LASER_{USB}
Shaker Control System

System Guide
Rev. 4.00

System Installation
  Maintenance
  Calibration
  Troubleshooting

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1 Introduction

This manual provides instructions on installing, maintaining, and calibrating a LASER\textsubscript{USB} Shaker Control System. It also provides information on power and environmental requirements and safety considerations. Any person responsible for installing, maintaining or calibrating the system should be fully familiar with the contents of this manual. For instructions on using the system refer to the following User’s Guides:

“Shaker Control Vibration Test and Analysis Series”
“RT Pro Dynamic Signal Analysis Series”

Other sections of this manual cover:
- Power and environmental requirements
- Safety
- Installation
- Maintenance
- Calibration
- Troubleshooting

System Description

Product Overview

The LASER\textsubscript{USB} Shaker Control System consists of two primary components: (1) the LASER\textsubscript{USB} hardware and (2) Windows-based application software. The LASER\textsubscript{USB} performs data measurement and drive signal generation. The LASER\textsubscript{USB} also performs digital signal processing tasks such as anti-alias filtering and tracking-filter processing.
Control-loop operations, communication between the user interface and \textit{LASER}_\text{USB}, and data transfer to the host PC are handled via USB.

The \textit{LASER}_\text{USB} is classified as a USB 2.0 device. It is backwards compatible with USB 1.0 and 1.1 communications, however, throughput to the host PC will be significantly reduced when used with USB 1.0 or 1.1 hosts. It is recommended that the host PC be equipped with USB 2.0 or a USB 2.0 bridge card, which converts a PCI or PCMCIA port into a USB 2.0 port.

The Windows application software manages operator commands, display of data, and data storage on the host PC. Shaker Vibration Control applications along with Signal Analysis applications are currently available for a range of noise and vibration testing.

The \textit{LASER}_\text{USB} Shaker Control System comes standard with two analog inputs having ICP\textsuperscript{®} sensor power and TEDS capability, one drive output signal source, one COLA output signal source, 6’ (1.83 m) USB 2.0 Type A to Type B cable, power cord, system guide, installation CD, calibration data and License Key disk, and a one year warranty.

**Options**

There are both hardware and software options available for the \textit{LASER}_\text{USB}. These options are listed in the table below.

<table>
<thead>
<tr>
<th>Hardware Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>One extra analog input</td>
<td>Two inputs standard, expandable to sixteen simultaneous channels (an additional unit is required for input channels 9 – 16).</td>
</tr>
<tr>
<td>Remote abort button</td>
<td>Remote abort button for source signal; 10 foot cable included</td>
</tr>
<tr>
<td>Rack mount kit</td>
<td>19” rack mountable brackets. Note: This option is not available when used in-conjunction with the fastener panel kit.</td>
</tr>
<tr>
<td>Fastener panel kit</td>
<td>Screw-in fastener panels allowing two units (Master/Slave) to be physically secured to one another. Note: This option is not available when used in-conjunction with the rack mount kit.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Software Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>Broadband random vibration control</td>
</tr>
</tbody>
</table>
System Hookups and Status Indicators

An on/off power switch, abort button, and three LED status indicators are present on the front panel.

The LED’s on the front panel are defined as follows:

-  (!) indicates power switch is depressed when lit.
-  SYS indicates DSP activity when lit.
-  ACQ indicates data is being acquired when lit.

The rear panel has 10 BNC connectors. The analog input connectors labeled 1 through 8 are for connection to sensor voltage signals. The Drive supplies an analog output signal to drive devices such as electrodynamic shakers. The COLA provides a constant 1 Volt amplitude drive signal.
**Warning**

Do not connect analog voltage signals exceeding +36 Volts to the input or tachometer channels. System electronics may be damaged if higher voltages are applied.

In addition, two 37-pin male D-SUB connectors on the rear panel provide for digital input/output interface to environmental chamber controllers for remote system control functions. A total of 48 TTL signal lines are available.

A remote abort receptacle, an expansion port for master/slave operation, USB, three-conductor AC power receptacle, and grounding stud, completes the list of connections to the rear.

**Alert**

It is good wiring practice to ensure that the system chassis is grounded. Use a suitably insulated ground conductor to connect the grounding stud on the rear of the chassis to earth ground. This will help prevent problems due to ground loops.
Specifications

**Inputs**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Channels</td>
<td>Two standard, expandable to sixteen simultaneous channels (an additional unit is required for input channels 9 – 16). All are differential inputs with 220k Ω impedance. Each input channel has overload detection before both the analog and digital anti-alias filters. Setup allows per channel selection of input voltage range (0.1V, 1V, 10V), transducer sensitivity, sensor type (e.g., acceleration, force, pressure, etc.), and coupling selections for DC, AC (high pass cutoff at 3 Hz defined as -0.1dB amplitude attenuation), ICP (cutoff at 0.7Hz, 4.7mA, and 23V), and TEDS.</td>
</tr>
<tr>
<td>Electronics</td>
<td>Differential amplifier, programmable gain amplifier, anti-aliasing filters, and 24 bit Analog to Digital Converter (ADC).</td>
</tr>
<tr>
<td>Filtering</td>
<td>An analog filter plus a 160 dB/octave linear-phase digital filter prevent aliasing and phase distortion.</td>
</tr>
<tr>
<td>Frequency range</td>
<td>Up to 21 kHz analysis frequency (48k samples per second). Extended frequency option available for 42 kHz (96k samples per second).</td>
</tr>
<tr>
<td>Voltage range</td>
<td>±10 Vpeak</td>
</tr>
<tr>
<td>Signal conditioning</td>
<td>Voltage, ICP sensor power (4.7 mA, 23 Vpeak open circuit), and TEDS.</td>
</tr>
<tr>
<td>Maximum input</td>
<td>±36 Vpeak without damage</td>
</tr>
<tr>
<td>Resolution</td>
<td>24-bit</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>120 dBfs, 110 dB minimum in FFT mode</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.08 dB (1 kHz sine at full-scale)</td>
</tr>
<tr>
<td>Channel Match Amplitude</td>
<td>Within ±0.04 dB</td>
</tr>
<tr>
<td>Phase</td>
<td>Within ±0.50 degree (from DC to 21kHz, frequency response measurement, both inputs on the same input range, linear average)</td>
</tr>
<tr>
<td>Alias protection</td>
<td>&gt;117 dB stopband rejection</td>
</tr>
<tr>
<td>Signal-to-noise</td>
<td>&gt; 100 dB (from DC to 1000 Hz measured with half-full-scale sine wave)</td>
</tr>
<tr>
<td>Cross-talk</td>
<td>&lt;110 dB</td>
</tr>
<tr>
<td>Total Harmonic Distortion+noise</td>
<td>&lt;105 dBfs</td>
</tr>
<tr>
<td>Frequency accuracy</td>
<td>Within 0.01 %</td>
</tr>
</tbody>
</table>

