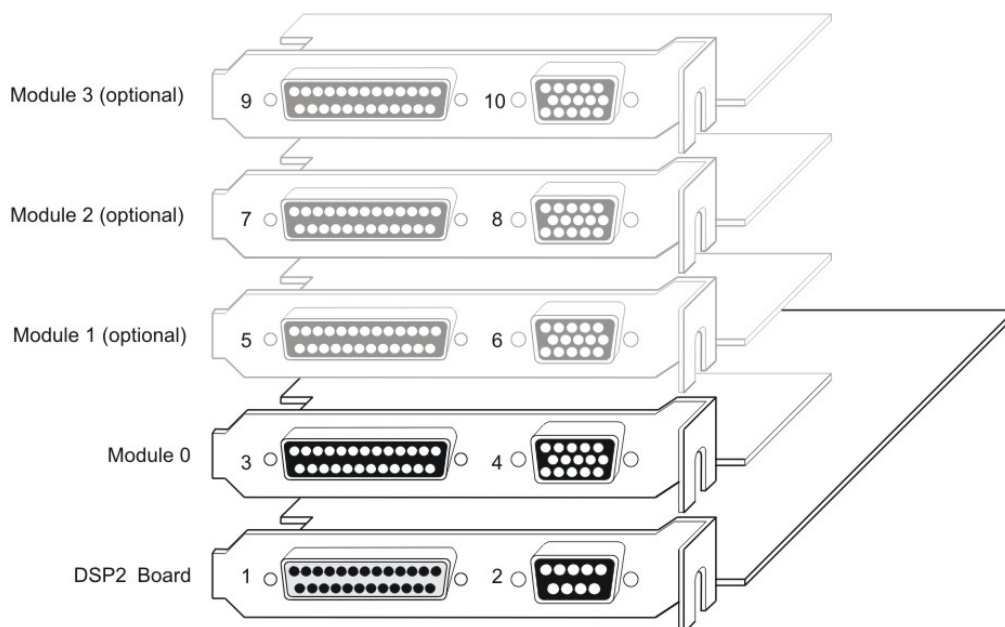


Characteristics of connecting Cables

- STS** Twisted pairs cable between Connector DB25 and the DB25 connector on D/A adapter of the scan head.
- PC** Canon 9 pin M pin-to-pin cable between laser rack and the DB 9 connector on the DSP Board.

DSP boards connectors

The electronic system which control the laser and the related I/O signals is composed of a board with DSP processor (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. There's always a Module 0, the subsequent modules are optional and manage I/O signals defined by the application.



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 startup	Random Blink	
Engraving software On (Smartist4) OK Status		Blinking
DSP 2 failure (run diagnostic problem for additional information)	ON	
Scan head communication problem	Random Blink	

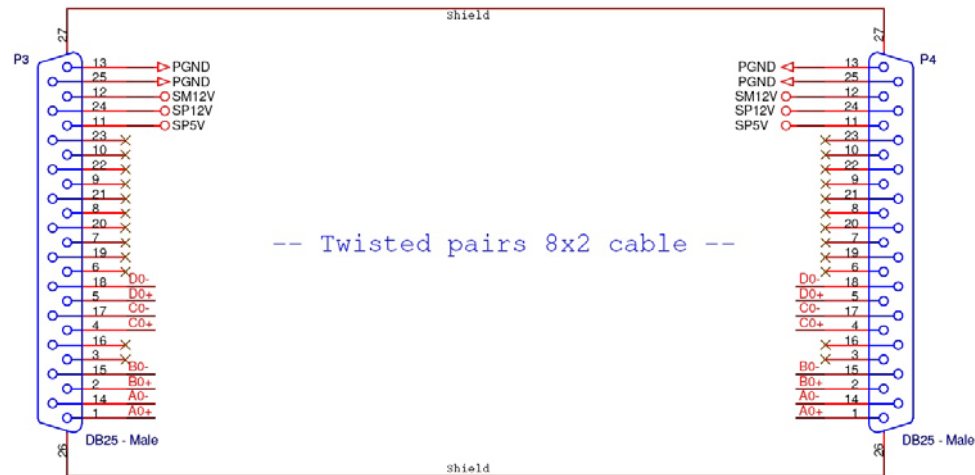
Connector 1

Mini Delta Ribbon 50 pin female– Digital scanner head connection between DSP board and Digital To Analogical 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

Single Head Cable



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:	N.U.
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.

