USER'S MANUAL

chroma+scan 4000

Version 5.4.3.0

Proprietary

Trademarks and Restrictions

This product is designated for use solely as a component and as such it does not comply with the standards relating to laser products specified in U.S. FDA CFR Title 21 Part 1040.

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1 Laser Safety

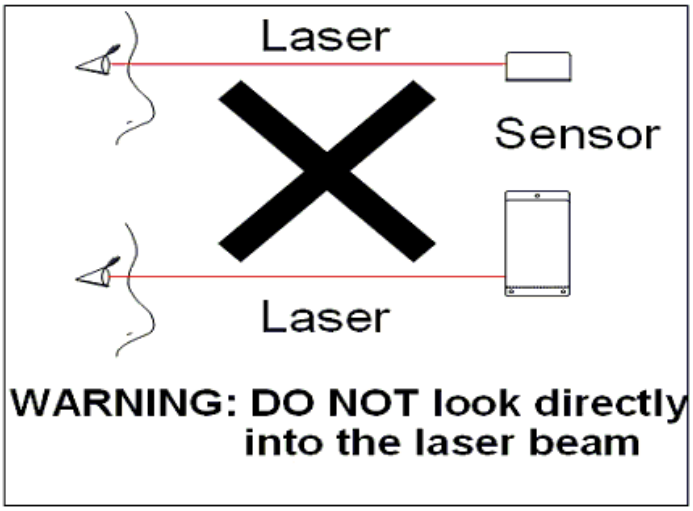
1.1 General Information

The laser light sources used in LMI Sensors are semiconductor lasers emitting visible light.

LMI Laser Sensors have a 2/II, 3R/IIIa or 3B/IIIb classification depending on model.

Class 2/II and 3R/IIIa sensors are referred to as “products” indicating that they fully comply with the standards relating to laser products specified in IEC 60825-1 and U.S. FDA CFR Title 21 Part 1040 except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001.

Class 3B/IIIb sensors are sold only to qualified OEM’s as “components” for incorporation into their own equipment. The sensors do not incorporate safety items which the OEM is required to provide in their own equipment (e.g. remote interlocks, key control). As such these sensors do not fully comply with the standards relating to laser products specified in IEC 60825-1 and FDA CFR Title 21 Part 1040.



Caution! Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1. **International Standard IEC 60825-1 (2001-08) Consolidated edition**, Safety of laser products – Part 1: Equipment classification, requirements and user's guide
2. **Technical Report TR 60825-10**, safety of laser products – Part 10. Application guidelines and explanatory notes to IEC 60825-1
3. **Laser Notice No. 50**, FDA and CDRH http://www.fda.gov/cdrh/rad-health.html

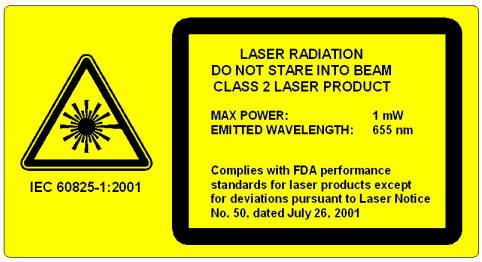
1.2 Laser Classification

1.2.1 Laser Classes

Class 2/II laser products:

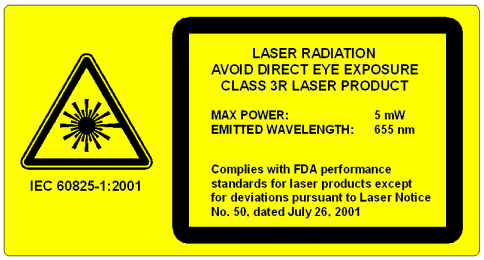
Class 2/II laser products would not cause permanent damage to the eye under reasonably foreseeable conditions of operation, provided that any exposure can be terminated by the blink reflex (assumed to take 0.25 sec). Because classification assumes the blink reflex, the wavelength of light must be in the visible range (400 nm to 700 nm). The Maximum Permissible Exposure (MPE) for visible radiation for 0.25 second is 25 Watt per square meter, which is equivalent to 1 mW entering an aperture of 7 mm diameter (the assumed size of the pupil).

Labels reprinted here are examples relevant to the laser classes. For detailed specifications observe the label on your laser sensor



Class 3R/IIIa laser products:

Class 3R/IIIa laser products emit radiation where direct intrabeam viewing is potentially hazardous, but the risk is lower than for 3B/IIIb lasers. Fewer manufacturing requirements and control measures for users apply than for 3B/IIIb lasers.



Class 3B/IIIb laser components:

Class 3B/IIIb components are unsafe for eye exposure. Usually only ocular protection would be required. Diffuse reflections are safe if viewed for less than 10 seconds.

1.2.2 User Precautions & OEM Responsibilities

The specific user precautions as specified in IEC 60825-1 and FDA CFR Title 21 Part 1040 are:

Requirements	Class 2/II	Class 3R/3a	Class 3B/3b
Remote interlock	Not required	Not required	**Required****
Key control	Not required	Not required	**Required**** Cannot remove key when in use
Power-On delays	Not required	Not required	**Required****
Beam attenuator	Not required	Not required	**Required****
Emission indicator	Not required	Not required	**Required****
Warning signs	Not required	Not required	**Required****
Beam path	Not required	Terminate beam at useful length	Terminate beam at useful length
Specular reflection	Not required	Prevent unintentional reflections	Prevent unintentional reflections
Eye protection	Not required	Not required	Required under special conditions
Laser safety officer	Not required	Not required	Required
Training	Not required	Required for operator and maintenance personnel	Required for operator and maintenance personnel

LMI Class 3B/IIIb laser components do not incorporate the safety items indicated by asterisks ** in the table above. These items must be added and completed by the OEM in the system design.

1.2.3 Class 3B/IIIb OEM Responsibilities

LMI Technologies has filed reports with the FDA to assist the OEM in achieving certification of their laser products. The OEM can reference these reports by an accession number that will be provided upon request.

Detailed descriptions of the safety items that must be added to the OEM design are listed below:

Remote Interlock

A remote interlock connection must be present in Class IIIB laser systems. This permits remote switches to be attached in serial with the keylock switch on the controls. The deactivation of any remote switches must prevent power from being supplied to any lasers.

Key Control

A key operated master control to the lasers that prevents any power from being supplied to the lasers while in the OFF position. The key can be removable in the OFF position but the switch must not allow the key to be removed from the lock while in the ON position.

Power-On Delays

A delay circuit is required that illuminates warning indicators for a short period of time prior to supplying power to the lasers.

Beam Attenuators

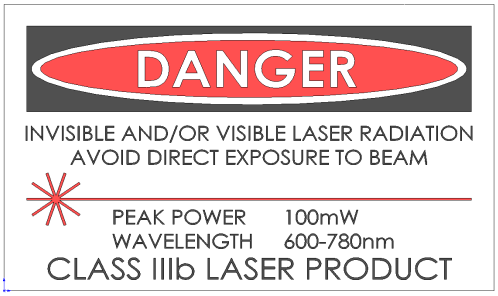
A permanently attached method of preventing human access to the laser radiation other than switches, power connectors or key control must be employed. On some LMI laser sensors, the beam attenuator is supplied with the sensor as an integrated mechanical shutter.

Emission Indicator

It is required that the controls that operate the sensors incorporate a visible or audible indicator when power is applied and the lasers are operating. If distance (>2 m between sensor and controls) or mounting of sensors intervenes with observation of these indicators, a second power-on indicator should be mounted at some readily observable position. When mounting the warning indicators, it is important not to mount them in a location that would require human exposure to the laser emissions.

Warning Signs

Laser warning signs must be located in the vicinity of the sensor such that they will be readily observed. Examples of laser warning signs are:



FDA Example

IEC Example

1.3 Requirements for Laser Systems Sold or Used In the USA

The OEM's laser system which incorporates laser components or laser products manufactured by LMI Technologies requires certification by the FDA.