All Specifications subject to change without notice.
Introduction

Outputs

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog channels</td>
<td>Waveform Source with 1 Drive channel and 1 COLA channel standard</td>
</tr>
<tr>
<td>Electronics</td>
<td>24-bit Digital to Analog Converter (DAC) with analog and digital anti-imaging filters</td>
</tr>
<tr>
<td>Filtering</td>
<td>A 160 dB/octave digital filter plus an analog filter prevent imaging and phase distortion</td>
</tr>
<tr>
<td>Frequency range</td>
<td>Up to 42 kHz output frequency (96k samples per second) with extended frequency option</td>
</tr>
<tr>
<td>Voltage range</td>
<td>±10 V peak with programmable attenuation</td>
</tr>
<tr>
<td>Resolution</td>
<td>24-bit</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>120 dbfs</td>
</tr>
<tr>
<td>Total Harmonic Distortion</td>
<td>&lt; -95 dbfs</td>
</tr>
<tr>
<td>Output impedance</td>
<td>50 Ω</td>
</tr>
<tr>
<td>Maximum current</td>
<td>24 mA peak</td>
</tr>
</tbody>
</table>

Hardware

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure</td>
<td>Metal case encloses low-noise inputs/outputs with multiple 50 MHz 32-bit floating-point DSP processors. Front Panel – status LEDs, power switch, and abort button. Rear Panel – BNC connections for eight inputs and two sources, USB, Master/Slave expansion port, two 37-Pin male D-sub digital I/O connections, AC power, remote abort, and grounding stud.</td>
</tr>
<tr>
<td>Input expansion</td>
<td>Two standard, expandable to sixteen simultaneous channels (an additional unit is required for input channels 9 – 16).</td>
</tr>
<tr>
<td>PC configuration</td>
<td>PC with a USB port, Windows 98SE/2000/ME/XP Operating System, and Microsoft Word are the only requirements.</td>
</tr>
<tr>
<td>PC expansion</td>
<td>PC upgrades and peripheral additions do not delay or interrupt the control loop process or data acquisition and realtime processing.</td>
</tr>
</tbody>
</table>

General

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains Power</td>
<td>100 - 240 VAC 47-63Hz 1A</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>30 Watts</td>
</tr>
<tr>
<td>Dimensions</td>
<td></td>
</tr>
<tr>
<td>(Excluding feet and BNC connectors)</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>3.5 in. (8.9 cm)</td>
</tr>
<tr>
<td>Width</td>
<td>16.5 in. (41.9 cm)</td>
</tr>
<tr>
<td>Depth</td>
<td>14.3 in. (36.3 cm)</td>
</tr>
<tr>
<td>Weight</td>
<td>13.0 lbs. (5.9 kg)</td>
</tr>
<tr>
<td>Temperature</td>
<td>41 to 113 °F (5 to 45 °C)</td>
</tr>
<tr>
<td>Humidity</td>
<td>10% to 90% RH non-condensing</td>
</tr>
</tbody>
</table>

All Specifications subject to change without notice.
Regulatory Compliance

<table>
<thead>
<tr>
<th>Compliance</th>
<th>CE(^1) Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>EN(^2) 61010-1, IEC(^3) 1010-1</td>
</tr>
<tr>
<td>EMC</td>
<td>FCC(^4) Part 15 (CFR 47) Class A, EN 61326 Class A, CISPR(^5) 22 Class A</td>
</tr>
</tbody>
</table>

\(^1\)CE = European Compliance.  
\(^2\)EN = European Norm.  
\(^3\)IEC = International Electrotechnical Commission.  
\(^4\)FCC = Federal Communications Commission.  
\(^5\)CISPR = International Special Committee On Radio Interference.

European Community Statement

This equipment complies with the following European directives:


FCC Class A Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference when operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area is likely to cause harmful interference, in which case, the user will be required to correct the interference at his own expense.

Any changes or modifications to this equipment not expressly approved by Dactron could void the user's authority to operate this equipment.

All Specifications subject to change without notice.
Safety and Equipment Protection

2 Safety and Equipment Protection

Safety Summary

The following general safety precautions must be observed during all phases of operation, maintenance, and calibration of the system. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards and/or design, manufacture, and intended use of the system. Dactron assumes no liability for the customer’s failure to comply with these requirements.

Connect the Chassis to Ground

To minimize shock hazard, the system must be connected to an electrical ground. The system is supplied with a three-conductor AC power cord. The power cord must be plugged into an approved three-contact electrical outlet to insure safe operation. An additional grounding stud on the chassis is provided if additional grounding is necessary.

Do Not Operate In an Explosive Atmosphere

Do not operate the system in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove the system cover. Qualified service personnel must make component replacement and internal adjustments. Do not replace components with the power cord connected. Under certain conditions, dangerous voltages may exist even with the power cord removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Substitute Parts or Modify the System

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the system. Return the system to Dactron for service and repair to ensure that safety features are maintained.
Safety and Equipment Protection

**Danger Warnings**

The warning messages below, and throughout this guide, are important notices regarding safe system operation and system protection. Instructions given by these warnings must be followed to ensure safety for both personnel and equipment.

**Warning**

Dangerous voltages may be present in the system. Use the same care as you would for any electronic equipment when handling, calibrating, or maintaining the system.

**Warning**

Under no circumstances should an operator remove any covers, screws, or in any way enter the LASERUSB. There are no operator settable controls or adjustments inside the LASERUSB.

**Warning**

To prevent potential fire or shock hazard, do not expose the system to rain or moisture.

**Warning**

Do not connect analog voltage signals exceeding ±36 Volts to the input or tachometer channels. System electronics may be damaged if higher voltages are applied.

**Warning**

Do not connect an analog voltage source to the output channel. System electronics may be damaged if a voltage source is connected to the output channel.

