USER'S MANUAL

chroma+scan 3xxx

Version 4.11.6.13

Proprietary

Trademarks and Restrictions

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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

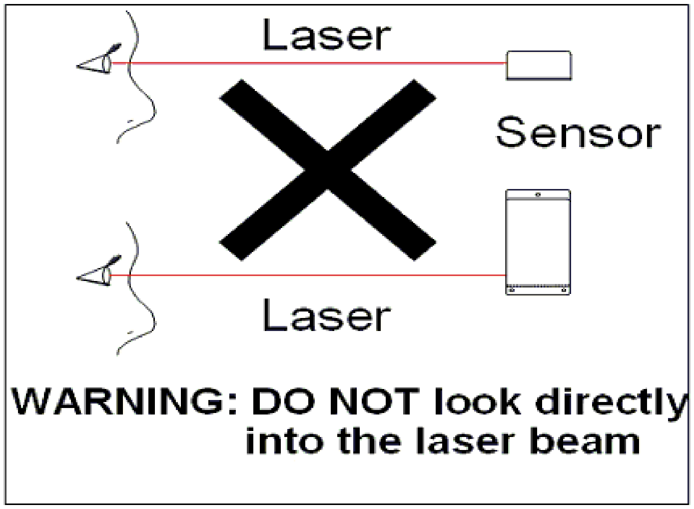
1.1 General Information

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

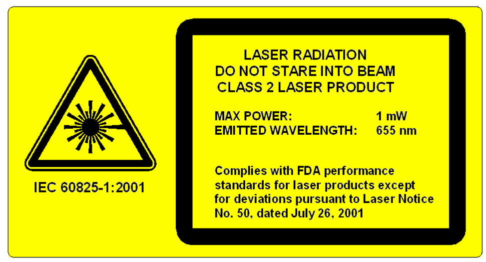
1.2 Laser Classification

1.2.1 Laser Classes

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

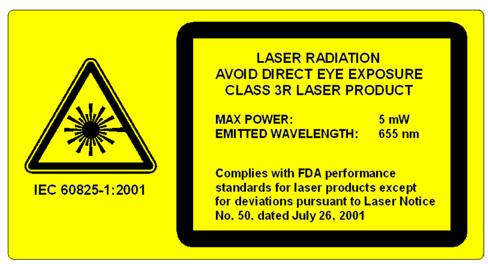
Class 2/II laser products:

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).



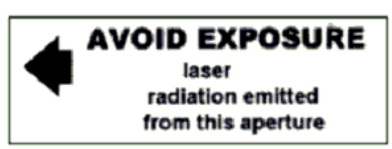
Class 3R/IIIa laser products:

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 and 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 3xxx Laser Safety Specification

Laser Classification:	3B/IIIb laser component
Peak Power:	100mW
Emitted Wavelength:	660nm

2 Proper Handling and Precautions

2.1 System Installation

2.1.1 Component Grounding

All sensors should be grounded to the earth/chassis through their housing. For sensors with through-hole mounts, this 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. For sensors with tapped hole mounts, conductive hardware must to be used between the sensor and the frame. This must be checked with a multi-meter by ensuring electrical continuity between the frame and the connector housing on the sensor. It is imperative that the scan frame or chassis that the sensor is mounted to is connected to earth ground.

Master networking products should have the housing connected to earth ground. This can be accomplished using star washers on the mounting holes or through the earth ground connection located on the rear of the Master 1200 and 2400. FireSync Networking products should be installed inside electrical cabinets that are suitably grounded to earth ground.

2.1.2 Shielded Cable

LMI Technologies recommends the use of shielded cables in all environments to ensure isolation from electrical noise. The shield should be electrically connected to both the sensor housing through the connector housing and to the electrical box containing either the Master (network systems) or the power supply (standalone sensors).

LMI Technologies supplies both shielded FireSync cordsets and shielded FireSync cable for building cordset.

2.1.3 Power Supply

The user must provide a suitable +48VDC power supply for the system capable of handling an infinite capacitive load. These power supplies must be isolated such that DC ground is NOT tied to AC ground. The power supply should be of a suitable capacity for the size of the system.

LMI Technologies recommends the Phoenix Contact QUINT series of power supplies.

2.1.4 Uninterruptible Power Supply (UPS)

To maximize the life of the sensor, LMI Technologies recommends the use of an on-line double-conversion UPS whenever the quality of the electrical supply to the system is poor. This includes but is not limited to when the electrical supply:

- contains high frequency noise (due to other electronics, electric motors or other factors)
- is prone to "brown-out" conditions or large voltage fluctuations
- is prone to electrical surges or spikes due other components or electrical storms.

LMI Technologies recommends the Tripp Lite SU2200RTXL2UA UPS.

2.1.5 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

2.2 Temperature and Humidity

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

2.3 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.

2.4 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.

2.5 Avoid Flash Writes (Standalone Sensors only)

Operation parameters for standalone sensors are stored with flash memory inside the sensor. Flash has an expected lifetime of 100,000 writes. Avoid frequent or unnecessary write commands to the sensor to maximize the lifetime of the sensor.

3 Getting Started

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

This section provides a brief introduction to the chroma+scan 3xxx. It identifies the components supplied by LMI Technologies, and the additional components required to get a basic system up and running. This is followed by instructions on how to connect these components together, and how to install and run our client software to acquire basic profile data to ensure sensor operation out-of-the-box.

More detailed information is given in the sections that follow this "Getting Started" guide.

3.1 Components

LMI Technologies provides chroma+scan 3100, 3150, 3155, 3250, 3300, or 3301 sensors, a Master, and information on cables to connect the Sensors, Master, and user provided equipment. The user must provide a power supply, station computer, host computer, a Gigabit Ethernet switch, and cables to connect the sensors and the Master.

3.1.1 Sensors

chroma+scan 3155

chroma+scan 3250

chroma+scan 3300

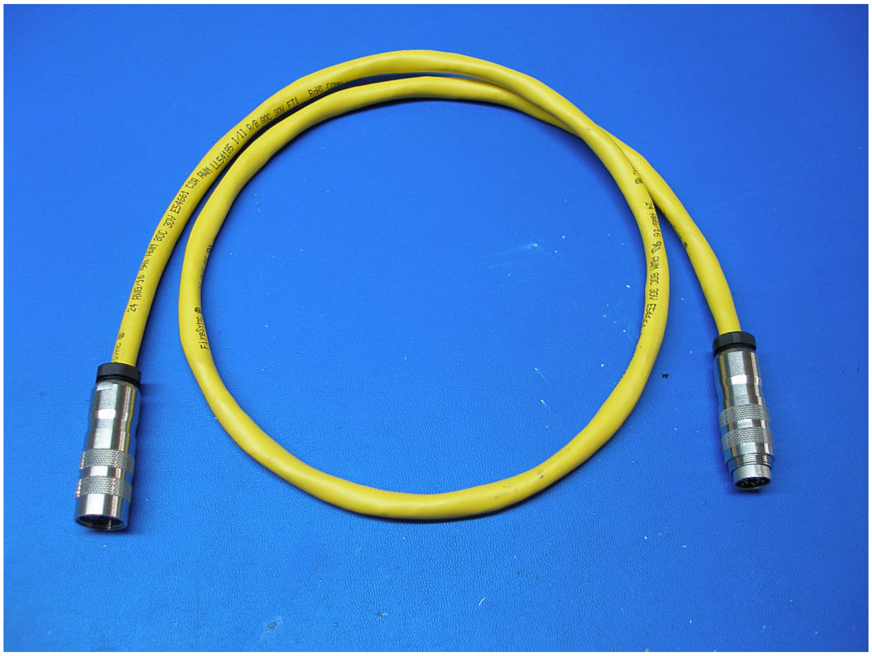
3.1.2 Master/Station

FireSync Master and Station or Station 1000
Generation 1

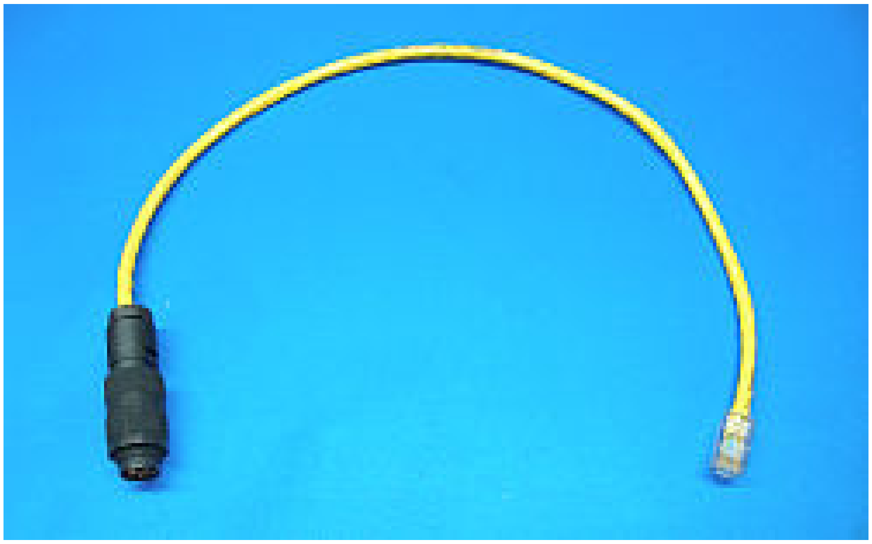
FireSync Master 1200 or 2400
Generation 2

3.1.3 Cables

FireSync Sensor Cordset Version 1 (5m)



FireSync Sensor Cordset Version 2 (1m)



Station Cordset (0.5m)

Network Cordset

The above cables are available from LMI and/or its suppliers. Also required is a standard CAT5e Gigabit Ethernet cable (RJ45 connectors) to connect the FireSync Station to the host computer.

3.1.4 Power Supply

The user must provide a suitable +48 VDC power supply for the system. If the system employs a Station 1000, a separate +12 VDC supply will also be required. **The output from these power supplies must be isolated from AC ground.**

LMI Technologies recommends the use of Phoenix Contact, QUINT series 48V DC power supplies for the Master and sensor power. The current rating of the power supply should be equal to the number of sensors connected to Master. For example, it is recommended that a 16 sensor system uses a +48V power supply capable of delivering 16A.