It is the responsibility of the OEM to achieve and maintain this certification.

OEM's are advised to obtain the information booklet *Regulations for the Administration and Enforcement of the Radiation Control for Health and Safety Act of 1968*: HHS Publication FDA 88-8035.

This publication, containing the full details of laser safety requirements, can be obtained directly from the FDA, or downloaded from their website at http://www.fda.gov/cdrh.

1.4 chroma+scan 4000 Laser Safety Specification

Laser Classification:	3B/IIIb laser component
Peak Power:	130mW
Emitted Wavelength:	660nm

2 Getting Started

Warning! chroma+scan 4000 sensors are class 3B/IIIb components. Please read Section 1: Laser Safety above, and institute the necessary safety precautions before turning these sensors on.

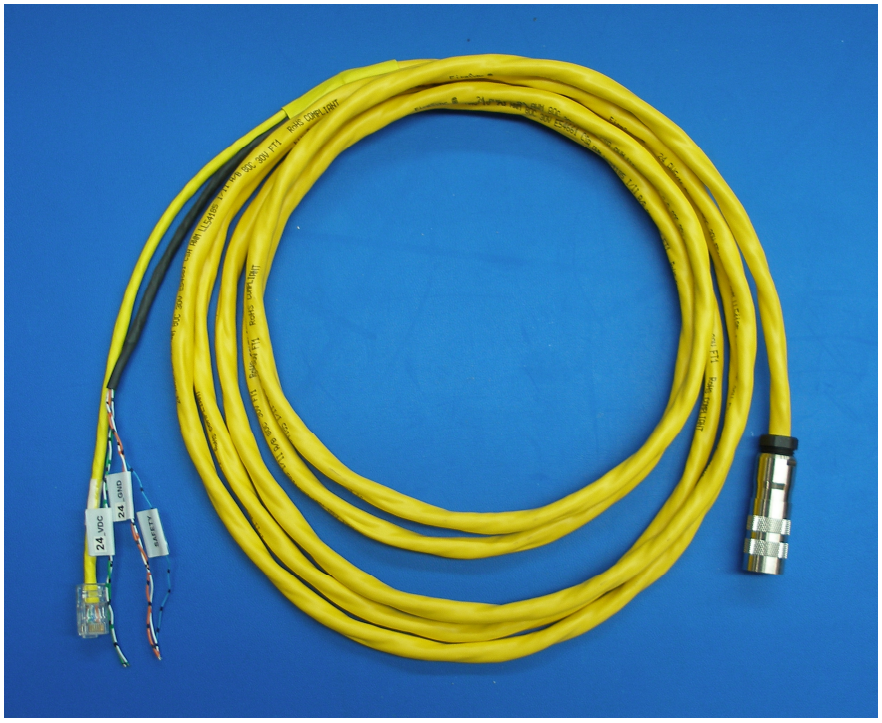
2.1 Components

LMI Technologies provides chroma+scan 4000 sensors and information on cables to connect the Sensors. External peripherals such as a power supply, host computer and cables must be provided by the user.

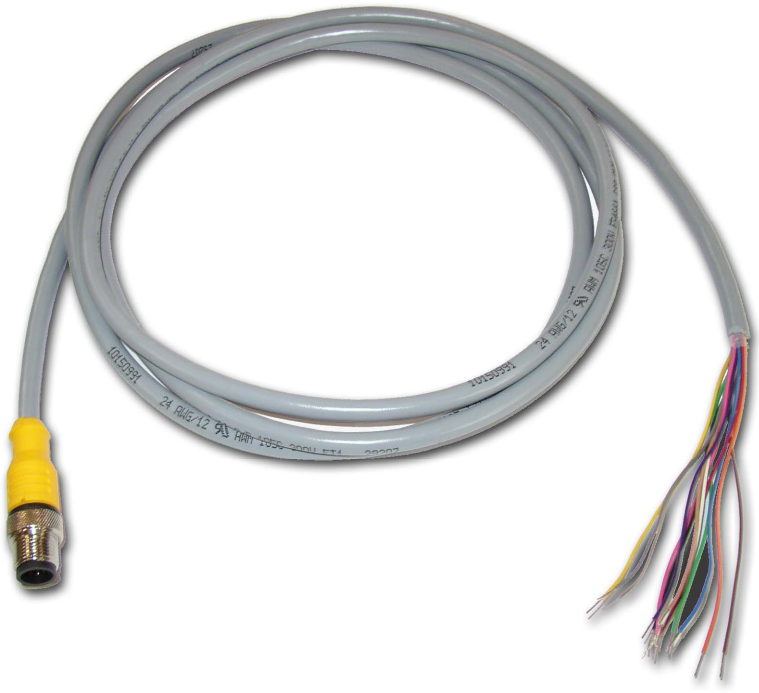
2.1.1 Sensors

chroma+scan 4000

2.1.2 Cables



FireSync Standalone Cordset (4m)



M12 I/O Inteface Cable, 12 pin, Male (2m)

2.1.3 Power Supply

The user must provide a suitable +24VDC power supply for the system with a minimum continuous rating of 1.0 Amp.

These power supplies must be isolated! This means that DC ground is NOT tied to AC ground!

LMI Technologies recommends use of a Phoenix Contact, QUINT, 3.5 Amp power supply (for +24VDC). This power supply is a DIN rail mounted device that can be connected in parallel to increase the overall available power.

+24VDC
Model: QUINT-PS/1AC/24DC/3.5
Order number: 2866747

2.1.4 Host computer

The user must provide a suitable host computer system. This machine should have TCP/IP based networking over Gigabit Ethernet.

2.2 Connections

LMI Technologies does not provide the cables required to connect to the chroma+scan 4000. The following describes the necessary connections required for proper communication between the sensor and the host computer.

2.2.1 Sensor connections

The chroma+scan 4000 uses two connectors to deliver data, receive power, and connect the encoder. The following table summarizes the details of these two connectors:

Connector	Total Number of Pins	Connector Manufacturer	Cable Drawing Number	Description
FireSync® Connector	14	Binder	131033	Uses LMI's FireSync® protocol to transmit data. Power is also delivered through this connector.
I/O Connector	12	Turck	N/A (see below)	Allows connector of an encoder to the sensor

The minimum required to connect to a chroma+scan 4000 sensor is a FireSync standalone cordset. Connect the RJ45 jack to the Ethernet port on the host computer. Connect the wires labeled "24 VDC " to the power supply positive and "24 GND" to the power supply ground.

The wire labeled "SAFETY" is for a safety interlock signal allows the user to turn on and off all light sources in the sensors without disrupting power to the system. In order to

activate these illumination devices and for the sensor to operate normally, the safety interlock input on the sensor must first be enabled. To enable the safety interlock apply +24VDC to the “SAFETY” wire on the FireSync standalone cordset.

More more details on these connectors and for full pinouts and wiring diagrams refer to section 5.3.