**Warning**

Never defeat the ground conductor or operate the equipment in the absence of a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available.
3 Power and Environmental Requirements

Power Requirements

The $\text{LASER}_{\text{USB}}$’s power supply is auto sensing and can be powered from any single phase AC power source supplying from 100 to 240 Volts. The line frequency can vary from 47 to 63 Hz.

The $\text{LASER}_{\text{USB}}$ consumes less than 40 Watts depending on the number of channels and sources activated.

USB Cable Requirements

It is recommended that a USB 2.0 cable be used with the $\text{LASER}_{\text{USB}}$. USB 2.0 cables are typically of higher quality than USB 1.0 or 1.1 cables.

The maximum USB cable length is 16 feet. Additional USB cables can be added to increase the length provided that either a powered USB hub is added between cables to boost the power or a USB Repeater Cable is used.

Environmental Requirements

Operation

When powered, the allowable ambient temperature for operation of the $\text{LASER}_{\text{USB}}$ is from 32 to 122 °F (0 to 50 °C). The relative humidity range for operation is from 10 to 90% under non-condensing conditions.

Care must be taken to ensure unobstructed airflow to the fan on the right side of the chassis. Vent holes on the left side of the chassis must also be free of obstruction. If the $\text{LASER}_{\text{USB}}$ is mounted in an enclosure, such as an equipment rack, care must be taken to prevent blocking the fan or air vents and an allowance made for adequate fresh air circulation.

In accordance with International Standards IEC 1010-1 (EN61010-1) the following conditions are also applicable:
Power and Environmental Requirements

1. Maximum relative humidity is 80% for temperatures up to 87.8 °F (31 ºC) and 50% for temperatures up to 104 °F (40 ºC).
2. Maximum operating altitude up to 6000 ft. (2000 m.).
3. For use in an indoor environment only.
4. For use with mains supply of Installation Category II.
5. For use in Pollution Degree 1 or 2 environments.

**Warning**

To prevent potential fire or shock hazard, do not expose the system to rain or moisture.

Storage and Shipment

Store the \textit{LASER}_{USB} in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature: -20 to 60 ºC (-4 to 140 ºF)

Humidity: Up to 95%

The system should also be protected against temperature extremes that would cause condensation within the system.

Packaging for Shipment

**Original Packaging**

Use the original factory packaging containers to return ship the system to Dactron for Re-calibration or service. If the system is being returned to Dactron for service, attach a tag indicating the return merchandise authorization (RMA) number provided by Dactron technical support, type of service required, return address, system model name, and serial number.

The following general instructions should be used for repackaging with commercially available materials:

1. Wrap the system with heavy paper or plastic.
2. Use a strong shipping container. A double wall carton made of 350-pound test material is adequate.
3. Use a layer of shock absorbing material 70 to 100 mm (3 to 4 inches) thick around all sides of the system to provide firm cushioning and
prevent movement within the container. Protect the control panel with cardboard.

**Caution**

_Styrene pellets in any shape should never be used as packing material. The pellets do not adequately cushion or prevent the system from shifting in the carton. The pellets also create static electricity that can damage electronic components._

4. Seal the shipping container securely.
5. Mark the shipping container FRAGILE to ensure careful handling.
6. In any correspondence, refer to the system by model name and serial number.
4 System Installation

Installation and Setup Procedure

Basic System Hardware Setup (8-Channels or less)

The 8-Channel configuration of a Dactron LASER\textsubscript{USB} Shaker Control System consists of a LASER\textsubscript{USB} master unit, and the associated connecting cables.

To install the 8-Channel System verify that you have the following components:

- LASER\textsubscript{USB} master unit
- 6’ (1.83 m) USB 2.0 Type A to Type B cable
- Power cord
- Installation CD
- Calibration data and License Key disk

Connecting the LASER\textsubscript{USB} master unit

1) Set the LASER\textsubscript{USB} master unit in position. Be sure that this unit is within six feet of the host PC (the length of the USB cable).

2) On the rear of the LASER\textsubscript{USB} master unit, insert the USB cable into the USB port. Verify that the cable is securely seated in the port.

3) Continue with the LASER\textsubscript{USB} driver installation as indicated in the LASER\textsubscript{USB} Driver Installation Instructions.

Basic System Hardware Setup (16-Channels or less)

The 16-Channel configuration of a Dactron LASER\textsubscript{USB} Shaker Control System consists of two LASER\textsubscript{USB} units, a master and a slave, and the associated connecting cables.

To install the 16-Channel System verify that you have the following components:

- LASER\textsubscript{USB} master unit
- LASER\textsubscript{USB} slave unit
System Installation

- Master-Slave Expansion Port cable
- 6’ (1.83 m) USB 2.0 Type A to Type B cable
- Two power cords
- Installation CD
- Calibration data and License Key disk

Connecting the *LASER*\textsubscript{USB} master and slave units

1) Set the master unit in position. Be sure that this unit is within six feet of the host PC (the length of the USB cable). Place the slave unit on top of the master unit.

Front View of 16 Channel System Configuration

2) Insert the Master-Slave Expansion Port cable into the master’s expansion port and then into the slave’s expansion port.

Rear View of 16 Channel System Configuration
port. Verify that the cable is securely seated in the two connectors. The Master-Slave Expansion Port is located on the rear of the unit.

**Warning**

*To prevent potential damage to the units, connect Expansion Cable as shown.*

3) Continue with the \textit{LASER}_{USB} driver installation as indicated in the \textit{LASER}_{USB} Driver Installation Instructions.

\textbf{NOTE:}

Only one USB port is required on the host PC for 16 Channel System Configuration. The USB connection is made between the \textit{LASER}_{USB} master unit and the host PC. Power must first be applied to the \textit{LASER}_{USB} slave unit, then the \textit{LASER}_{USB} master unit for the system to initialize properly.
Step 1: \textit{LASER}_{USB} Driver Installation Instructions

The \textit{LASER}_{USB} communicates with the PC through a USB connection. This requires Windows driver software to enable the USB connection. The USB is a “plug and play” device, which means that after the driver is initially installed, the configuration of the driver is automatically launched every time the device is plugged into the USB port. To install the \textit{LASER}_{USB} driver you will need the \textit{LASER}_{USB} hardware, a USB cable, and the Installation CD.