For older systems using +12VDC Station hardware, LMI Technologies recommends the use of a Lambda DSP60-12 power supply.

Both the Phoenix QUINT series and the Lambda power supplies are DIN rail mounted devices that can be connected in parallel to increase the overall available power.

+48 VDC
Model: QUINT-PS-100-240AC/48DC/10
Order number: 2938248

+12 VDC
Model: DSP60-12
Order number: 285-1233-ND

3.1.5 Host Computer

The user must provide a suitable host computer. This must be equipped with a Gigabit Ethernet port to communicate with the FireSync Station. The Client Interface to the Station is OS independent. However, Windows XP is required on this computer in order to install and run our FireSync Client demonstration application.

3.2 Connections

3.2.1 Sensors to Master

Please refer to the *FireSync Network User Manual* for complete details on connecting the sensors to the FireSync Master and Station.

3.2.2 Station to Host Computer

A standard CAT5e Gigabit Ethernet cable (RJ45 connectors) is used to connect the FireSync Station, via the RJ45 connector "OUT", to a Gigabit Ethernet port on the host computer. If two or more Stations are required in the system, this connection can be made to a single host computer via separate Gigabit Ethernet cards, via a Gigabit Ethernet switch, or via multiple processing stations.

3.2.3 Power Supply to Master/Station

The +48 VDC power supply is wired to the Phoenix connectors on the Master, Station* and Slave (if a Slave is required). Refer to the *FireSync Network User Manual* for details.

*A separate +12 VDC power supply will be required to power up any Station 1000s in the system.

3.2.4 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. If the sensor is “safety-enabled”, the laser safety control signal must be provided at the Master *and* at all Slaves for the sensors to properly function. Please refer to the *FireSync Network User Manual* for the Safety Interlock connection requirements.

3.3 FireSync Client (Basic)

FireSync Client is a software application that can be used to set up, demonstrate, or diagnose problems with a chroma+scan 3xxx system. The following sections describe how to use FireSync Client to connect to a system and verify that all connected devices are functioning normally. For a detailed description of the FireSync Client application, see the section entitled *FireSync Client (Complete)* in the *Software* chapter of this manual.

3.3.1 Installation

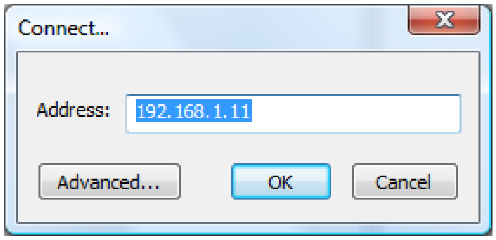
The FireSync Client application is available for Windows XP, and can be downloaded from the LMI Technologies support website. To begin, download the software and install it on a suitable client machine. The client machine should have an Ethernet adaptor that can be configured for a static IP address and that supports 1000 Mb/s operation.

A FireSync Station typically ships with the address 192.168.1.10, though this may vary by request. Set the client machine to an available address on the same subnet (e.g. 192.168.1.9) and then connect a suitable Ethernet cable from the client machine to the FireSync Station's OUT port.

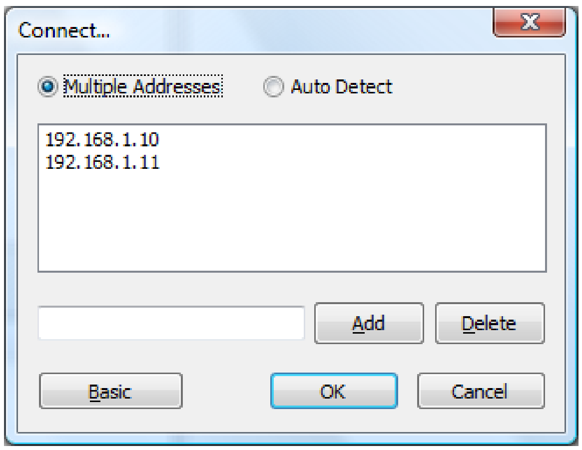
If you are using multiple FireSync Stations, you may need to connect to each Station individually in order to assign each Station unique IP addresses (both public and private), using the *Set IP* command from the *Server* menu. After each Station has been assigned a unique address, you can reconnect to all stations simultaneously.

3.3.2 Connection

After starting FireSync Client, use the lightning (left-most) icon in the toolbar to display the *Connect...* dialog. To connect to a single server, enter the IP address of the server to which you wish to connect, and then click *OK*.

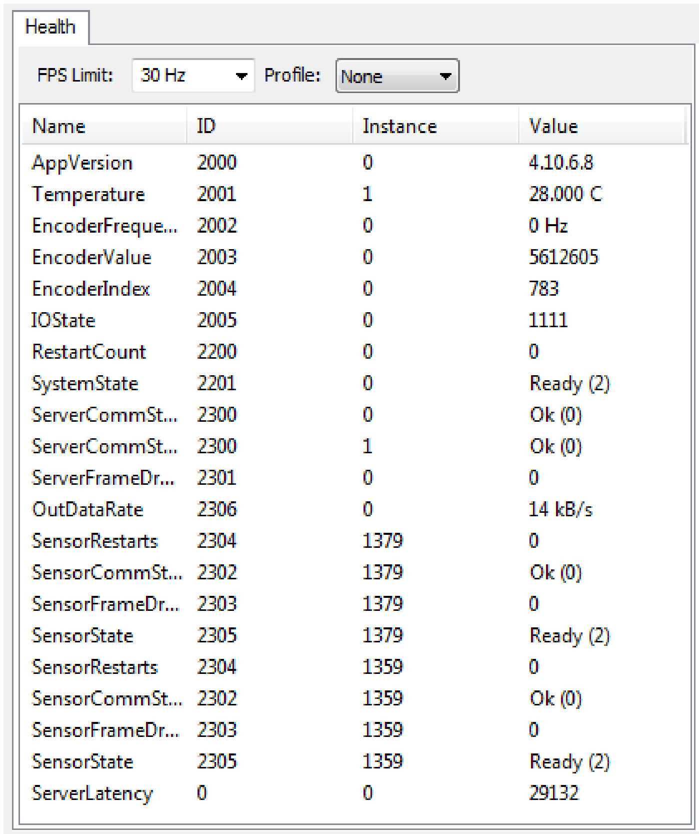


To connect to multiple servers simultaneously, click the *Advanced…* button, add the IP addresses of the servers, and then click *OK*.



3.3.3 Server Health

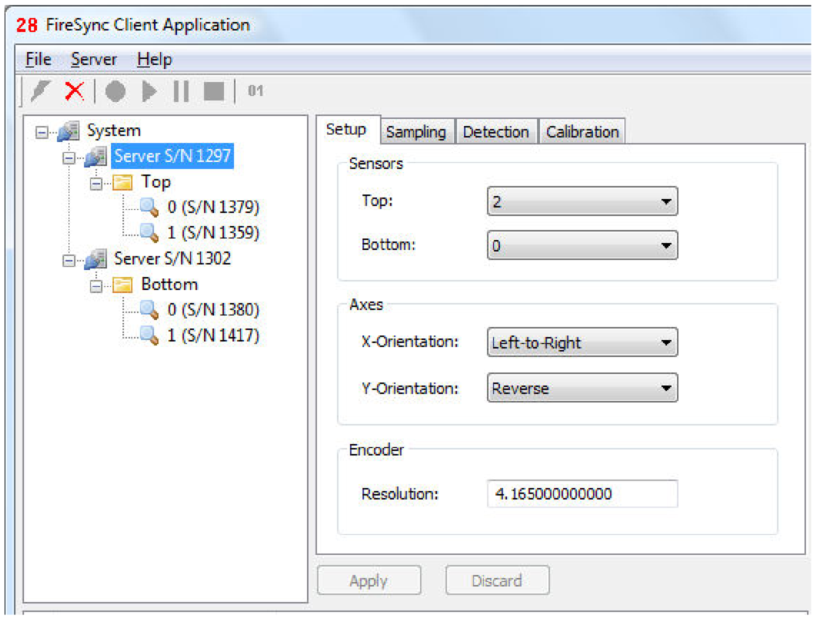
After connecting, click on the device tree node for each server and then click on the *Health* visualization tab, as show below. Health indicators can be used to help diagnose a wide variety of conditions. Note that some indicators are updated constantly, while others are only updated if the system is in the *Running* state.



Name	ID	Instance	Value
AppVersion	2000	0	4.10.6.8
Temperature	2001	1	28.000 C
EncoderFreque...	2002	0	0 Hz
EncoderValue	2003	0	5612605
EncoderIndex	2004	0	783
IOState	2005	0	1111
RestartCount	2200	0	0
SystemState	2201	0	Ready (2)
ServerCommSt...	2300	0	Ok (0)
ServerCommSt...	2300	1	Ok (0)
ServerFrameDr...	2301	0	0
OutDataRate	2306	0	14 kB/s
SensorRestarts	2304	1379	0
SensorCommSt...	2302	1379	Ok (0)
SensorFrameDr...	2303	1379	0
SensorState	2305	1379	Ready (2)
SensorRestarts	2304	1359	0
SensorCommSt...	2302	1359	Ok (0)
SensorFrameDr...	2303	1359	0
SensorState	2305	1359	Ready (2)
ServerLatency	0	0	29132