Pin out	
1:	+12V 500mA
2:	Step Y.
3:	Step Z.
4:	Break X.
5:	Break Y.
6:	Break Z.
7:	Zero X.
8:	Zero Y.
9:	Zero Z.
10:	Disable X.
11:	Disable Y.
12:	Disable Z.
13:	GND.
14:	N.U.
15:	Step X.
16:	Dir Z.
17:	Dir Y.
18:	Dir X.
19:	Input8.
20:	Input4.
21:	Input2.
22:	Input1.
23:	Output9
24:	N.C.
25:	GND.

The signals are described below:

Step :	Out - Axis drive step signal (Clock) for axis control.
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.
Input8,4,2,1:	Inputs for signalling system faults. They form a four bit number allowing to signal up to 15 different error statuses plus OK (0000).
Output9:	Output for customized signal

Connector 4

Hight Densiti DB 15 pin on DSP2.1 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.

DSP2.1 - 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: | Input13. |
| 7: | Input15. |
| 8: | Output15. |
| 9: | +12V 500mA. |
| 10: | Out – Laser Running. Active when DSP is running. |
| 11: | N.U. |
| 12: | GND. |
| 13: | Input12. |
| 14: | Input14. |
| 15: | Output14. |

DSP2.1 – DAC2 digital galvo control specifications

Galvo Head Control

The DSP2.1 board incorporates two complete double synchronous serial ports for digital control of up to two galvo-heads. Each port is able to transmit and receive 16bit words independently. SPORT signals are differential and need a couple of twisted-pairs cable to work properly. SPORT signals meet 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.
- TXDx_Y – Y coordinates 16bit.

The receiver needs:

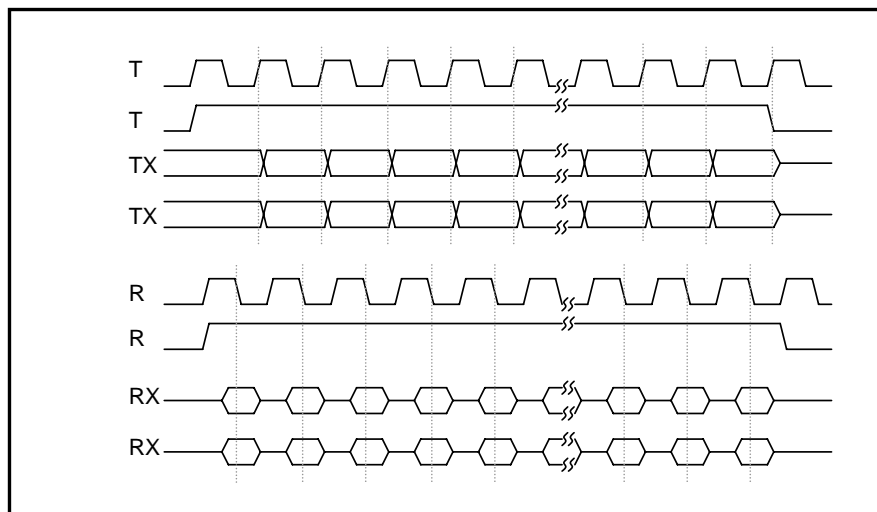
- RCKx – Clock signal active on the falling-edge.
- RFSx – Frame synchronization signal, active high.
- RXDx_X – Status flags from the galvo head.
- RXDx_Y – Feedback signal containing the exclusive or (XOR) of the transmitted data.

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

DSP2.1 pinout

DSP2.1 board use a DB25 connector. The table below shows the entire list of available signals. The following signals are designed to drive two independent galvo heads. Connection between DSP2.1 and DAC2 need to be made using twisted-pairs cable.

<i>Pin</i>	<i>Signal</i>
1	TXD0_X+
2	TFS0+
3	TCK0+
4	TXD0_Y+
5	RXD0_X+
6	RFS0+
7	RCK0+
8	RXD0_Y+
9	GND
10	+5V
11	GND
12	+12V
13	GND
14	-12V
15	GND
16	GND
17	N.C.
18	TXD1_X+
19	TFS1+
20	TCK1+
21	TXD1_Y+
22	RXD1_X+
23	RFS1+
24	RCK1+
25	RXD1_Y+

DAC2 pinout

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 DSP2.1 connector using a 11x2 twisted-pair cable.

<i>Pin</i>	<i>Signal</i>	<i>Pin</i>	<i>Signal</i>
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 Laservall DSP board based engraving system. This module is made as a dynamic linked library designed for 32bit Microsoft® Windows™ platforms.

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

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



NOTE:

Windows™ 98 e Windows™ Me are no longer supported.

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