The driver installation process first locates the INF file named \textit{VCSUSB.INF} on the Installation CD. Using the information provided by \textit{VCSUSB.INF}, the device driver file \textit{VCSUSB.SYS} is copied into the \textit{WINDOWS\|SYSTEM32\|DRIVERS} folder. The operating system registers the \textit{LASER}_{USB} device in its registry so the next time the \textit{LASER}_{USB} is plugged in it can be identified. Finally, the \textit{VCSUSB.INF} file is copied into the \textit{WINDOWS\|OTHER\|INF} or its subfolder for future use.

Follow the instructions below to install the \textit{LASER}_{USB} driver software.

1. Turn on the PC and launch Windows. Your PC must use one of the following operating systems: Windows 98 Second Edition, 2000, ME, or XP. If you are using Windows 2000 or XP you must be logged on with administrator privileges to install a new driver.

2. Place the Installation CD into the CD drive.

3. Turn on the \textit{LASER}_{USB}.

4. Plug the USB cable into the \textit{LASER}_{USB} and the PC.

The PC will auto detect the presence of the new hardware and launch the “New Hardware Wizard.” Note the dialog boxes shown below are from Windows XP. The dialog for Windows 98SE, ME, and 2000 will vary slightly.
5. Select, “Install from a list or specific location (Advanced)” and click on the Next button.

The driver files are named *VCSUSB.SYS* and *VCSUSB.INF* and are located on the root directory of the Installation CD.

6. Select, “Search for the best driver in these locations.” Specify a location, and enter the path to the driver files on the CD drive. For example if the CD drive is the E:\ drive, you would type E:\ as the path. Click on the Next button. Windows remembers the path to the previous USB device installation so you may need to delete the old path and re-type the path to the CD drive.
7. When Windows finds the driver file *VCSUSB.INF*, it may display the following dialog. Select, “Dactron Laser-USB (USB 2.0 device)” and click on the Next button to complete the installation. Otherwise, Windows will automatically install the driver.

![Found New Hardware Wizard dialog](image1)

For Windows XP, after the driver installation starts the following dialog may open. Click on “Continue Anyway” to complete the installation. This dialog indicates that Dactron has not registered the driver with Microsoft Corporation.

![Hardware Installation dialog](image2)

8. The driver installation should now be complete. Click on the Finish button to close the New Hardware Wizard.
System Installation

The driver is now installed and the LASER_USB should be auto-detected every time it is plugged into the specific USB port on the host PC.

Step 2: Installing Application Software on the PC

Application software, such as the Shaker Control Vibration Test and Analysis Series or the RT Pro Dynamic Signal Analysis Series, is installed on the host PC. Refer to the “Shaker Control Vibration Test and Analysis Series” or the “RT Pro Dynamic Signal Analysis Series” User Guide, “Installation and Setup Procedure”, for complete details on installation of application software.

The LASER_USB is now ready to run. Start the Dactron application software from the host PC and you will be ready to use the application software.

Step 3: Running the Application Software

The Dactron software running on the LASER_USB system consists of the following three modules:

Windows application software running on the host PC or a remote PC.
Server software running on the host PC.
DSP software running on the DSP chip in the LASER_USB.
Updating the Device Driver

The device driver must be updated when you install a new version of the Dactron application software that uses a new driver. The application software will detect the driver version before it launches and indicate whether an update is necessary. If you get an error message indicating that a newer version of the device driver is required, then you must update the LASER_USB device driver.

To update the Dactron LASER_USB device driver follow these instructions. The figures following are for Windows XP and may vary with other operating systems.

1. Go to the Windows Start button and select Control Panel, and then double click System from the list of control panels. Click on the Hardware tab and then the Device Manager button.

2. Scroll down to “Universal Serial Bus controllers”, click the “+” icon to expand the selection and right click on Dactron Laser-USB (USB 2.0 device). Select “Update Driver…” from the pop up menu.
Select, “Install from a list or specific location (Advanced)”. And click on the Next button.

The updated driver files are named \textit{VCSUSB.SYS} and \textit{VCSUSB.INF} and are located on the root directory of the Installation CD.

3. Select, “Search for the best driver in these locations”. Specify a location and enter the path to the CD drive. For example, if the CD drive is the E:\ drive, you would type E:\ as the path. Click on the Next button. Note that Windows remembers the path to the previous USB device so you may need to delete the old path and re-type the path to the CD drive.
4. Note that the Hardware Update Wizard shows the existing \textit{LASER}_{USB} driver information as well as the new \textit{LASER}_{USB} driver information found on your Installation CD. Select the new \textit{LASER}_{USB} driver found on your Installation CD. Click Next.

For Windows XP, after the driver installation starts the following dialog may open. Click on “Continue Anyway” to complete the installation. This dialog indicates that Dactron has not registered the driver with Microsoft Corporation.
5. Click on the Finish button to close the Hardware Update Wizard.

6. Windows 2000, ME, and XP do not require restart after updating drivers. For Windows 98SE, you will need to restart your computer to let the system update the new changes.
Uninstall the Device Driver

Under rare circumstances you may need to uninstall the device driver for the Dactron LASERusb. Follow these steps carefully. Failure to follow the instructions can result in damage to the operating system or other software. It is recommended that a network administrator or other computer expert perform this operation.

The process of uninstalling the device driver is vastly different for each operating system. Refer to the instructions below for your specific operating system.

Windows 98SE

To uninstall the LASERusb device driver in Windows 98SE, follow these instructions.

1. Delete the following 3 files:
   
   C:\WINDOWS\INF\OTHER\VCSUSB.INF
   C:\WINDOWS\SYSTEM32\DRIVERS\VCSUSB.SYS
   C:\WINDOWS\SYSTEM32\DRIVERS\VCSUSB.HEX

2. From the Start Menu, choose Run, type “regedit” to run the registry editor program. Be extremely careful when using the registry editor program as you can damage the operating system and other software by inadvertently deleting the wrong items.

   Expand the HKEY_LOCAL_MACHINE by clicking on the + button to the left.

   Continue to expand to the following path:
   HKEY_LOCAL_MACHINE \ ENUM\USB\%

   Delete the folder named VID_0B90&PID_3000 by right clicking in it and selecting Delete from the pop-up menu.