2.3 FireSync Client (Basic)

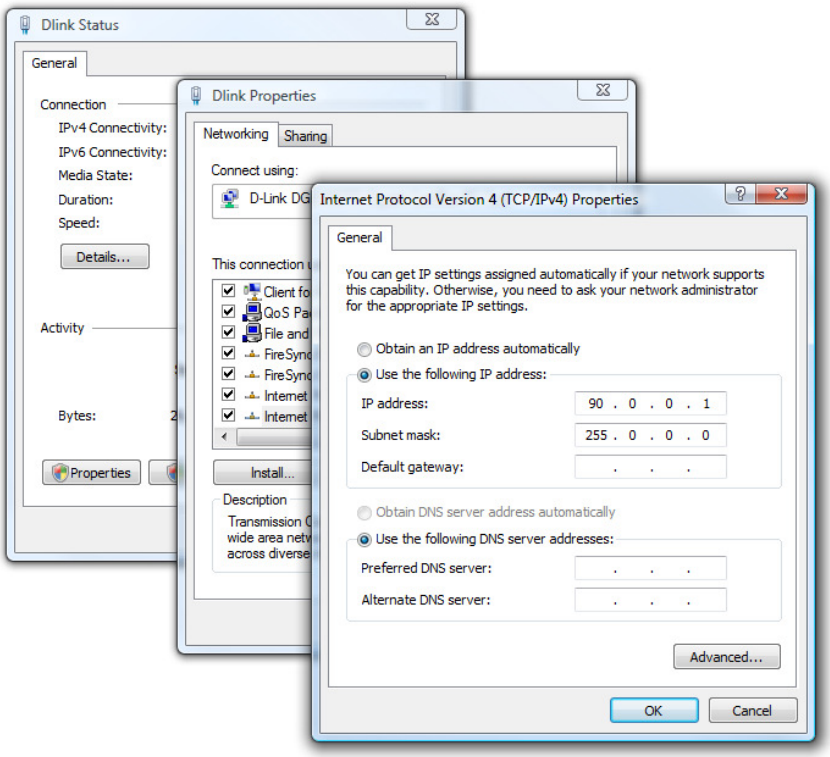
FireSync Client (kClient.exe) is a software application that can be used to set up, demonstrate or diagnose the operation of the chroma+scan 4000 sensor. This section describes basic activities performed with the FireSync Client application.

2.3.1 Installation

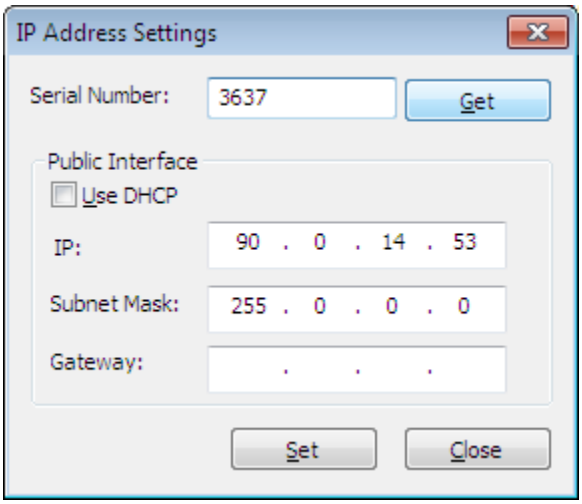
The FireSync Client application is available for Microsoft Windows XP and Vista. Obtain the software from LMI Technologies and install it on a suitable host computer.

2.3.2 Connection

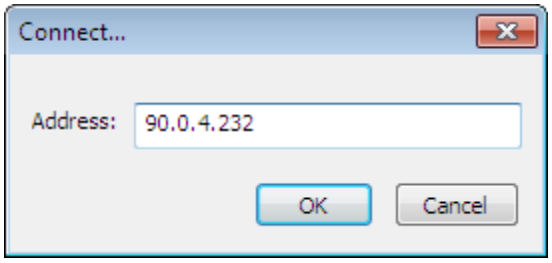
Each chroma+scan 4000 sensor is assigned a static IP address in the 90.x.x.x subnet. In order to communicate with a chroma+scan 4000 sensor the host computer should also be configured with a static IP address on the 90.x.x.x subnet.



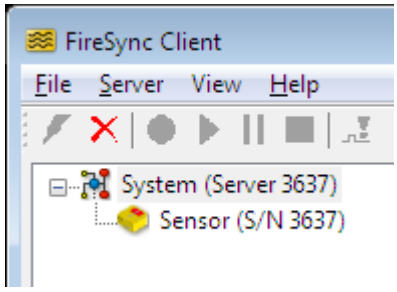
chroma+scan 4000 network settings can be retrieved or set using FireSync Client (connection is not needed). To retrieve network settings, select "*Server->Address Settings…"* from the menu item. Enter the serial number of the sensor and press "*Get"*. The network information should show up.



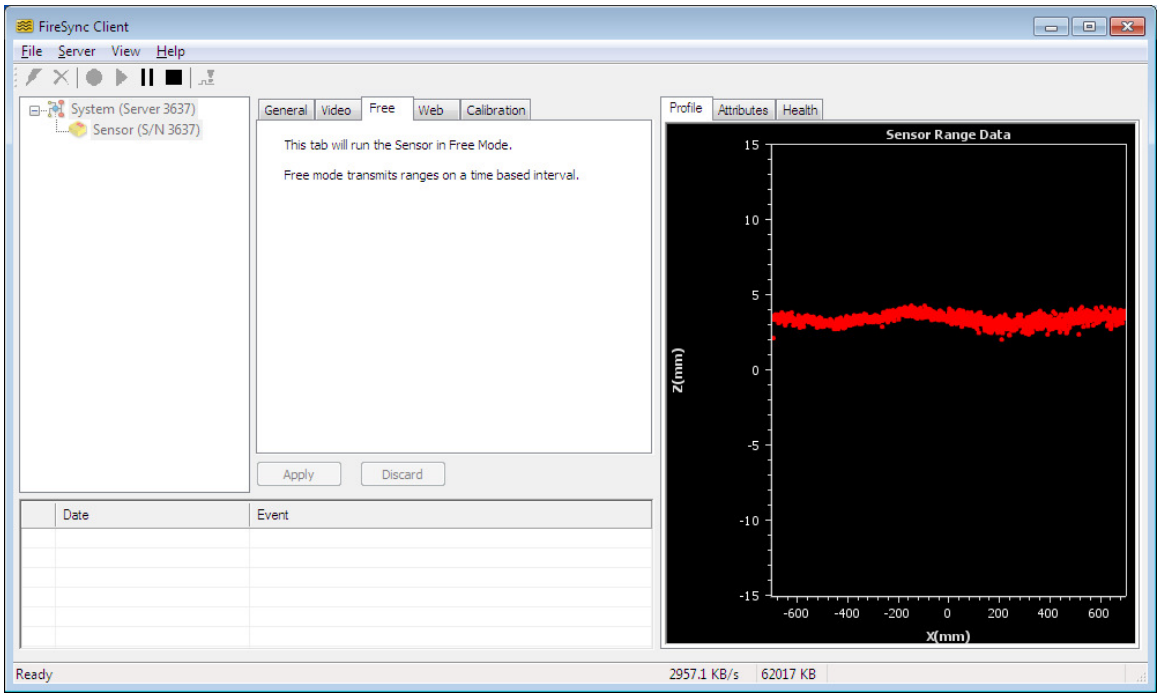
Now the IP address is known, use it to connect to the sensor. Click on the lightning (left-most) icon in the toolbar to display the "*Connect…"* dialog. To connect to the chroma+scan 4000 sensor, enter its IP address and then click "*OK"*.



Once connected to the sensor, click on the *"Server"* node in the left pane to activate the Sensor.



A number of tabs will now appear each of which exposes some aspect of the sensor's configuration parameters or operation modes. Select the "*Free"* tab and press the "*Play"* button (black triangle) in the toolbar. Profile data from the sensor will be displayed in the window to the right.



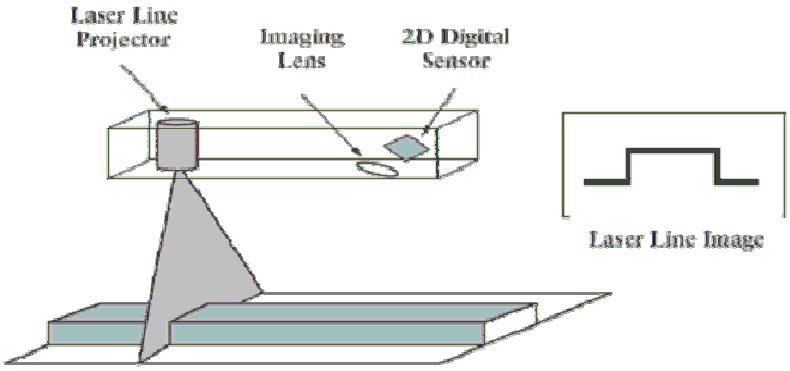
3 Product Overview

3.1 Introduction

The chroma+scan 4000 is a high-speed, high-density 3D profile scanning system for sanding applications. This sensor offers high density profile data and high resolution sampling at 500 Hz. The sensor is based on LMI's field-proven FireSync platform, which provides a synchronized, scalable, distributed vision processing architecture for building reliable, high performance systems. High reliability and simple, rapid installation are achieved with a single cable for power, data, and synchronization, and a single cable for encoder connection. Communication is via Gigabit Ethernet.