3.3.4 Sensor Enumeration

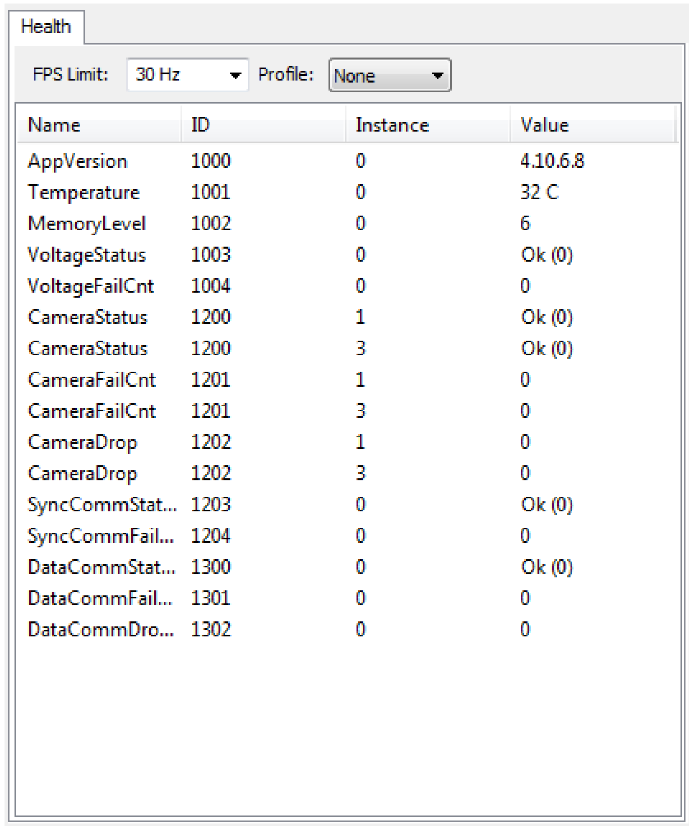
The *Server Setup* tab, shown below, contains general settings for the chroma+scan 3xxx server that affect most of its operating modes. Each server can have a *Top* group of sensors, a *Bottom* group of sensors, or both. Use the pull-down lists in the *Server Setup* tab to specify the number of sensors in each group. When the number of sensors in either group is changed, the number of sensor nodes in the device tree changes accordingly.



Assign a serial number to each sensor by right-clicking on the sensor's node in the device tree, and selecting a serial number from the list of detected sensors. If you do not see a specific sensor (or any sensors) in the context-menu, it implies that the sensor was not detected. If this is the case, check the cabling, cycle the power, and then reconnect with kClient.

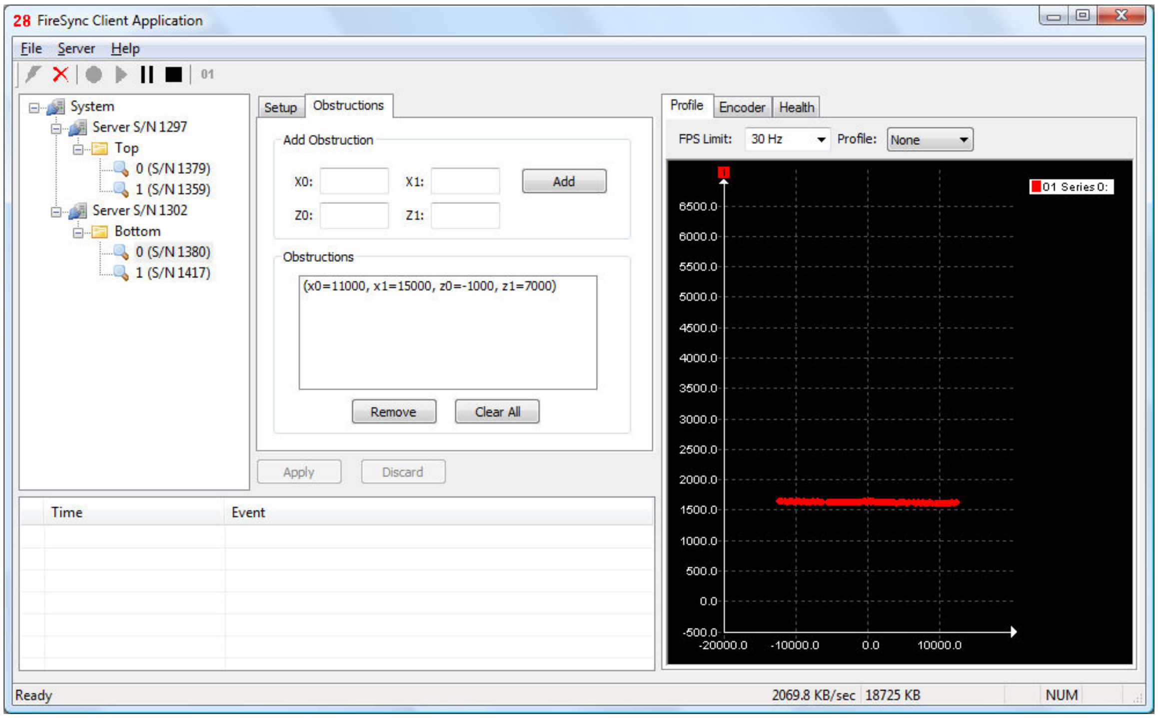
3.3.5 Sensor Health

After creating entries for each sensor, click on the device tree node for each sensor and review the *Sensor Health* visualization tab. As with the server health indicators, some sensor health indicators are updated constantly, while others are only updated if the system is in the *Running* state.



3.3.6 Sensor Data

To view live laser profile data from a sensor, click on the sensor's node in the device tree, and then select the *Obstructions* tab. Press the *Play* button in the FireSync Client toolbar. The *Profile* visualization tab will display live laser profile measurements. This display can be used in conjunction with a stationary or moving target to verify that laser profiling is operating correctly.



4 Product Overview

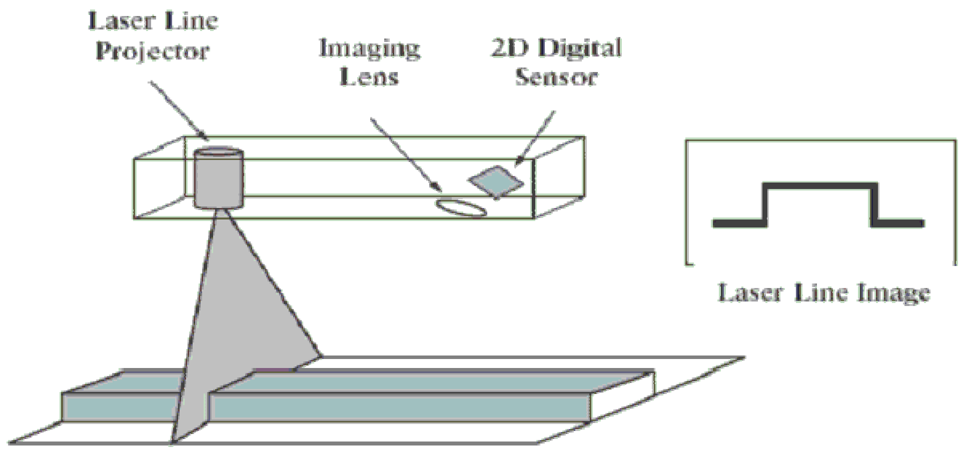
4.1 Introduction

The chroma+scan 3100, chroma+scan 3150, chroma+scan 3155, chroma+scan 3250, chroma+scan 3300, and chroma+scan 3301 are the new-generation, high-speed, high-density 3D profile scanning system for primarily green-side edger and trimmer applications. These systems offer high density, along-board profile data and high resolution across-board sampling at 2000 Hz. The chroma+scan 3300 system offers additional optimization possibilities by providing colour images of the surface of the boards, while the chroma+scan 3250 system offers tracheid measurements alongside board sampling at 2500 Hz. The sensors are 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. Communication is via Gigabit Ethernet.

The chroma+scan 3xxx sensor system consists of a number of chroma+scan 3xxx sensors, plus a FireSync Master and a FireSync Station or a user provided Station PC.

4.2 Measurement Principles

The chroma+scan 3xxx sensors function on the principle of structured light triangulation. A semiconductor laser with special optics projects a fan of light onto the target. A digital



camera mounted at an angle to the laser plane acquires images of the light pattern created on the target. These images contain the basic information needed to compute distances to the target.

4.3 True Differential Measurement

The chroma+scan 3xxx sensors can be aligned co-planar top-to-bottom and side-to-side down the length of the system. This prevents profile measurement errors that could be introduced by hard-to-control mechanical realities such as chain vibration and boards bouncing as they are transported through the scanner system.

4.4 Vision

The chroma+scan 3300 and chroma+scan 3301 models of sensors incorporate colour imagers and LED lighting into their design. This provides a reliable and simple method of capturing features on the top and bottom surfaces of the boards along the length of the system.

4.5 Tracheid

The chroma+scan 3250 model of sensors have the ability to measure the tracheid cells, reporting the angle of the grain, the scatter along that axis, and the effect of the tracheid on the size of the laser spots.

4.6 High Scan Rates

The chroma+scan 3xxx sensor family provides scan rates of 2000 Hz (2500 Hz for the chroma+scan 3250). At the same time, the sensors maintain excellent dark wood performance (equivalent to level 19 on the Kodak gray scale chart), insensitivity to laser saturation, and immunity to ambient light.

4.7 Temperature Compensated Ranges

Chroma+scan 3xxx sensors are calibrated at several temperature points in their operational range to ensure reliable and accurate range measurement throughout changes in ambient temperature.

5 chroma+scan 3xxx Sensor Specifications

This section presents sensor specific chroma+scan 3xxx information. It describes the different models, and gives dimensions of the scan zone and sensor.

5.1 Models

chroma+scan 3xxx sensors are available in five current models:

chroma+scan 3100:	2000 Hz profiler
chroma+scan 3150:	2000 Hz profiler, safety interlocked
chroma+scan 3155:	2000 Hz profiler, safety interlocked
chroma+scan 3250:	2500 Hz profiler, safety interlocked, with tracheid
chroma+scan 3300:	2000 Hz profiler with vision
chroma+scan 3301:	2000 Hz profiler with vision, safety interlocked

These sensors all have identical mounting footprints to allow for future upgrades. The chroma+scan 3300 and 3301 sensor is slightly taller to provide the LED lighting for vision. The chroma+scan 3150 and 3155 offer an extended scan range and have a safety interlock for the lasers.

Safety interlocked sensors require the use of the FireSync Sensor Cordset Version 2 to provide a +48 VDC control signal to each sensor in the system. This signal is controlled at the FireSync Master or Slave by the Safety Interlock input. Without this signal, all of the light sources in the sensor, including the lasers, will be disabled.