   Expand to the following path:
   HKEY_LOCAL_MACHINE \ SYSTEM\CURRENTCONTROLSET\ SERVICES\CLASS\USB\%

   This folder may contain many entries. Click on each one and read the Driver Description. Delete any driver that has a description of “Dactron Laser-USB (USB 2.0 device)”

   Exit the Registry Editor program.

   The driver should now be completely uninstalled.
Please be very careful when you delete files from your PC’s Windows system folder. If other files are accidentally deleted, your PC or software programs may not function correctly.
Windows 2000

To uninstall the *LASER*$_{\text{USB}}$ device driver in Windows 2000 follow these instructions.

1. Go to the Windows Start button and select Control Panel, and then double click Add/Remove Hardware. Click Next.

   ![Add/Remove Hardware Wizard](image)

2. Select “Uninstall/Unplug a device”. Click Next.

   ![Add/Remove Hardware Wizard](image)
3. Select “Uninstall a device”. Click Next.

![Add/Remove Hardware Wizard]

4. Select the Dactron Laser-USB (USB 2.0 device) device. It will be hidden if the \textit{LASERUSB} is not connected and power is not applied to the unit. If this is the case, then place a check next to “show hidden devices” to display it. Click Next.

![Add/Remove Hardware Wizard]

5. Select “Yes, I want to uninstall this device”. Click Next.
6. Click on the Finish button to close the Add/Remove Hardware Wizard.
7. Optional:

After you remove the device, manually delete the following 5 files:

C:\WINNT\INF\OTHER\VCSUSB.INF
C:\WINNT\SYSTEM32\DRIVERS\VCSUSB.SYS
C:\WINNT\SYSTEM32\DRIVERS\VCSUSB.HEX
C:\WINNT\INF\OEM#\INF
- There may be several #s, e.g., OEM0.INF, OEM1.INF, OEM2.INF, etc… You can open each OEM#.INF file and find the one that lists “VCSUSB” at the top of the file. There may be more than one. Note the # of the OEM#.INF file/s, close the file and then delete it.

C:\WINNT\INF\OEM#\PNF
- Delete the file with the number associated with the OEM#.INF file/s from the previous step.

The driver should now be completely uninstalled.

Please be very careful when you delete files from your PC’s Windows system folder. If other files are accidentally deleted, your PC or software programs may not function correctly.
Windows ME

To uninstall the **LASER**\textsubscript{USB} device driver in Windows ME follow these instructions.

1. Go to the Windows Start button and select Control Panel, and then double click System from the list of control panels. Click on the Device Manager tab. Scroll down to Universal Serial Bus controllers and click the “+” icon to expand the selection. Highlight the Dactron LASERUSB (USB 2.0 device). The **LASER**\textsubscript{USB} will only be listed if it is connected via the USB cable and power is applied to the unit. If the **LASER**\textsubscript{USB} is not connected and power is not applied, then it will not be listed in the Device Manager list. Click on the Remove button.

2. Click OK to confirm the device removal.

3. Optional:
   After you remove the device, manually delete the following 4 files:
   
   C:\WINDOWS\INF\OTHER\DACTRON INC. VCSUSB.INF
   C:\WINDOWS\INF\OTHER\DACTRON VCSUSB.INF
   C:\WINDOWS\SYSTEM32\DRIVERS\VCSUSB.SYS
   C:\WINDOWS\SYSTEM32\DRIVERS\VCSUSB.HEX

   The driver should now be completely uninstalled.

   *Please be very careful when you delete files from your PC’s Windows system folder. If other files are accidentally deleted, your PC or software programs may not function correctly.*
Windows XP

To uninstall the LASER\textsubscript{USB} device driver in Windows XP follow these instructions.

1. Go to the Windows Start button and select Control Panel, and then double click System from the list of control panels. Click on the Hardware tab and then the Device Manager button.

2. Scroll down to “Universal Serial Bus controllers,” click the “+” icon to expand the selection and right click on Dactron Laser-USB (USB 2.0 device). Select Uninstall from the pop up menu.

The LASER\textsubscript{USB} will only be listed if it is connected via the USB cable and power is applied to the unit. If the LASER\textsubscript{USB} is not connected and power is not applied, then it will not be listed in the Device Manager list.
3. Click OK to confirm the device removal.
4. Optional:
   After you remove the device, manually delete the following 5 files:
   
   C:\WINDOWS\INF\OTHER\VCSUSB.INF
   C:\WINDOWS\SYSTEM32\DRIVERS\VCSUSB.SYS
   C:\WINDOWS\SYSTEM32\DRIVERS\VCSUSB.HEX
   
   C:\WINDOWS\INF\OEM#.INF - There may be several #s, e.g., OEM0.INF, OEM1.INF, OEM2.INF, etc... You can open each OEM#.INF file and find the one that lists “VCSUSB” at the top of the file. There may be more than one. Note the # of the OEM#.INF file/s, close the file and then delete it.
   
   C:\WINDOWS\INF\OEM#.PNF - Delete the file with the number associated with the OEM#.INF file/s from the previous step.
   
   The driver should now be completely uninstalled.

   Please be very careful when you delete files from your PC’s Windows system folder. If other files are accidentally deleted, your PC or software programs may not function correct.
5 Maintenance

Maintenance should be performed periodically to ensure proper system operation and product life. Cleaning of the fan filter is the only routine maintenance required. The fan filter (located on the right side of the chassis) should be inspected routinely and cleaned when there is a visible buildup of dust. For clean laboratory environments an annual filter cleaning may be sufficient. For environments that are dusty or have other air borne contaminants, more frequent inspection and cleaning intervals are required.

Procedure to Remove and Clean the Fan Filter:

1. Power off the system.
2. Disconnect the power cord from the receptacle in the rear of the system.
3. Using a Phillips screwdriver, remove the (10) Phillips screws securing the LASERUSB enclosure cover. (5) screws are located on each side of the enclosure.
4. Remove the LASERUSB enclosure cover. Slightly tilt the cover upward from the rear, slide the lip of the cover out of the groove of the LASERUSB front bezel, and remove.
5. Use a flathead screwdriver to remove the plastic fan guard. To do this, insert the head of the screwdriver under the centerpiece of the plastic fan guard, and then gentle pry the centerpiece up until the guard snaps out of the chassis side.
6. Remove the filter and wash in a water solution using a mild soap.
7. Insert the dry filter back into position on the side of the chassis.
8. Snap the plastic filter guard back into position. Check that the filter is secured and properly positioned. Remove the guard and reposition the filter if necessary.
9. Replace the LASERUSB enclosure cover. Slightly tilt the cover upward, slip the lip of the cover into the groove located in the LASERUSB front bezel and slide in place.
10. Using a Phillips screwdriver, replace the (10) Phillips screws securing the LASERUSB enclosure cover. (5) screws are located on each side of the enclosure.
**Warning**

Under no circumstances should an operator remove any covers, screws, or in any way enter the \( \text{LASER}_{\text{USB}} \) other than noted. There are no other operator settable controls or adjustments inside the \( \text{LASER}_{\text{USB}} \). Any hardware expansion must be performed by an authorized Dactron representative.
6 Calibration

What Do We Calibrate?