3.2 Measurement Principles

The chroma+scan 4000 sensors function on the principle of structured light triangulation. A semiconductor laser with special optics projects fans of light onto the target. Digital cameras mounted at an angle to the laser plane acquire images of the light pattern created on the target. These images contain the basic information needed to compute distances to the target.



3.3 Laser Exposure Control

The chroma+scan 4000 sensors provide on the fly automatic laser exposure control to allow optimum exposure on a variety of surface colours and finishes. The sensor also allows the distance to the conveyor to be programmed allowing the background image to be filtered from the laser exposure control calculation.

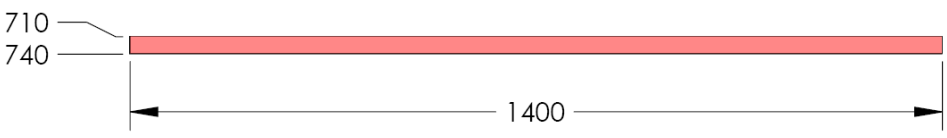
4 Sensor

The chroma+scan 4000 is a 500 Hz line profiling sensor. This section presents chroma+scan 4000 specific information.

4.1 Specifications

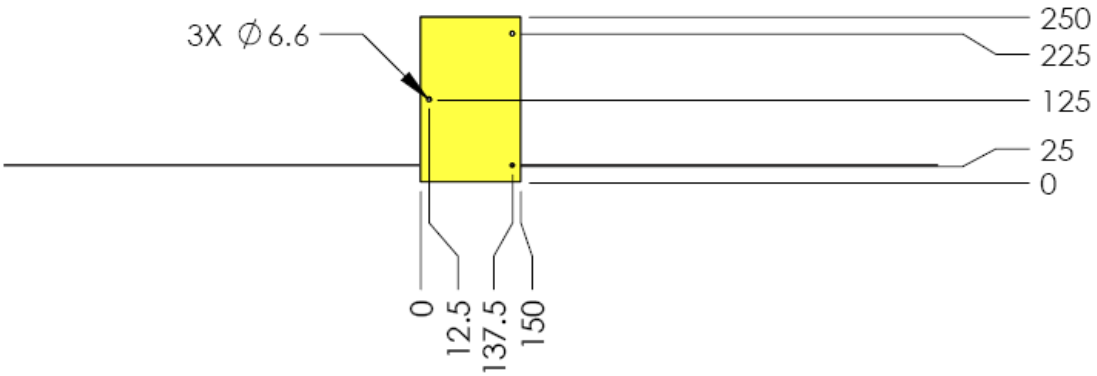
Operating Temperature	0 – 50 °C	32 – 122 °F
Voltage Requirement	24 VDC ± 10%	
Maximum Current	600 mA	
Housing	IP67, Powder Coated, Aluminum	
Weight	3.5 kg	7.7 lb
Laser Line Width (Mid Range)	1mm	

4.2 Scan Zone



Clearance Distance (CD)	710 mm	27.95 in
Measurement Range (MR)	30 mm	1.18 in
Field of View (FOV)	1400 mm	55.12 in

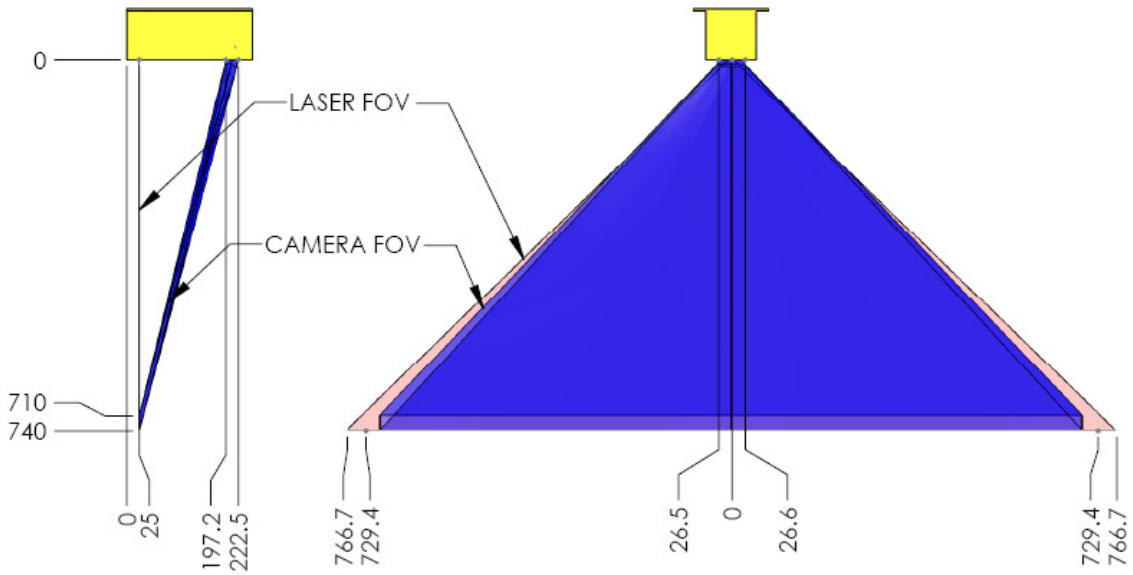
4.3 Dimensions & Mounting



The sensor should be mounted with appropriate length M6 or 1/4" fasteners. Moreover, the **sensor should be grounded to the earth/chassis.** This can be accomplished by using star washers on the four M6 mounting holes. The star washers should cut through the powder coating to provide electrical conductivity from the mounting hardware to the sensor housing. This can be checked with a multi-meter. Also note that the laser fan is emitted through the clear window and that the camera is located behind the red tinted window. When mounting the sensor, ensure that there are no obstructions between the camera window and the scan zone.

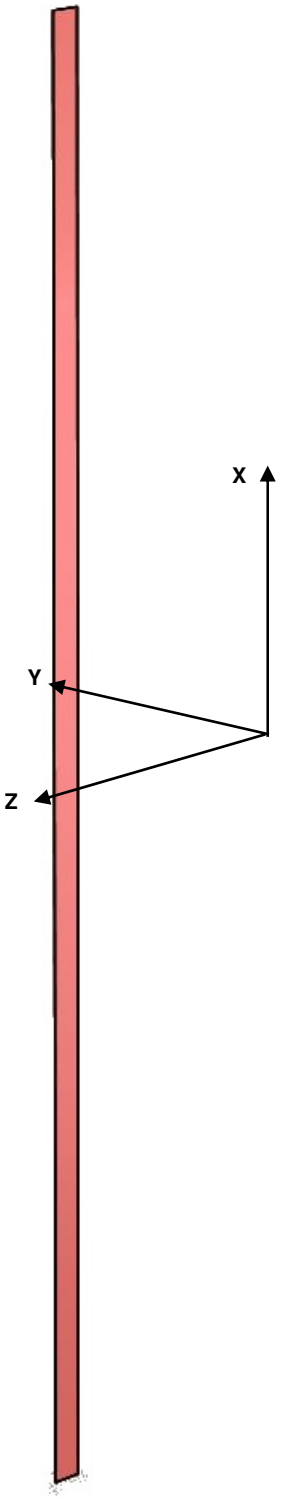
4.1 FOV Envelope

The following drawings detail regions in front of the sensor that should be kept free of obstructions. These regions envelope the laser fan projection and the camera view of the scan zone.