Please refer to the *FireSync Network User's Manual* for more information on safety interlock.

For backwards compatibility, safety interlocked sensors can be used in older systems by modifying the sensor cordset to a safety-bypass cable, or by providing a short safety-bypass patch cable at the sensor end. Either of these solutions will provide the required +48 VDC control signal to the sensor, overriding the safety interlock. This is an alternative to re-cabling older systems.

5.2 Performance

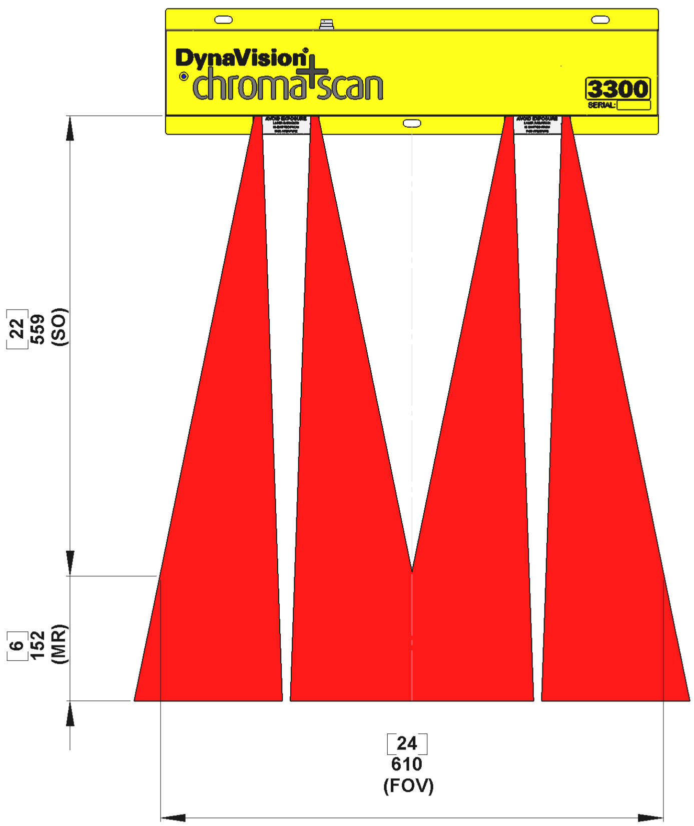
Range Accuracy	±0.38 mm	±0.015 in
Profile Resolution	8.5 mm	0.333 in
Scan Resolution @ 1m/s (197 fpm) (@ 1.25m/s (246 fpm) for chroma+scan 3250)	0.5 mm	0.020 in

5.3 Specifications

Operating Temperature (Non-condensing)	0 - 50°C	32 - 122°F
Input Power	+48VDC @ 1A	
Housing	IP67, Powder Coated, Aluminum	

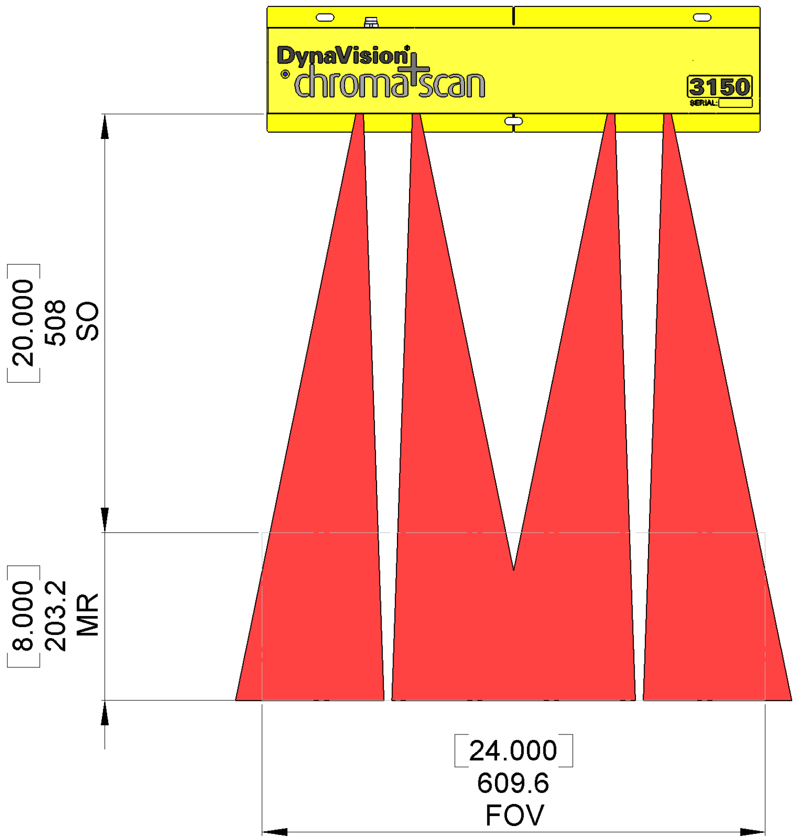
5.4 Scan Zone

5.4.1 chroma+scan 3100/3300/3301 Scan Zone



Standoff (SO)	559 mm	22.0 in
Measurement Range (MR)	152 mm	6.0 in
Field of View (FOV) through entire range	610 mm	24.0 in

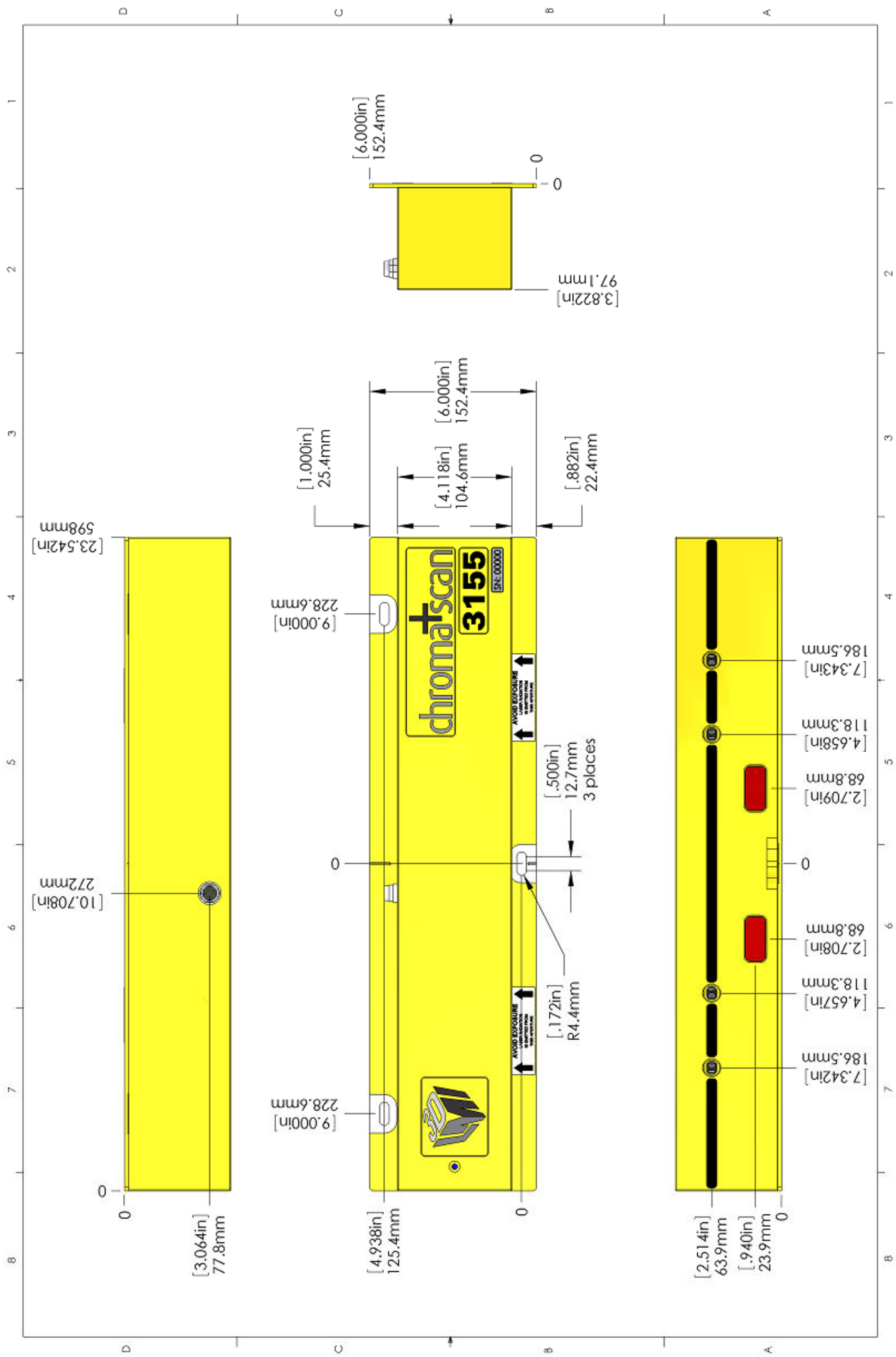
5.4.2 chroma+scan 3150/3155/3250 Scan Zone