This section documents the procedure for offset and gain error calibration of the input channels. The offset is a constant DC offset, and the gain error is an error of the amplification factor in the input and signal source paths.

Both offset and gain errors are gain-dependent. The gain settings will influence the offset estimate and the gain error itself. Therefore, it is necessary to calibrate all the voltage ranges.

The purpose of calibration is to ensure accuracy by estimating the offset value and the gain error in all possible ranges (gain-settings). Once this calibration data is stored, the input measurement and the signal source can be adjusted back to the most accurate value.

The Dactron system uses sigma-delta A/D and D/A converters and an anti-aliasing filter with a very high cutoff frequency. As a result, the amplitude characteristics of the input and signal source are not frequency dependent. Satisfactory flatness is guaranteed over the entire useful frequency range. Therefore, we do not recommend calibration of the amplitude vs. frequency characteristics.

The Drive output channel of the LASERUSB can be used to calibrate the input channels. The key is a good signal reference measurement, such as that provided by a high-precision voltmeter. If the voltmeter meets accuracy specifications, the actual signal source is inconsequential.

Signal Source Used for Calibration

A single sine tone generated by the Source channel is used for both input and signal source calibration. Multiple frames are captured, windowed, and averaged to reduce the variance of the sine tone amplitude estimation.

The amplitude flatness (ripple) within the analysis frequency range is about ±0.01 dB. This very low number is due to digital implementation of the anti-aliasing filter (for the inputs) and the reconstruction filter (for the signal sources). The gain characteristics are frequency-independent within the analysis frequency range.
Two panes display the time capture trace and the power spectrum for each channel. This display allows you to simultaneously view the time domain and frequency domain signals captured by the input channels. This provides a visual comparison of channel levels and is helpful in diagnosing problems if the calibration fails.

Install the Calibration Software

Insert the Installation CD into the CD drive. The CD will then automatically launch the setup routine. If it does not, on the CD drive, locate the file “Setup.exe” and double-click on it.

From the installation main menu for Shaker Control, select “Shaker Control Series” then select "Calibration". If you have the RT Pro Installation CD, then from the installation main menu, select "Signal Analysis Series" then select "Calibration".

This will invoke the dialog box shown below:

Follow the step-by-step instructions to install the software. A License Key will be needed to complete the process. Either “import” the License Key or copy-and-paste it directly from the License Key file.
Calibration Tools

To calibrate the LASERUSB with Dactron’s calibration software, you will need the following:

1. 9 BNC cables.
2. Voltmeter BNC adapter cable.
3. BNC T Connectors or connecting adapters linking each of the individual BNC cables together at one end.
4. Voltmeter with a valid calibration certificate. The voltmeter should be able to measure DC and True RMS to an accuracy of 0.25%. The AC bandwidth for the voltmeter should be higher than 10 kHz.

The voltmeter accuracy should be 0.25% in order to ensure that the Dactron system is calibrated to an accuracy of $\pm 1\%$ ($\approx \pm 0.1\db$). Generally, the accuracy of the calibration meter should be four times higher than the system being calibrated.
Calibration Procedure (8-Channels or less)

Calibration involves the following major steps:

1. Connect cables to the $LASER_{USB}$.
2. Start the calibration software.
3. Measure the Drive output channel offset with no input signal.
4. Perform Drive output channel calibration.
5. Perform Input channel calibration.
6. Validate the calibration results.
7. COLA output channel calibration (optional)
Cable Connection

Connect one end of the BNC cables to Analog Input Channels 1-8 and Drive output channel. Connect all the other ends together with BNC T Connectors. Connect this cable harness to a voltmeter that is certified to the accuracy standard noted in the calibration tool requirements section (0.25%).

Note that during the calibration process, you will be prompted to disconnect and relocate BNC cables, as necessary.

Power up the LASER_USB and wait at least 10 minutes. If required, record environmental parameters such as pressure, humidity etc…

Start the Calibration Software

Start the calibration software by clicking the Calibration icon.
Select New under the File menu:

LASER_USB System Guide 43
You are then prompted to enter the following information:

![Type Calibration Information](image)

Select OK after the appropriate information has been entered. This will open the normal Dactron Control System screen and a warning message reminding you to allow the hardware to warm up sufficiently prior to system calibration.

![Warning Message](image)

Click OK to acknowledge the warning. The normal Dactron Control System screen is now fully visible. Before pressing the Start button, measure the DC voltage offset on the Drive channel. A typical reading for the Drive offset is under 5 millivolts. Select Start on the Control Panel. Then follow the step-by-step instructions.
Output Channel Calibration

The first step is to measure the DC offset of the drive channel. A dialog box will appear repeatedly until all output ranges are measured. Each time, you should read the DC measurement from the voltmeter and type the value in the edit box.

Please allow enough time for voltmeter readings to stabilize. Stability can be assumed if the readings vary less than 2% of the total measurement reading on all ranges.

The DC output measurement will be repeated three times; one measurement is made at the 10, 1 and 0.1 Volt full-scale ranges.
You will also be requested to measure the RMS value of the output at three levels and type it into the dialog box. **Please make sure that the voltmeter is switched to AC measurement.** This concludes the calibration of the Drive output.

**Input Channel Calibration**

The input channels are calibrated automatically. The system will now use the calibrated Drive as the signal source. The gain error and offset estimation are calculated automatically for all the input range settings.

The input calibration process depends on an accurately calibrated Drive channel. If the Drive is not accurately calibrated, the validation report will document less than satisfactory results for both input and output channels.