4.1 Coordinate Definitions

Throughout this document and software interface, displacements are represented in x-, y- and/or z-coordinates. The coordinates are defined as follows:



Axis	Definition
x	Field of view (along the laser line)
y	Field of view (axis of motion or axis of time)
z	Range from a sensor to the object being scanned.

5 System

5.1 Overview

A chroma+scan 4000 system consists of some or all of the following components:

- chroma+scan 4000 sensor
- FireSync Cordsets
- Power Supply
- Encoder
- Host Computer
- Scanner Frame
- System Calibration Target
- Power & Encoder Wiring

In a typical system, a single chroma+scan 4000 sensors is placed above a scanner frame with its laser fan perpendicular to the direction of motion, spanning the width of the conveyor belt.

The chroma+scan 4000 sensor connects directly to the host computer.

5.2 Power Supply

The user must provide a suitable +24VDC power supply for the system with a minimum continuous rating of 1.0 Amp.

These power supplies must be isolated! This means that DC ground is NOT tied to AC ground!

LMI Technologies recommends use of a Phoenix Contact, QUINT, 3.5 Amp power supply (for +24VDC). This power supply is a DIN rail mounted device that can be connected in parallel to increase the overall available power.

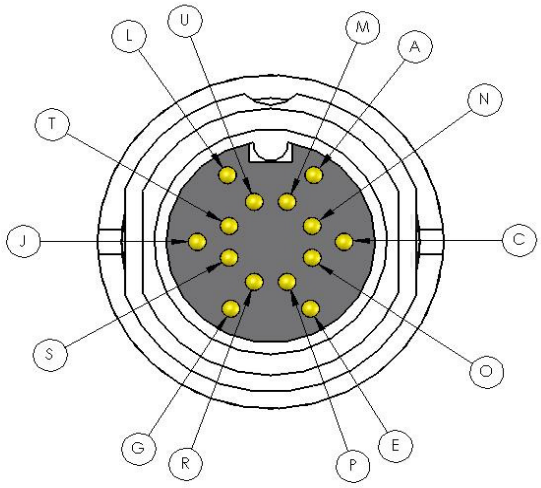
+24VDC
Model: QUINT-PS/1AC/24DC/3.5
Order number: 2866747

5.3 Connections

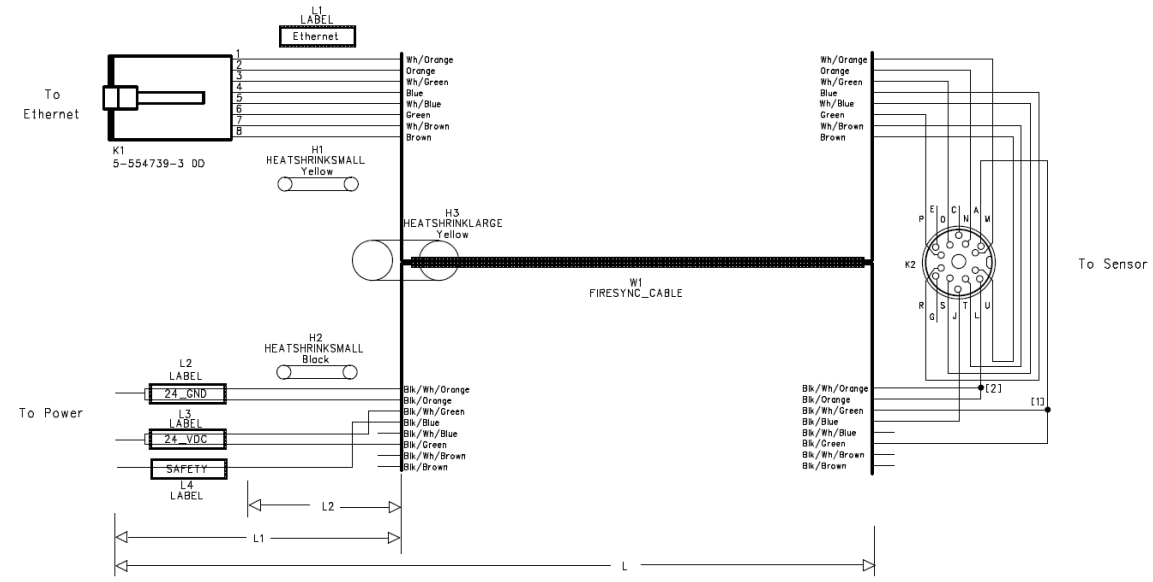
5.3.1 FireSync Connector

FireSync Connector Pinout (front view):

Pin	Description
M	Tx+
N	Tx-
O	Rx+
R	POE_1
S	POE_1
P	Rx-
T	POE_2
U	POE_2
A	+24V DC
L	24V GND
E	SYNC+
C	SYNC-
J	CTRL+
G	CTRL-



The FireSync standalone cordsets LMI Technologies supplies provide a sensor connector at one end; and separate RJ45 connector for Ethernet communications, and pigtails for input power at the other end. The user can assemble their own cables using the following schematic:

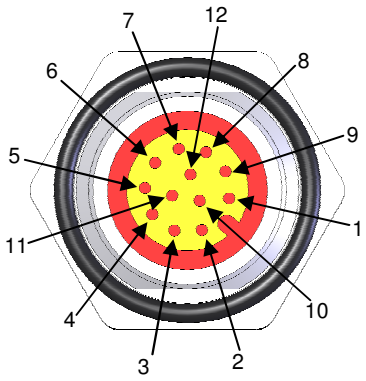


Note: [1] +24V consists of Blk/Wh/Green and Blk/Green twisted pair
[2] 24V_GND consists of Blk/Wh/Orange and Blk/Orange twisted pair
[1] and [2] Both wires in the pair are to be soldered together onto K1 and K2

5.3.2 I/O Connector

I/O Connector Pinout (front view):

Pin	Signal	Voltage Levels	Wire Colour
1	A+	RS485	White
2	A-	RS485	Brown
11	B+	RS485	Black
12	B-	RS485	Violet



Before powering up the sensor, please be sure to check the following:

1. Double check connector wiring with supplied cable drawings/pinouts.
2. The +24VDC power supply, used to power the sensor, must be isolated from AC ground. This means that AC ground cannot be tied to DC ground

The blue power indicator LED on the front of the sensor will indicate when power is correctly applied to the sensor.

5.3.3 Safety Interlock

The Safety Interlock signal allows the user to turn on and off all light sources in the sensors without disrupting power to the system. In order to activate these illumination devices and for the sensor to operate normally, the safety interlock input on the sensor must first be enabled. To enable the safety interlock apply +24VDC to the safety interlock wire on the FireSync standalone cordset.

5.4 Encoder

The user must provide a suitable encoder. The requirements are:

- Differential quadrature output (maximum 7 V)

The encoder interface on the sensor provides the following:

- X4 quadrature decoding
- Maximum 300kHz count rate

The user should choose an encoder with the appropriate number of pulses per revolution to match the transport mechanism and speed.

5.5 Frame Design

The scan frame supports the sensor above the conveyor. The frame should allow the sensor to be positioned such that when the conveyor height is adjusted, the top plane of the object being scanned in always aligned with the center of the sensors field of view. This can be achieved by either changing the height of the sensor, or by changing the height of the conveyor.

5.6 System Calibration Target

The system calibration target is required to perform a system calibration. This target should be perfectly flat and uniform in colour, however the exact colour is not important. The target should span the entire field of view of the sensor for system calibration to be completed correctly.

5.7 Proper Handling and Precautions

5.7.1 Component grounding

All sensors should be grounded to the earth/chassis through their housing. Grounding can be accomplished by using star washers on the mounting bolts. The star washers must cut through the powder coating to provide electrical conductivity from the mounting hardware to the sensor housing.

5.7.2 Hotswapping

The chroma+scan 4000 does not provide adequate current limiting to guarantee that hotswapping can be done safely. The absence of a current limiting circuit could cause the power supply to run into overcurrent protection mode when hotswapping.