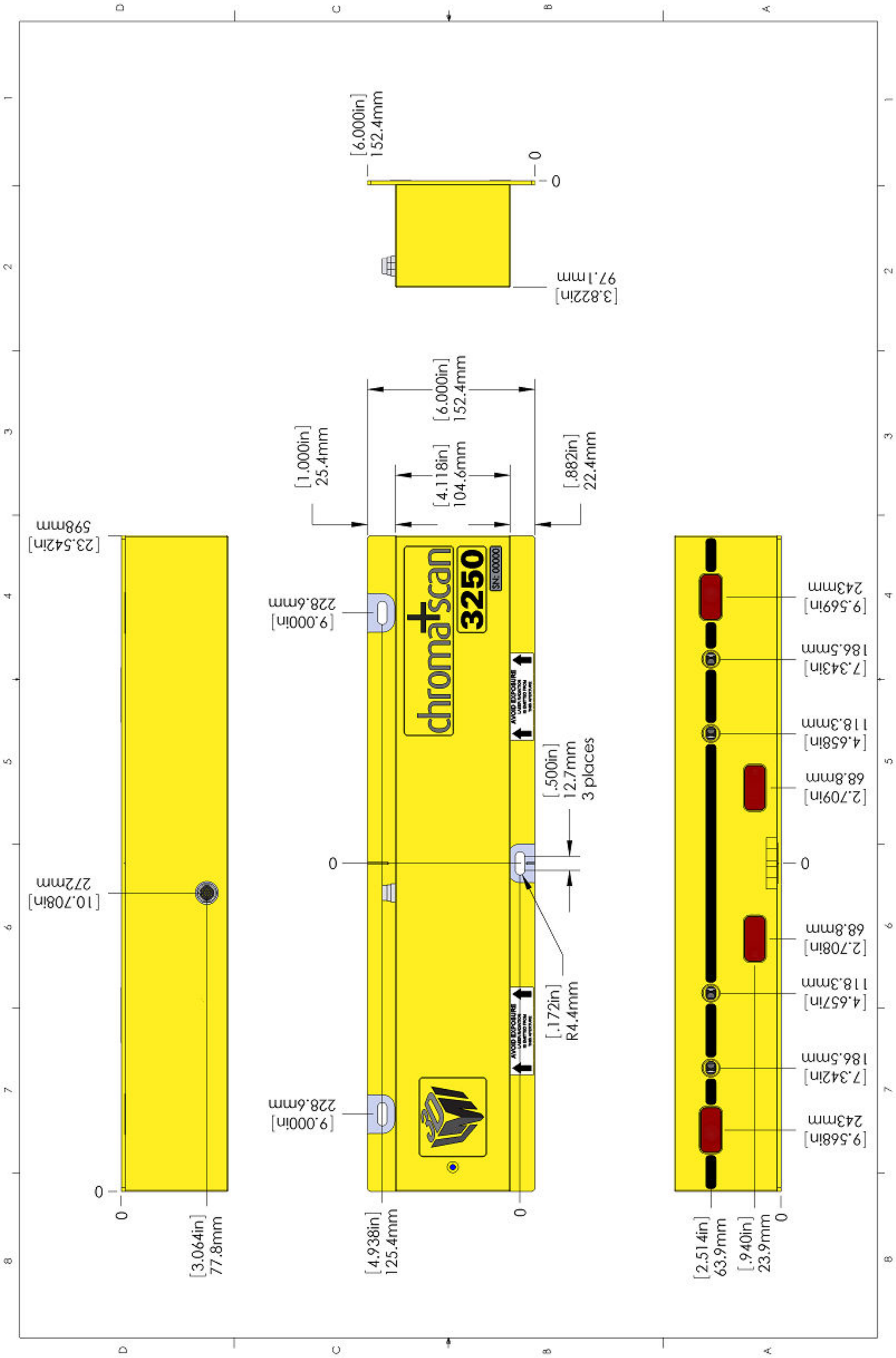
Standoff (SO)	508 mm	20.0 in
Measurement Range (MR)	203.2 mm	8.0 in
Field of View (FOV) through entire range	609.6 mm	24.0 in

5.5 Dimensions and Mounting

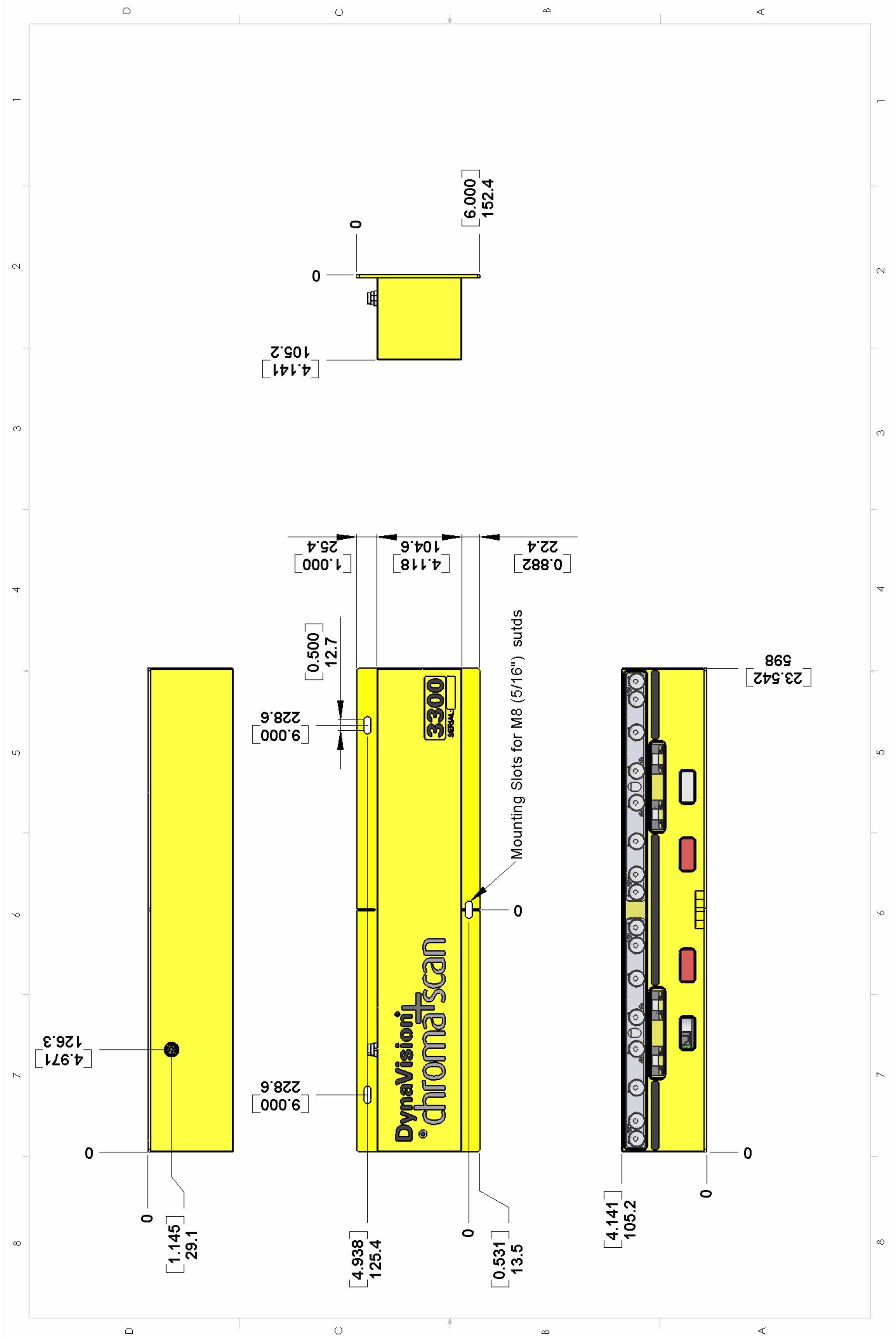
5.5.1 chroma+scan 3100/3150/3155 Sensor Dimensions



5.5.2 chroma+scan 3250 Sensor Dimensions



5.5.3 chroma+scan 3300/3301 Sensor Dimensions



The sensor can be mounted with either M8 or 5/16" hardware. Provision to adjust the position and orientation of the sensor to align its laser plane with the laser planes of other sensors, above and beside, is highly recommended. This alignment is critical to prevent sensor crosstalk and ensure true differential measurements; aligned laser planes also provide a better appearance to the end user of the system.

Caution! Use star washers to mount the sensors to the frame to ensure proper component grounding. Please refer to section 2 for more information on component grounding.

The laser dots are emitted through the two clear windows in-line with the black painted channel along the window face of the sensor[1]. This channel controls laser reflections in the system as well as giving a target to aim the lasers of opposing sensors at during sensor installation and alignment. The laser dots down the length of the system are required to be aligned within these painted channels. A more critical alignment can be made for aesthetic purposes.

The profile cameras are located behind the two red tinted windows and the vision cameras (chroma+scan 3300 sensors only) are located in the two clear windows adjacent to the profile camera windows. The Tracheid camera windows (chroma+scan 3250 only) are located in-line with the laser windows and the painted black alignment channel. When mounting the sensor, ensure that there are no obstructions between the camera windows and the Scan Zone.

5.6 Cleaning

The windows on a sensor must be kept clean and free of debris at all time. If the windows become dirty, clean them with an *ammonia-based* cleaner only.

Window cleanliness for the chroma+scan cs3250 is extra critical as any distortion of laser spots or impediment to the cameras' view can cause error in the Tracheid measurement.

[1] The chroma+scan 3155 and 3250 have four clear, round laser windows in-line with the black painted channel instead of the two, larger rectangular windows in the chroma+scan 3100, 3150, 3300 and 3301 models.

6 System

6.1 Overview

A chroma+scan 3xxx system consists of some or all of the following components:

chroma+scan 3100, 3150, 3155, 3250, 3300 or 3301 sensors

FireSync Master, Master 1200, or Master 2400

FireSync Station, Station 1000, or a user supplied Station PC*

FireSync Slave

FireSync Cordsets

Power Supply

Encoder

Host Computer

Scanner Frame

System Calibration Target

Power and Encoder Wiring

*The FireSync Station 1000 has all of the same functionalities as the FireSync Station, but runs on a +12VDC power supply. The same functionality is also provided by a Station PC running the FireSync Station software. This manual will refer to all different Station models as a Station.

In a typical system, up to 24 chroma+scan 3xxx sensors are placed top-and-bottom and end-to-end along the length a scanner frame. However, in some systems the bottom sensors may be omitted if mechanical constraints of the chain design prevent mounting sensors there.

The Master is the central hub of the system, and provides power, encoder, Safety Interlock, and digital I/O routing. Each sensor and the encoder connect to the Master via sensor cordsets. The power supply provides power to the Master and FireSync Station (if applicable). The Master distributes power to the sensors and encoder. A single CAT5E Gigabit Ethernet cable provides the communication link from the Station to the host computer.