**Calibration Result Validation**

After the input calibration, the software validates the calibration results. During this validation, it requires the remeasurement of the DC offset and RMS values. Both the DC offset and the RMS measurement will be made at all three voltage ranges as before.

A dialog box asks for a measurement and entry of the DC reading from the meter. The software will check the deviation of its expected value and the measured value.
After validation, both the offset and gain error should be within tolerance.

The pass/no-pass tolerance used during the validation is:

- 10 volt range: 1% of the Full Scale
- 1.0 volt range: 2% of the Full Scale
- 0.1 volt range: 5% of the Full Scale

**COLA Channel Calibration (optional)**

Following the calibration of the Drive output and input channels, the software will prompt you to calibrate the COLA output channel. Click Yes to start the COLA calibration. Otherwise, click No to finish and skip to the next section, “Calibration Data File and Report”.

The first step is to measure the DC offset of the COLA channel. A dialog box will appear for the output range to be measured. You should read the DC measurement from the voltmeter and type the value in the edit box.

Please allow enough time for the voltmeter readings to stabilize. Stability can be assumed if the readings vary less than 2% of the total measurement reading on all ranges.
The DC output measurement is made at the 10 Volt full-scale range.

You will also be requested to measure the RMS value of the output and type it into the dialog box. **Please make sure that the voltmeter is switched to AC measurement.** This concludes the calibration of the COLA output.

After the COLA calibration, the software validates the calibration results. During this validation, it requires the remeasurement of the DC offset and RMS values. Both the DC offset and the RMS measurement will be made at the 10 volt range as before.

**Calibration Data File and Report**

At the end of the calibration process, a dialog box showing the calibration report will be opened for review. The calibration data file
and a text report are saved in the “DactronCalib” directory. You can view the calibration report in text mode at any time. This Calibration Report is the basis for any calibration certification requirement.

Preview of the Calibration Report

To use the calibration data file, copy it into the \BIN folder where the main software application resides.

**Important**

The calibration software does not copy the calibration files to the \BIN folder. This must be done manually by the user.
Calibration Procedure (16-Channels or less)

This section provides instructions for calibrating a Dactron 16 Channel $\text{LASER}_\text{USB}$ Shaker Controller System. Calibration of a 16 channel system is similar to calibration of an 8 channel system. The process is as follows:

Calibration involves the following major steps:

1. Connect cables to the $\text{LASER}_\text{USB}$ master.
2. Start the calibration software.
3. Measure the Drive output channel offset with no input signal.
4. Perform Drive output channel calibration.
5. Perform input channel calibration.
6. Validate the calibration results.
7. Relocate the BNC cables from the master to the slave unit.
8. Perform slave input channel calibration
9. Validate the calibration results
10. COLA output channel calibration ($optional$)
Cable Connection

Connect one end of the BNC cables to the Analog Input Channels 1-8 and the Drive output channel of the master unit. Connect all the other ends together with BNC T Connectors. Connect this cable harness to a voltmeter that is certified to the accuracy standard noted in the calibration tool requirements section (0.25%).

Note that during the calibration process, you will be prompted to disconnect and relocate BNC cables, as necessary.

Power on the $\text{LASER}_\text{USB}$ Slave first, then the $\text{LASER}_\text{USB}$ Master. Connect the USB cable between the $\text{LASER}_\text{USB}$ Master and the host PC and wait at least 10 minutes. If required, record environmental parameters such as pressure, humidity etc…

Start the Calibration Software

Start the calibration software by clicking the Calibration icon.

Select New under the File menu:

You are then prompted to enter the following information:
Select OK after the appropriate information has been entered. This will open the normal Dactron Control System screen and a warning message reminding you to allow the hardware to warm up sufficiently prior to system calibration.

Click OK to acknowledge the warning. The normal Dactron Control System screen is now fully visible. Before pressing the Start button, measure the DC voltage offset on the Drive channel. A typical reading for the Drive offset is under 5 millivolts. Select Start on the Control Panel. Then follow the step-by-step instructions.
Output Channel Calibration

The first step is to measure the DC offset of the Drive channel. A dialog box will appear repeatedly until all output ranges are measured. Each time, you should read the DC measurement from the voltmeter and type the value in the edit box.

Please allow enough time for voltmeter readings to stabilize. Stability can be assumed if the readings vary less than 2% of the total measurement reading on all ranges.

The DC output measurement will be repeated three times; one measurement is made at the 10, 1 and 0.1 Volt full-scale ranges.
You will also be requested to measure the RMS value of the output at three levels and type it into the dialog box. **Please make sure that the voltmeter is switched to AC measurement.** This concludes the calibration of the Drive output.

![AC Measurement for Gain Calibration](image)

**Master Input Channel Calibration**

The input channels are calibrated automatically. The system will now use the calibrated Drive as the signal source. The gain error and offset estimation are calculated automatically for all the input range settings.

The input calibration process depends on an accurately calibrated Drive channel. If the Drive is not accurately calibrated, the validation report will document less than satisfactory results for both input and output channels.

**Master Calibration Result Validation**

After the input calibration, the software validates the calibration results. During this validation, it requires remeasurement of the DC offset and RMS values. Both the DC offset and the RMS measurement will be made at all three voltage ranges as before.

A dialog box asks for a measurement and entry of the DC reading from the meter. The software will check the deviation of its expected value and the measured value.
DC Measurement for the Offset Validation

After validation, both the offset and gain error should be within tolerance.

The pass/no-pass tolerance used during the validation is:

- 10 volt range: 1% of the Full Scale
- 1.0 volt range: 2% of the Full Scale
- 0.1 volt range: 5% of the Full Scale

Move the BNC Cables from the Master Inputs to the Slave Inputs

Once the master unit is calibrated, the software will prompt if you want to calibrate the slave unit.

A message box appears on the Instructions dialog box prompting the user to move the BNC cables from the master unit inputs to the slave unit inputs. Move the BNC cables as shown on the Instruction dialog box. Note that one BNC cable must remain on the master Drive channel. Click on Yes to continue once the new wiring configuration has been completed.
Slave Input Channel Calibration

The input channels are calibrated automatically. The system will now use the calibrated Drive as the signal source. The gain error and offset estimation are calculated automatically for all the input range settings.

The input calibration process depends on an accurately calibrated Drive channel. If the Drive is not accurately calibrated, the validation report will document less than satisfactory results for both input and output channels.