5.7.3 Installation Environment

To prevent damage to LMI 3D sensors and ensure reliable operation, avoid installing the sensor in locations:

- that are humid, dusty, or poorly ventilated
- with a high temperature such as a place exposed to direct sunlight
- where there are flammable or corrosive gases
- where the unit may be directly subjected to vibration or impact
- water, oil, or chemicals may splash onto the unit
- where static electricity is easily generated

5.7.4 Temperature and Humidity

LMI 3D Sensors are rated for operation between 0- 50°C, and 25-85% Relative Humidity (non-condensing).

5.7.5 Maintenance

LMI 3D sensors are high-precision optical instruments. To ensure the highest accuracy is achieved in all measurements, the windows on the front of the sensor should be kept clean and clear of debris.

Use dry, clean air to remove dust or other dirt particles. If dirt remains, clean the windows carefully with a soft, lint-free cloth using an ammonia based cleaner. Ensure that no residue is left on the windows after cleaning.

5.7.6 Laser Lifetime

LMI Technologies uses semiconductor lasers in their 3D measurement sensors. To maximize the lifespan of the sensor it is recommended to turn off the laser by stopping the sensor whenever it is not in use.

5.7.7 Avoid flash writes

Operation parameters are stored on a flash based storage device inside the sensor. Flash will wear out more rapidly when excessive writes occur. Avoid frequent write commands to the sensor to save lifetime.

Warning! Interrupting power while writing to storage may cause immediate damage (corruption) and can affect correct operation. Make sure the sensor is idle when powering off.

6 Software

6.1 Introduction

The following table lists the provided software files. All files can be downloaded from the LMI Technologies support website.

Name	Description
14374-X.X.X.X_CLIENT_CS_4000.exe	Client installer. This installer provides FireSync Client (kClient.exe) and C-language source code to communicate with the chroma+scan 4000 sensor.
14375-X.X.X.X_UPGRADE_CS_4000.dat	Upgrade packge. This file can be used to upgrade the chroma+scan 4000 firmware.

The software interface to the sensor is OS independent. However, in order to run the installer or FireSync Client the host computer must run Microsoft Windows XP or Vista.

6.2 Configuring the Network interface

Each chroma+scan 4000 sensor is assigned a static IP address in the 90.x.x.x subnet. In order to communicate with a chroma+scan 4000 sensor the host computer should also be configured with a static IP address on the 90.x.x.x subnet.

Select a Gigabit Ethernet interface on the host computer and configure it as follows:

Setting	Value
Static IP Address	90.0.0.1
Subnet Mask	255.0.0.0
Default Gateway	(N/A)

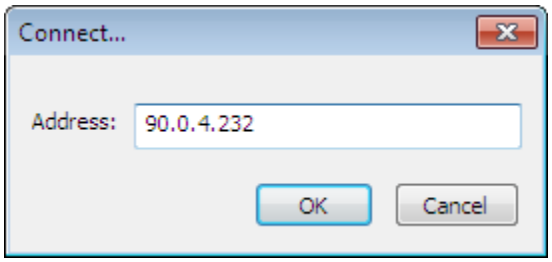
6.3 FireSync Client (Complete)

FireSync Client (kClient.exe) is a software application that can be used to set up, demonstrate or diagnose the operation of the chroma+scan 4000 sensor. The following sections describe the most common activities performed with the FireSync Client application.

6.3.1 Connection

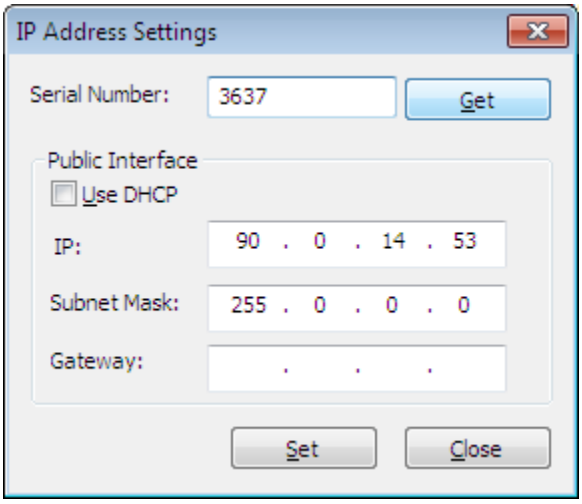
After starting FireSync Client, use the lightning (left-most) icon in the toolbar to display the "*Connect…"* dialog. To connect to the chroma+scan 4000 sensor, enter its IP address and then click "*OK"*.

The default IP address of the chroma+scan 4000 is typically set to 90.0.x.x, where the last two fields are dependent on the sensor's serial number. As an example a sensor's serial number is 1256. In hexadecimal, the serial number becomes 0x04E8. Its most significant byte (0x04 = 4) becomes the third number of the IP address and its least significant byte (0xE8 = 232) becomes the forth number of the IP address. Hence, the sensor's IP address becomes 90.0.4.232.



chroma+scan 4000 network settings can be retrieved or set using FireSync Client (connection is not needed). To retrieve network settings, select "*Server->Address Settings…"* from the menu item. Enter the serial number of the sensor and press "*Get"*. The network information should show up. To configure the network settings, go to menu item "*Server->Address Settings…"* enter the serial number and the desired network configuration and press "*Set*". The sensor is then automatically reset, after which the new IP settings will be in effect.

Please note that the DHCP flag for the public interface and the private address are not supported for the chroma+scan 4000 at the present.



6.3.2 Firmware Update

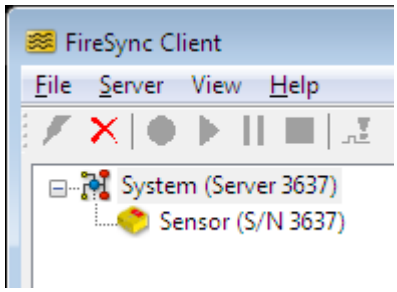
To perform a Firmware update, first make sure that the FireSync Client is connected to the sensor. Select "*Server->Upgrade..".* from the menu. When prompted, select a firmware update file (supplied by LMI) and click the "*Perform Upgrade"* button. When the upgrade is completed, close the "*Upgrade"* dialog box. The sensor will reboot automatically.

Once the sensor reboots, restart the FireSync Client and then reconnect to the sensor.

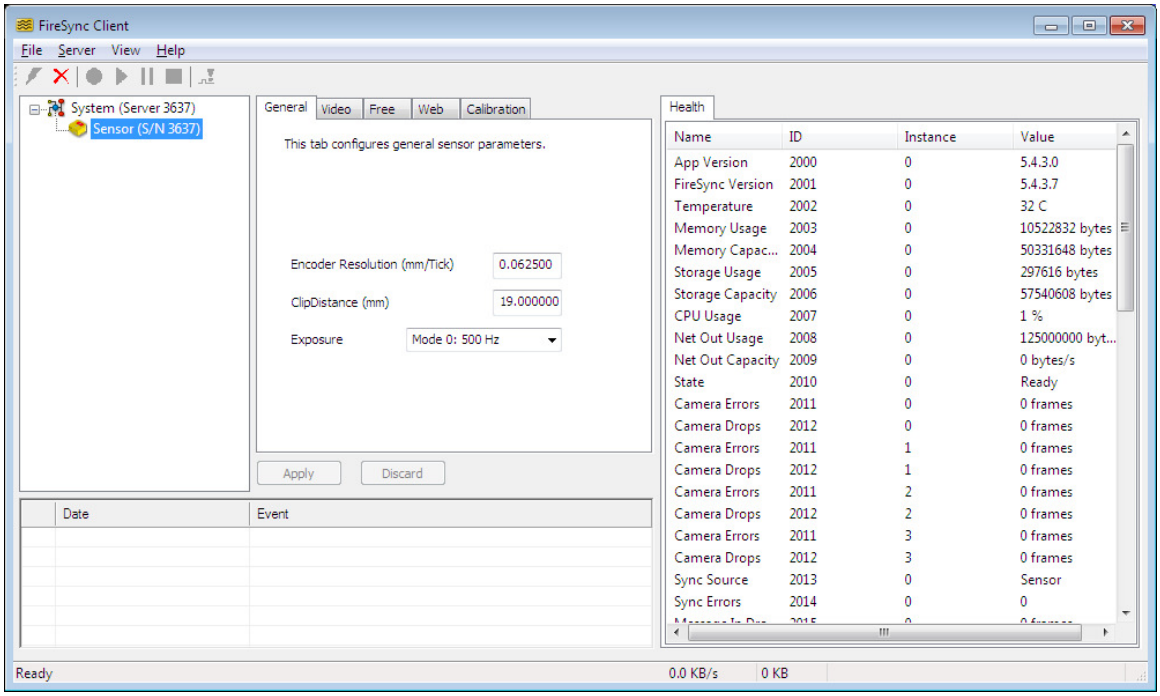
6.3.3 Sensor Operation

Upon successful connection kClient provides configuration of parameters and operation in each of the sensor's modes.