The FireSync Master 1200 supports 12 sensors while the FireSync Master 2400 supports 24 sensors. The FireSync Master has 13 ports, but that can be extended with the addition of a FireSync Slave. The Slave is wired for power and Safety Interlock independently from the Master and communicates through its UP port to the Master. Depending on the system design, the UP port of the Slave can be connected to either the DOWN port of the Master (when an additional Station is being used) or to one of the Master's standard Sensor ports (P01 to P13). A Master to Slave cordset provides the link between the Master and Slave, ensuring all sensors are synchronized within the entire system.

The Station routes data between the Master and Slave(s) and the client's host computer. A server application, running on the Station, integrates data from the encoder and sensors, and transmits the processed output to the client.

6.2 FireSync Master and Station

Complete details of the FireSync Master, Master 1200, Master 2400, Slave, and Station are provided in the *FireSync Network User Manual*.

The FireSync Master provides:

- 13 FireSync interfaces
- An encoder interface
- A safety interlock interface
- A digital I/O interface
- System synchronization

The FireSync Master 1200 provides:

- 12 FireSync interfaces
- An encoder interface
- A safety interlock interface
- A digital I/O interface
- System synchronization

The FireSync Master 2400 provides:

- 24 FireSync interfaces
- An encoder interface
- A safety interlock interface
- A digital I/O interface
- System synchronization

The Station stacks behind the FireSync Master (not Master 1200 or 2400) in the mounting bracket. It provides:

- A Gigabit Ethernet interface to the sensor network (connects to Master or Slave)
- A Gigabit Ethernet interface to the client network

NOTE: FireSync Stations have a maximum data load capacity that cannot be exceeded for proper system operation. The vision output from chroma+scan 3300 sensors can exceed this limit. In a chroma+scan 3300 system, there must be one dedicated Station per 5 chroma+scan 3300 sensors.

6.3 FireSync Slave

The Slave provides:

13 FireSync interfaces

A safety interlock interface (independent from the Master)

System synchronization (via a Master and connection through the UP port)

6.4 Power Supply

The user must provide a suitable +48 VDC power supply for the system. If the system employs a Station 1000, a separate +12 VDC supply is also required.

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

LMI Technologies recommends the use of a Phoenix Contact, QUINT, 10 Amp power supply (for +48 VDC) and a Lambda DSP60-12 power supply (for +12 VDC). They are both DIN rail mounted device that can be connected in parallel to increase the overall available power.

+48 VDC

Model:	QUINT-PS-100-240AC/48DC/10
Order number:	2938248

+12 VDC

Model:	DSP60-12
Order number:	285-1233-ND

6.5 Encoder

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

- Differential quadrature output (maximum 18 V)
- +5 VDC power supply input

The encoder interface on the Master provides the following:

- X4 quadrature decoding
- Maximum 300 kHz count rate
- +5 VDC to power the encoder

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

6.6 Wiring and Connections

Refer to the *FireSync Network User Manual* for details on connecting the power supplies, encoder, Master, Slave, Station, and sensors in a chroma+scan 3xxx sensor system.

6.6.1 Safety Interlock

Safety Interlock is a signal controlled by the Safety input on both the Master and the Slave. This input is required to be energized by +48 VDC before any lights in the system will receive power. If this input is disabled, although the sensors are powered and running, the light sources are disabled.

Systems with Safety Interlock require:

- Safety interlock-enabled sensors
- FireSync Sensor Cordsets Version 2
- An external switch connecting the Safety Interlock signal at the Master to +48 VDC

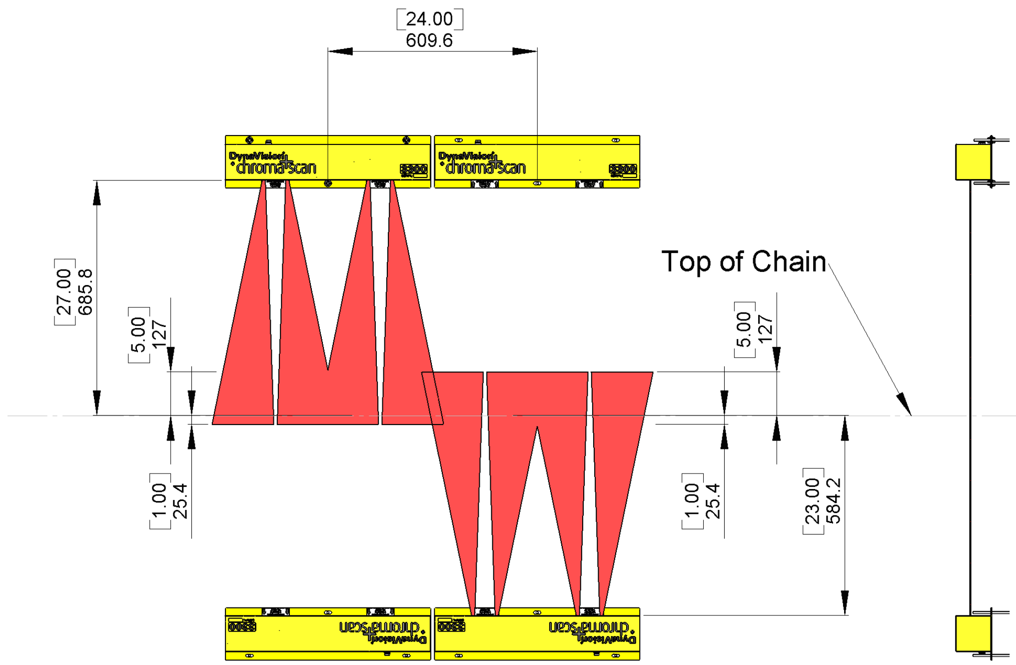
Refer to the *FireSync Network User Manual* for details on wiring the Safety Interlock circuit.

6.7 Frame Design

The scan frame supports the sensors above and below the chain deck to the maximum size of the boards to be scanned. Typically, there are 10 to 12 sensors mounted above the chain and another 10 to 12 sensors mounted below. This provides complete coverage of the top and bottom surfaces of the boards. A means of adjusting the sensors' location and orientation is required to ensure that the sensors do not experience crosstalk and also to ensure that the board thickness is measured differentially.

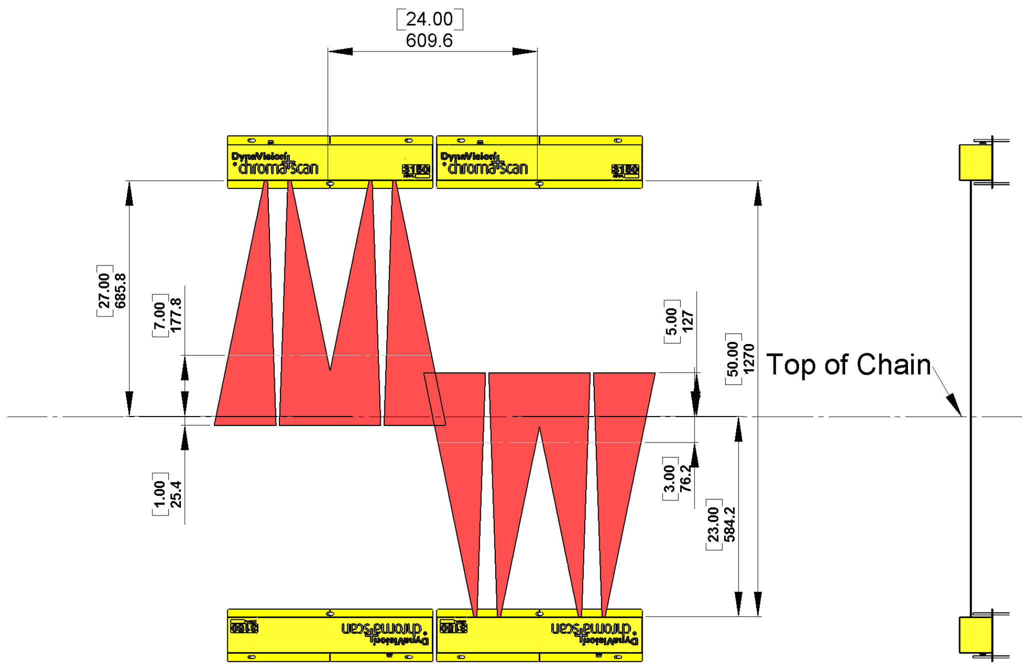
The scan frame must also be connected to earth ground to provide a ground path for the sensors.

6.7.1 chroma+scan 3100/3300/3301 System Configuration



The above separation of sensors provides a full 6 inch overlapped scan zone range that begins from 1 inch below the chainway and extends to 5 inches above the chainway. No sensor stagger is required in the system (top to bottom or side to side).