Slave Calibration Result Validation

After the input calibration, the software automatically validates the calibration results. This validation process is done automatically and does not require user interaction.

After validation, both the offset and gain error should be within tolerance.

The pass/no-pass tolerance used during the validation is:

- 10 volt range: 1% of the Full Scale
- 1.0 volt range: 2% of the Full Scale
- 0.1 volt range: 5% of the Full Scale

COLA Channel Calibration (optional)

Following the calibration of the Drive output and input channels, the software will prompt you to calibrate the COLA output channel. Click Yes to start the COLA calibration. Otherwise, click No to finish and skip to the next section, “Calibration Data File and Report”.

Cable Connection for Slave Unit Calibration
The first step is to measure the DC offset of the COLA channel. A dialog box will appear for the output range to be measured. You should read the DC measurement from the voltmeter and type the value in the edit box.

Please allow enough time for the voltmeter readings to stabilize. Stability can be assumed if the readings vary less than 2% of the total measurement reading on all ranges.

The DC output measurement is made at the 10 Volt full-scale range.

You will also be requested to measure the RMS value of the output and type it into the dialog box. Please make sure that the voltmeter is switched to AC measurement. This concludes the calibration of the COLA output.
After the COLA calibration, the software validates the calibration results. During this validation, it requires remeasurement of the DC offset and the RMS values. Both DC offset and RMS measurement will be made at the 10 volt range as before.

**Calibration Data File and Report**

At the end of the calibration process, a dialog box showing the calibration report will be opened for review. The calibration data file and a text report are saved in the “DactronCalib” directory. You can view the calibration report in text mode at any time. This Calibration Report is the basis for any calibration certification requirement.
Calibration

To use the calibration data file, copy it into the \BIN folder where the main software application resides.

Important

The calibration software does not copy the calibration files to the \BIN folder. This must be done manually by the user.
7 System Troubleshooting

The diagram below shows the structured layers of the Dactron LASER_{USB} System. Each layer generates and sends a message to the system user interface in the event of an error condition. These messages aid in diagnosing and resolving problems.
Check if USB driver is installed correctly

To determine if the driver software has been installed and if the PC recognizes the $\text{LASER}_{\text{USB}}$, first connect the $\text{LASER}_{\text{USB}}$ to the PC with a USB cable and apply power to the system. Go to the Windows Start button and select Control Panel. Double click System from the list of control panels. Click on the Hardware tab and then the Device Manager button.

Scroll down to “Universal Serial Bus controllers”, click the “+” icon to expand the selection and see all installed USB devices. If the device and driver have been installed correctly, then you should see “Dactron Laser-USB (USB 2.0 device)” in the list as shown below.
The LASER_USB will only be listed if it is connected via the USB cable and power is applied to the unit. If the LASER_USB is not connected and no power is applied, then it will not be listed in the Device Manager list. Try reinstalling or updating the device driver, if the device driver is not listed even when the LASER_USB is connected and power is applied. In this case, the driver may not have been installed correctly.

**USB not connected at application startup**

The LASER_USB must be connected to the PC via the USB cable and powered before the application software is started.

If you start the application software before powering on the unit, you will receive the following error message.
Click on Abort, apply power to the $\text{LASER}_{\text{USB}}$ disconnect and reconnect the USB cable, and restart the application software.

If you start the application software before the PC initializes the USB connection, you will receive the following error message.

Click on Abort, disconnect and reconnect the USB cable and restart the application software to establish communication between the $\text{LASER}_{\text{USB}}$ and the host PC.

**Failure to initialize the $\text{LASER}_{\text{USB}}$**

If power is lost or reduced below the minimum requirements during operation of the $\text{LASER}_{\text{USB}}$, follow the instructions provided on the screen to re-establish communication with the $\text{LASER}_{\text{USB}}$.

If the USB cable is inadvertently disconnected between the $\text{LASER}_{\text{USB}}$ and the PC while the application software is running, the following error message will be displayed.
Follow the instructions provided to re-establish communication with the \textit{LASER_{USB}}.

If the slave unit is inadvertently disconnected between the master unit while the application software starts, the following error message will be displayed.

Click on OK, connect the Expansion Port cable between the \textit{LASER_{USB}} master and slave unit, and restart the application software.

\textbf{Windows Application Software Failure}

If any Windows application or DSP software module is missing, the following type of error message will be displayed.
8 Limited Warranty Statement

LDS warrants to you that LDS software will not fail to execute its programming instructions, for a period of one year from date of shipment, due to defects in material and workmanship when properly installed. If LDS receives notice of such defects during the warranty period, LDS will, at its option, either repair or replace software media which does not execute its programming instructions due to such defects.

LDS does not warrant that the operation of LDS products will be uninterrupted or error free.

LDS products may contain remanufactured parts equivalent to new in performance or may have been subject to incidental use.

Warranty does not apply to defects resulting from (a) improper or inadequate maintenance or calibration, (b) software, interfacing, parts or supplies not supplied by LDS, (c) unauthorized modification or misuse, (d) operation outside of the published environmental specifications for the product, or (e) improper site preparation or maintenance.

NO OTHER WARRANTY OR CONDITION, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED AND LDS SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY, SATISFACTORY QUALITY, AND FITNESS FOR A PARTICULAR PURPOSE.

THE REMEDIES IN THIS WARRANTY STATEMENT ARE BUYER’S SOLE AND EXCLUSIVE REMEDIES. EXCEPT AS INDICATED ABOVE, IN NO EVENT WILL LDS OR ITS SUPPLIERS BE LIABLE FOR LOSS OF DATA OR FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFIT OR DATA), OR OTHER DAMAGE, WHETHER BASED IN CONTRACT, TORT, OR OTHER LEGAL THEORY.
ASSISTANCE

If you are unable to solve a problem with your LDS-Dactron product, contact your LDS Representative. To locate the LDS Representative in your area refer to LDS web site www.lds-group.com. You can also contact LDS-Dactron directly at using the contact information on the cover page.

TO RECEIVE WARRANTY REPAIR SERVICE

To obtain warranty service or repair, LDS-Dactron products must be returned to a service facility designated by LDS. Buyer shall prepay shipping charges to LDS and LDS shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to LDS from countries and locations outside of the United States.
## 9 Manual Revision History

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<td>4.00, 66 pages</td>
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