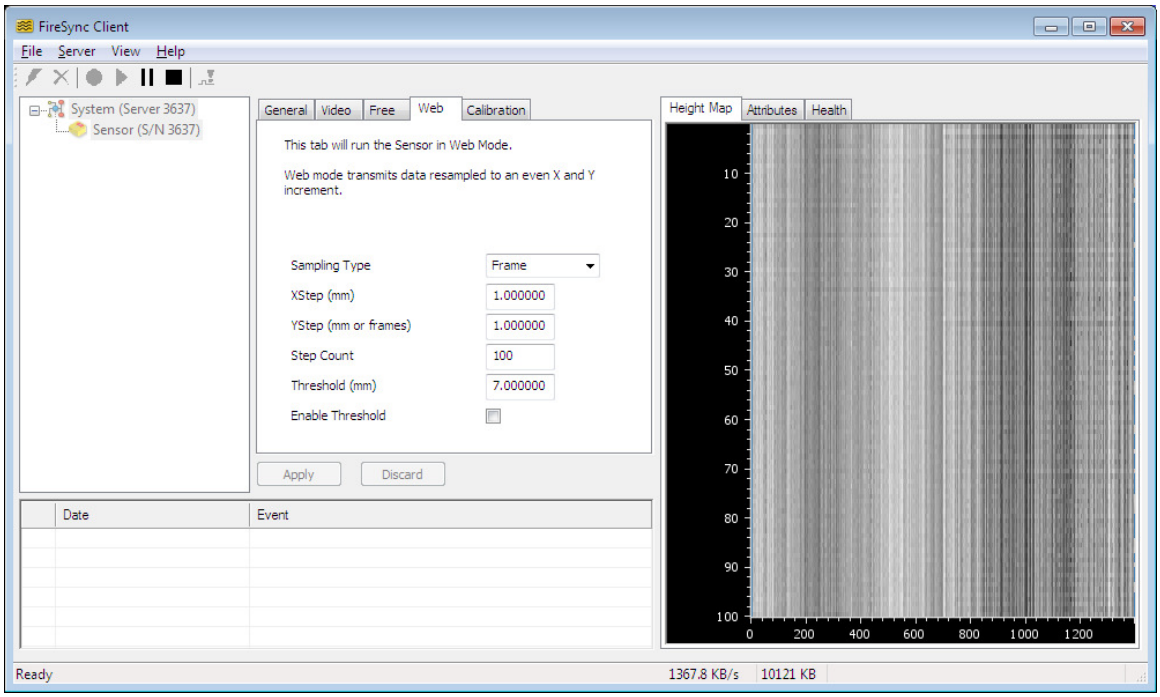
Click on the *"Server"* node in the left pane to activate the Sensor:



A number of tabs will now appear each of which exposes some aspect of the sensor's configuration parameters or operation modes.



To view live data from the sensor press the *"Play"* button in the FireSync Client toolbar. The tab pages in the left-most part of the screen allow to review the data that is sent out by the sensor.



6.4 Software Interface

6.4.1 The FireSync Host Protocol

The FireSync Host Protocol enables communication between any FireSync based sensor system and any Operating System that supports TCP/IP. Besides the general FireSync Host Protocol rules some specific rules apply for the chroma+scan 4000.

The next sections describe the aspects of communication that are specialized for the chroma+scan 4000 sensor. Please see the *FireSync Host Protocol Manual* for a detailed description of the protocol and use this manual for the specialized aspects.

6.4.2 Sensor Modes

The system can operate in different operation modes, each of which has a specialized purpose. The following table defines the chroma+scan 4000 modes.

Name	Description
Video	This operation mode will send out video data at a low, fixed framerate. Video is used for diagnostics.
Free	Free mode transmits ranges on a time based interval. The ranges are not resampled.
Web	Web mode transmits data resampled to an even X and Y increment according to settings provided by the user.
Calibration	This mode is used for system calibration which determines the Sensor's coordinate system with respect a calibration target placed into the measurement range of the sensor.

As the sensor runs, data will be transmitted to the computer in a mode specific format. Refer to 6.4.8.1, 6.4.8.2, 6.4.8.3 and 6.4.8.4 for detailed information about operation modes and output formats.

6.4.3 Sensor Operation Guidelines

For a successful and predictable operation of the sensor any host system should perform a number of steps in a structured sequence. When working with FireSync Client the application itself is responsible for this as well as the user operating the user interface. When working with the FireSync Host Protocol directly (as a computer programmer) make sure to invoke commands in the right order.

Here are some guidelines:

1. If Settings need to be modified and / or updated, send the *"Read File"* command to retrieve a file from the sensor.

2. Send the *"Write File"* command to commit settings to the sensor.

3. Send *"Set Mode"* to set system in any of the modes: *"Video"*, *"Free"*, *"Web"*, or *"Calibration"*.

4. Send *"Start"* command to initialize system.

5. To stop the system, send *"Stop"* command.

Of course a succeeded TCP/IP connection to the sensor is needed before any commands can be sent to the sensor. Please ensure that the TCP/IP connection is closed after working with the sensor.

6.4.4 Zen Api and example source code

The chroma+scan 4000 installer ships with a C-language source code that implements the FireSync Host Protocol and all the supported modes.

The source code is split up into two projects:
- the Zen API (zApi)
- example code that uses the Zen API

The Zen API is LMI's common library for that provides basic classes for things like: networking, threading and XML parsing. The example code shows how to use the Zen API in a console based application and provides basic functionality to operate the chroma+scan 4000 sensor.

After installing the chroma+scan 4000 client package, various files and folders are found inside the installation folder. The following table provides an overview of these entities.

Name	**Description**
bin	Place holder for executables
include	Zen Api include files to compile your application against
lib	Place holder for import library to link your application against
example	Example source for chroma+scan 4000
zApi	Zen Api source files

The top-level directory contains documentation for the Zen API.

6.4.5 Sensor Settings (Settings.xml)

The chroma+scan 4000 sensor is configured by an XML file inside the storage of the sensor. This file is called *"Settings.xml"*. Use the *"Write File"* host protocol command to write transfer settings into the sensor.