6.7.2 chroma+scan 3150/3155/3250 System Configuration

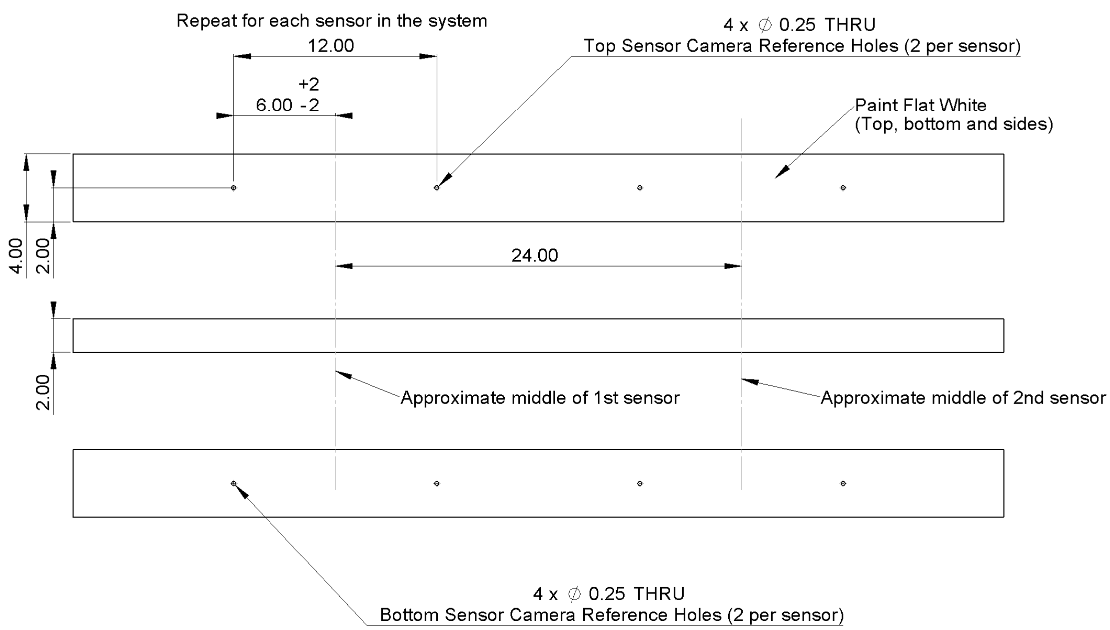


The above configuration of chroma+scan 3150/3155/3250 sensors provides a full 6 inch overlapped scan zone starting from 1 inch below the chainways and extends to 5 inches above the chainways. The extended range of the chroma+scan 3150/3155/3250 sensors provides an additional 2 inches of coverage from the top sensors above this overlapped zone as well as an additional 2 inches below the overlapped zone from the bottom sensors.

An alternative system configuration for the chroma+scan 3150, 3155, and 3250 is to overlap the sensors for the full 8 inches of the sensors' range by moving the bottom sensors 2 inches closer to the chainways. This would reduce the sensor separation to 48 inches and provide 7 inches of scan zone above the chain and 1 inch below.

6.8 System Calibration Target

The system calibration target is required to perform a system calibration. This process locates each sensor with respect to a global coordinate system defined relative to the target. For the chroma+scan 3300/3301 system, additional reference holes are required to properly calibrate the relative position of each colour camera in the system. The target illustrated below is designed for the chroma+scan 3300/3301 system with sensors spaced on 24" centers. Note that the reference holes are every 12 inches to provide a reference location for each colour camera in the system. These reference holes are not required for the chroma+scan 3100, 3150, 3155, and 3250 systems.



Example of a 4-sensor, top and bottom system calibration target

Section 7

7 Software

This section describes the software interfaces to a chroma+scan 3xxx system, including the FireSync Client user interface, settings file format, message formats, and health indicators.

7.1 FireSync Client (Complete)

FireSync Client is a software application that can be used to set up, demonstrate, or diagnose problems with a chroma+scan 3xxx system. The following sections describe how to use FireSync Client to configure a chroma+scan 3xxx system.

7.1.1 Installation

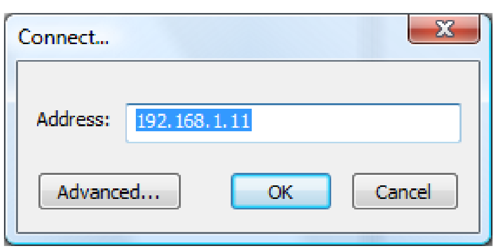
The FireSync Client application is available for Windows XP, and can be downloaded from the LMI Technologies support website. To begin, download the software and install it on a suitable client machine. The client machine should have an Ethernet adaptor that can be configured for a static IP address and that supports 1000 Mb/s operation.

FireSync Stations typically ships with the address 192.168.1.10, though this may vary by request. This default may be used when configuring a user provided Station PC. Set the client machine to an available address on the same subnet (e.g. 192.168.1.9) and then connect a suitable Ethernet cable from the client machine to the Station.

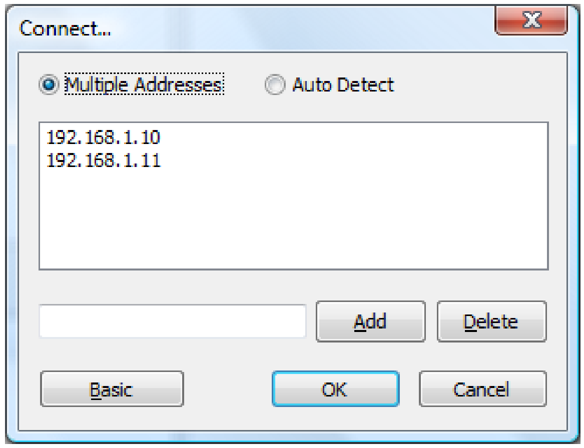
If you are using multiple Stations, you may need to connect to each Station individually in order to assign each Station a unique IP address (use the *Set IP* command from the *Server* menu). It is usually safest to leave all Stations but one physically disconnected during this step.

7.1.2 Connection

After starting FireSync Client, use the lightning (left-most) icon in the toolbar to display the *Connect...* dialog. To connect to a single server, enter the IP address of the server to which you wish to connect, and then click *OK*.



To connect to multiple servers simultaneously, click the *Advanced…* button, add the IP addresses of the servers, and then click *OK*. You can only connect to multiple servers after they have all been individually upgraded (see 7.1.3 Server Upgrade).



7.1.3 Server Upgrade

After connecting, the server will be displayed as "Server S/N 0". This means that the Station is new from the factory and has not had the 3xxx software installed on it. The next step is to upgrade the server. Select the server, then select *Upgrade* from the *Server* menu. You will be prompted to select an upgrade file. This file is may be obtained from the LMI Technologies support website. Ensure that you select the upgrade file specific to the sensor type (31xx, 3250, or 33xx) in your system.

This process will take several minutes. After upgrading each Station in your system individually, you can connect to all of them simultaneously.

Follow this procedure whenever a firmware update is released by LMI.

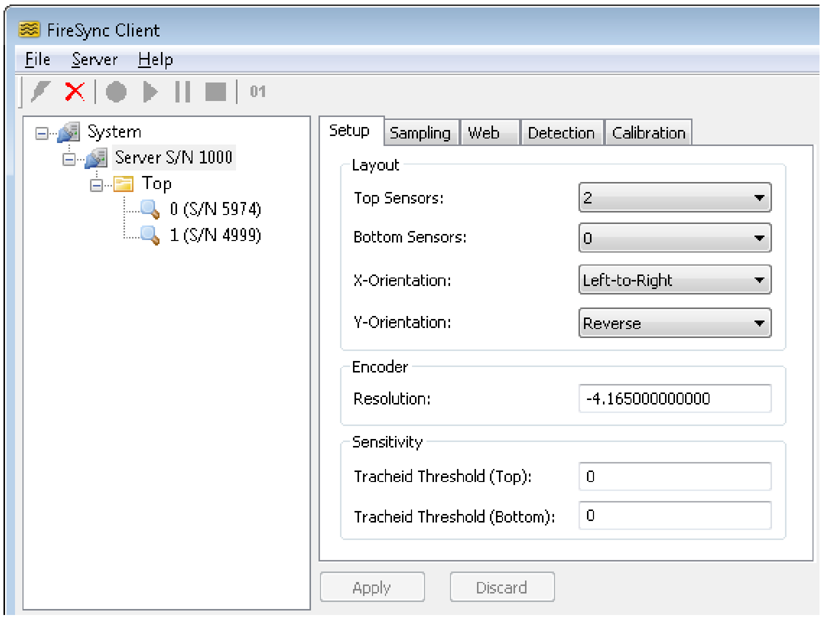
7.1.4 Server Setup

After upgrading, the next step is to set up the servers. For each server in the device tree, click the server's device tree node and enter the settings described in the following sections.

NOTE: It is highly recommended that once the Server Setup is complete and the system is operating as desired that the user creates a **Backup** of all Stations in the system. Select the server, click on the *Server* tab, and select *Backup.*

7.1.4.1 Server Setup Tab

The *Server Setup* tab, shown below, contains general settings for the chroma+scan 3xxx server that affect most of its operating modes.



Top Sensors	Count of top-mounted sensors connected to this server.
Bottom Sensors	Count of bottom-mounted sensors connected to this server.
X-Orientation	Specifies the side of the system that will act as the zero-reference. If you are viewing the sensors from the front (i.e. you can see the sensors' power indicators), a *Left-to-Right* orientation has the sensor at index 0 mounted on the left, whereas a *Right-to-Left* orientation has the sensor at index 0 mounted on the right.
Y-Orientation	Specifies the direction of conveyor movement in relation to the sensors. If you are viewing the sensors from the front (i.e. you can see the sensors' power indicators), a *Forward* orientation implies that boards will move towards you, whereas a *Reverse* orientation implies that boards will move away from you.
Encoder Resolution	The resolution of the encoder, in mils per pulse. Note that if the encoder value decrements when the system is running (the *Reverse* indicator on the Master is illuminated, or the *Encoder Value* server health indicator decreases), then the encoder resolution should be entered as a negative value. Also note, 4x quadrature decoding is assumed (one A/B cycle produces 4 encoder pulses).

The resolution of the encoder is not measured automatically. If the encoder resolution is not already known, use the *Encoder Value* server health indicator to record the number of pulses over a measured distance, and then use these values to calculate the resolution (distance in mils / encoder pulses).

Tracheid Threshold

Specifies a global modifier for all the Top and Bottom sensors' Tracheid thresholds applied at the raw image level (applies only to systems with Tracheid cameras).