The following example illustrates the format of the *"Settings.xml"* file:

```
<?xml version="1.0" ?>
<Settings>
  <EncoderResolution>0.06250</EncoderResolution>
  <ClipDistance>19.000000</ClipDistance>
  <Exposure>0</Exposure>
  <WebMode>
    <SamplingType>0</SamplingType>
    <XStep>1.000000</XStep>
    <YStep>2.000000</YStep>
    <StepCount>1</StepCount>
  </WebMode>
</Settings>
```

System-level settings include the following entries:

Setting	Description
EncoderResolution	Specifies resolution of encoder in mm/Tick
ClipDistance	Specifies maximum Z distance to be taken into account for Exposure control (mm).
Exposure	Specifies whether high or low exposure is used

Mode-specific XML settings include the following:

Mode	Setting	Description
Web	SamplingType	0: Use encoder 1: No encoder
	XStep	Specifies X step (mm per increment)
	YStep	Specifies Y step (mm per increment)
	StepCount	Specifies number of steps in output message

Setting up the "*EncoderResolution"* and "*YStep"* is critical for correct operation in Web mode. Always use the following to verify that settings don't exceed limits.

$$YStep \geq \frac{ConveyorSpeed}{SensorSpeed}$$

Variable	**Unit**
YStep	mm/Profile
ConveyorSpeed	mm/sec
SensorSpeed	Profile/sec

"SensorSpeed" depends on "*Exposure"* field in "*Settings.xml"*

Exposure	**SensorSpeed (Profile/sec)**
0	500
1	250
2	200
3	150
4	100

The following equation shows how conveyor speed relates to the physical encoder and the "*EncoderResolution"* setting.

$$ConveyorSpeed = EncoderFreq * EncoderResolution$$

Variable	**Unit**
EncoderFreq	Tick/sec
EncoderResolution	mm/Tick

In the typical case where "*ConveyorSpeed"* is 500mm/sec and "*Exposure"* is 0, "*YStep"* has to be 1.0 mm/Profile or greater.

6.4.6 Sensor Calibration (Calibration.xml)

System Calibration writes a file named *"Calibration.xml"* into flash when successful. The following example illustrates the format of the *"Calibration.xml"* file:

```
<?xml version="1.0" ?>
<SystemCalibration>
  <Camera>
    <Angle>0.000000</Angle>
    <ZOffset>-1.000000</ZOffset>
  </Camera>
  <Camera>
    <Angle>0.000000</Angle>
    <ZOffset>-1.10000</ZOffset>
  </Camera>
</SystemCalibration>
```

The following table describes the fields:

Setting	Description
Angle	Compensation angle (degrees)
ZOffset	Compensation Z distance (mm)

6.4.7 Volatile Sensor Parameters

The following parameters can be accessed by the *"Get Parameter"* and *"Set Parameter"* host protocol commands to make temporary changes.

Parameter name	Description
ClipDistance	Specifies maximum Z distance to be taken into account for Exposure control (µm). To mimic the *"Settings.xml"* value, remember to account for the unit (mm v/s µm)
Exposure	Same meaning and usage as Exposure in *"Settings.xml"*
SamplingType	Same meaning and usage as SamplingType in *"Settings.xml"*
YStep	Specifies YStep in (µm). To mimic the *"Settings.xml"* value, remember to account for the unit (mm v/s µm)

6.4.8 FireSync Result Format

The FireSync Result Format is the general format for all messages transmitted during operation of FireSync sensors. For more information about the FireSync Result Format refer to the *FireSync Host Protocol Manual*.

Although general rules apply for the FireSync Result Format, the meaning of the various fields needs to be described. The next sections (6.4.8.1, 6.4.8.2, 6.4.8.3 and 6.4.8.4) will explain the output for each of the sensor's modes.

6.4.8.1 Video Mode

Video mode transmits video images at a low, fixed frame rate. Video mode messages have Message identifier (ID) 0.

Video Message Attributes

Field	Type	Description
deviceId	64s	Sensor serial number
viewIndex	64s	Camera index

Video Message Descriptors [0]

Field	Value	Description
Length0	height	Image height
Length1	width	Image width
Length2	0	N/A

Video Message Data [0]

Field	Type	Description
pixels[height][width][1]	8u	Image pixels

6.4.8.2 Free Mode

In Free mode, profile data is transmitted without any attempt to resample data. The capture rate is governed by the sensor mode, which is 500 Hz or 250 Hz, depending on the "*Exposure"* field in "*Settings.xml"*. Range coordinates are transmitted as (X and Z) pairs. Free mode messages have ID 1.

Free Message Attributes

Field	Type	Description
deviceId	64s	Sensor serial number
xResolution	64s	Unit of X values (µm)
zResolution	64s	Unit of Z values (µm)
nullRange	64s	Value representing an invalid profile point

Batching of profiles is currently unsupported, making the length0 dimension 1 by default in the table below. Invalid profile points are represented by *nullRange* value specified in the attributes.

Free Message Descriptors [0]

Field	Value	Description
Length0	1	Allows for batching, currently unsupported
Length1	3	Number of entries in Message Data [0]
Length2	1	N/A

Free Message Descriptors [1]

Field	Value	Description
Length0	1	Allows for batching, currently unsupported
Length1	width	Number of ranges per profile. The number is determined by characteristics of the sensor during manufacturing.
Length2	2	Number of channels is two: X and Z

Free Message Data [0]

Field	Type	Description
frameIndex	64s	Sequence index within a view
Timestamp	64s	Capture time (µs)
Position	64s	Capture position (encoder count)

Free Message Data [1]

Field	Type	Description
ranges[1][width][2]	16s	Ranges: X and Z

6.4.8.3 Web Mode

In Web mode, the sensor monitors the encoder and collects profiles to resample the data to an even X and Y increment. Web mode messages have ID 2.

Web Message Attributes

Field	Type	Description
deviceId	64s	Sensor serial number
frameIndex	64s	Sequence index
encoderPos	64s	Position of the encoder
xResolution	64s	Sampling resolution along fov (µm)
yResolution	64s	Sampling resolution across line (µm)
zResolution	64s	Unit of range values (µm)
nullRange	64s	Value representing an invalid range
pointCount	64s	Number of ranges

Invalid profile points are represented by *nullRange* value specified in the attributes.

Web Message Descriptors [0]

Field	Value	Description
Length0	length	This value is determined by *StepCount* specified in *Settings.xml (6.4.5)*
Length1	width	This value is determined by dividing the FOV width (1400mm) by the specified *XStep* in *Settings.xml (6.4.5)*
Length2	0	N/A

Web Message Data [0]

ranges[length][width][1]	16s	Profile(s) (array of ranges).

6.4.8.4 Calibration Mode

In Calibration Mode, the sensor records a sequence of profiles and calculates compensation values. Messages sent by the sensor show the progress of system calibration. Once a sufficient quantity of data has been captured a status flag is set to 1 to indicate system calibration has succeeded. After that, the sensor ignores any new readings and will continue to send out messages with the *"Complete"* flag set. Calibration mode messages have ID 3.

Calibration Message Attributes

Field	Type	Description
deviceId	64s	Sensor serial number
Status	64s	-1: Failed 0: Busy 1: Complete

7 Warranty

7.1 Warranty policies

The sensor is warranted for two years from the date of purchase from LMI Technologies Inc. Products that are found to be non-conforming during their warranty period are to be returned to LMI Technologies Inc. The shipper is responsible for covering all duties and freight for returning the sensor to LMI. It is at LMI's discretion to repair or replace sensors that are returned for warranty work. LMI Technologies Inc. warranty covers parts, labor and the return shipping charges. If the warranty stickers on the sensors are removed or appear to be tampered with, LMI will void the warranty of the sensor.

7.2 Return policy

Before returning the product for repair (warranty or non-warranty) a Return Material Authorization (RMA) number must be obtained from LMI. Please call LMI to obtain this RMA number. Carefully package the sensor in its original shipping materials (or equivalent) and ship the sensor prepaid to your designated LMI location. Please insure that the RMA number is clearly written on the outside of the package. With the sensors, include the address you wish this shipment returned to, the name, email and telephone number of a technical contact should we need to discuss this repair, and details of the nature of the malfunction. For non-warranty repairs, a purchase order for the repair charges must accompany the returning sensor. LMI Technologies Inc. is not responsible for damages to a sensor that is the result of improper packaging or damage during transit by the courier.

8 Getting Help

If you wish further help on the component or product, contact your distributor or LMI directly. Visit our website at www.lmi3D.com for the agent nearest you.

For more information on Safety and Laser classifications, contact:

Center for Devices and Radiological Health, FDA
Attn: Electronic Product Reports
Electronic Product Document Control (HFZ-309)
Office of Communication, Education, and Radiation Programs
9200 Corporate Blvd.
Rockville MD 20850