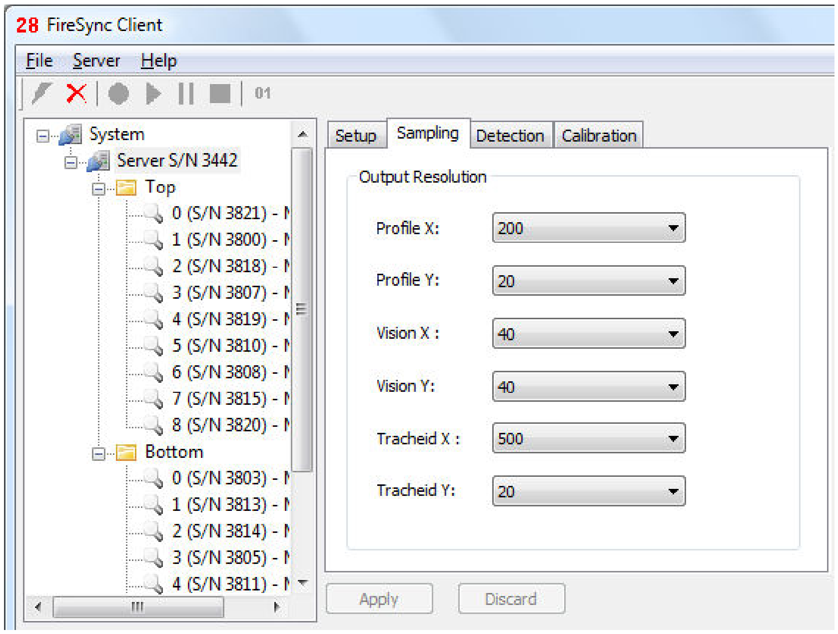
Increasing this value raises the threshold and tends to increase the dot independence. This helps increase the accuracy of near-horizontal Angle measurements. Increasing this value can cause dots to appear rounder in the Aspect Ratio output.

Decreasing this value lowers the threshold and tends to increase the scatter signal processed, resulting in a stronger Aspect Ratio. Lowering this value too much begins including more noise in the dot data.

Recommended values: -20 to +20 (default is 0).

7.1.4.2 Server Sampling Tab

The *Server Sampling* tab, shown below, contains settings that affect how profile points and vision image pixels are sampled in order to produce fixed-resolution outputs.



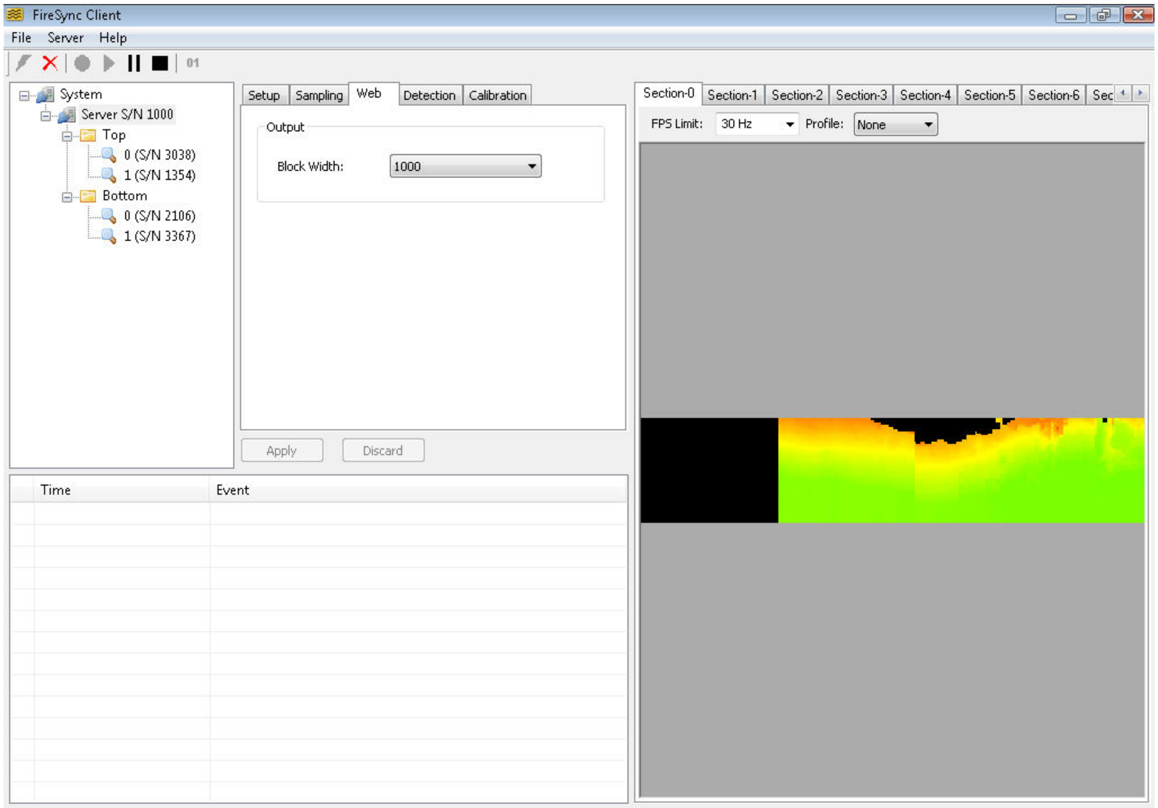
Profile X	X-resolution (length axis) of profile data, in mils per sample.
Profile Y	Y-resolution (width axis) of profile outputs, in mils per sample.
Vision X	X-resolution (length axis) of vision outputs, in mils per pixel.
Vision Y	Y-resolution (width axis) of vision outputs, in mils per pixel.
Tracheid X	X-resolution (length axis) of tracheid outputs, in mils per pixel.
Tracheid Y	Y-resolution (width axis) of tracheid outputs, in mils per pixel.

7.1.4.3 Server Web Tab

[**Note:** Web mode is presently under development and should not be used in production. Web mode message formats are subject to change until this notice is removed.]

The *Server Web* tab, shown below, contains settings that affect the operation of *Web* mode. When selected, this tab enables Web mode; the *Play*, *Pause*, and *Stop* buttons can be used to run the system and outputs will be shown in FireSync Client visualization tabs.

Note: The system must be fully configured and calibrated before Web mode will operate correctly. The system can be run in Web Mode without calibration, but the resulting measurement data may be inaccurate.



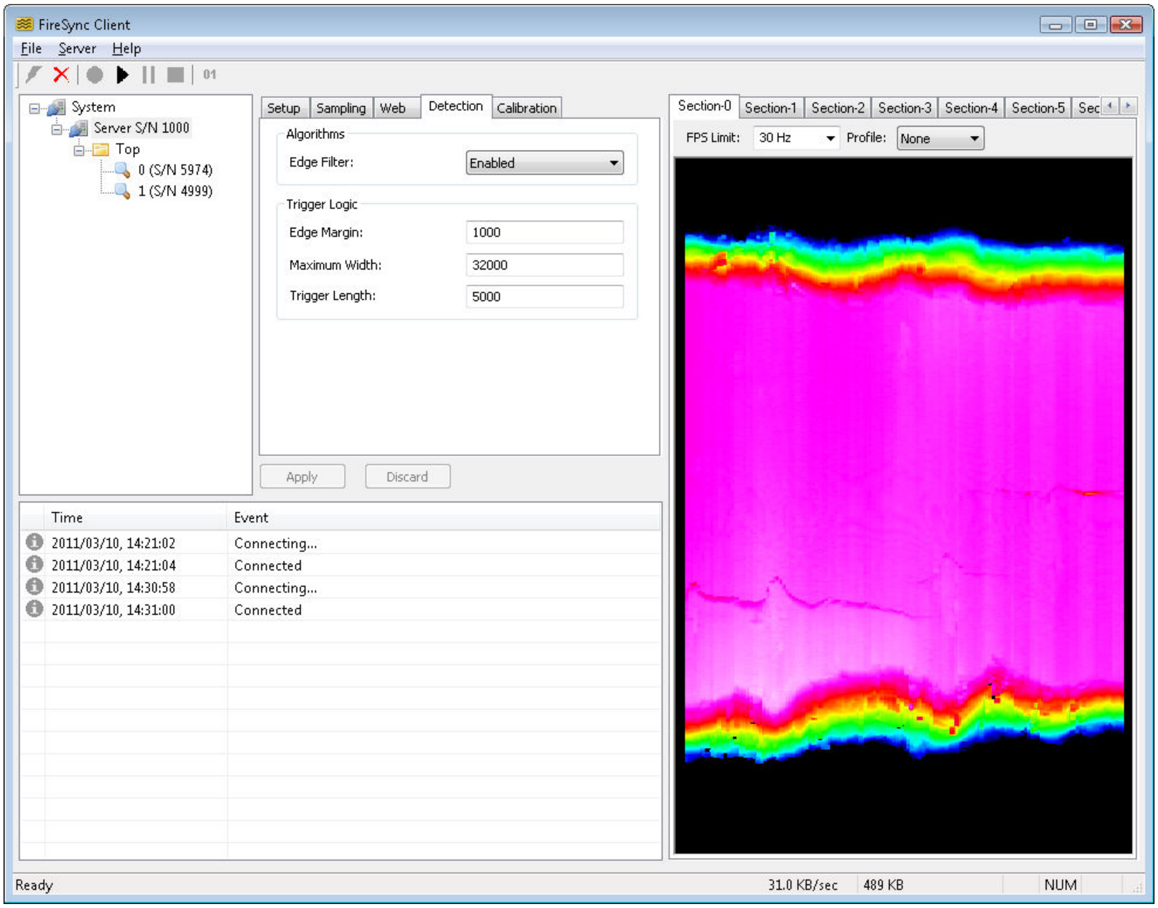
Tile Width — Y extent (width) of profile, tracheid, and/or vision data sent in each web message.

Data from different Sections can be viewed by selecting the Section's tab in the display window. kClient only displays up to 12 Sections, but your system can be designed to include more than 12 Sections.

7.1.4.4 Server Detection Tab

The *Server Detection* tab, shown below, contains settings that affect the operation of *Detection* mode. When selected, this tab enables Detection mode; the *Play*, *Pause*, and *Stop* buttons can be used to run the system and outputs will be shown in FireSync Client visualization tabs.

Note: The system must be fully configured and calibrated before Detection mode will operate correctly. The system can be run in Detection Mode without calibration, but the resulting measurement data may be inaccurate.



Edge Filter — chroma+scan 3xxx sensors can generate occasional profile spikes on transitions between empty space and solid material. When enabled, the edge filter will minimize the occurrence of these spikes.

Edge Margin — The size of the margins (in mils) that will be added to the leading and trailing edge of each detected board.

Maximum Width — The maximum width of a board output (in mils), including edge margins. When boards exceed this width, they will be divided into multiple output messages.

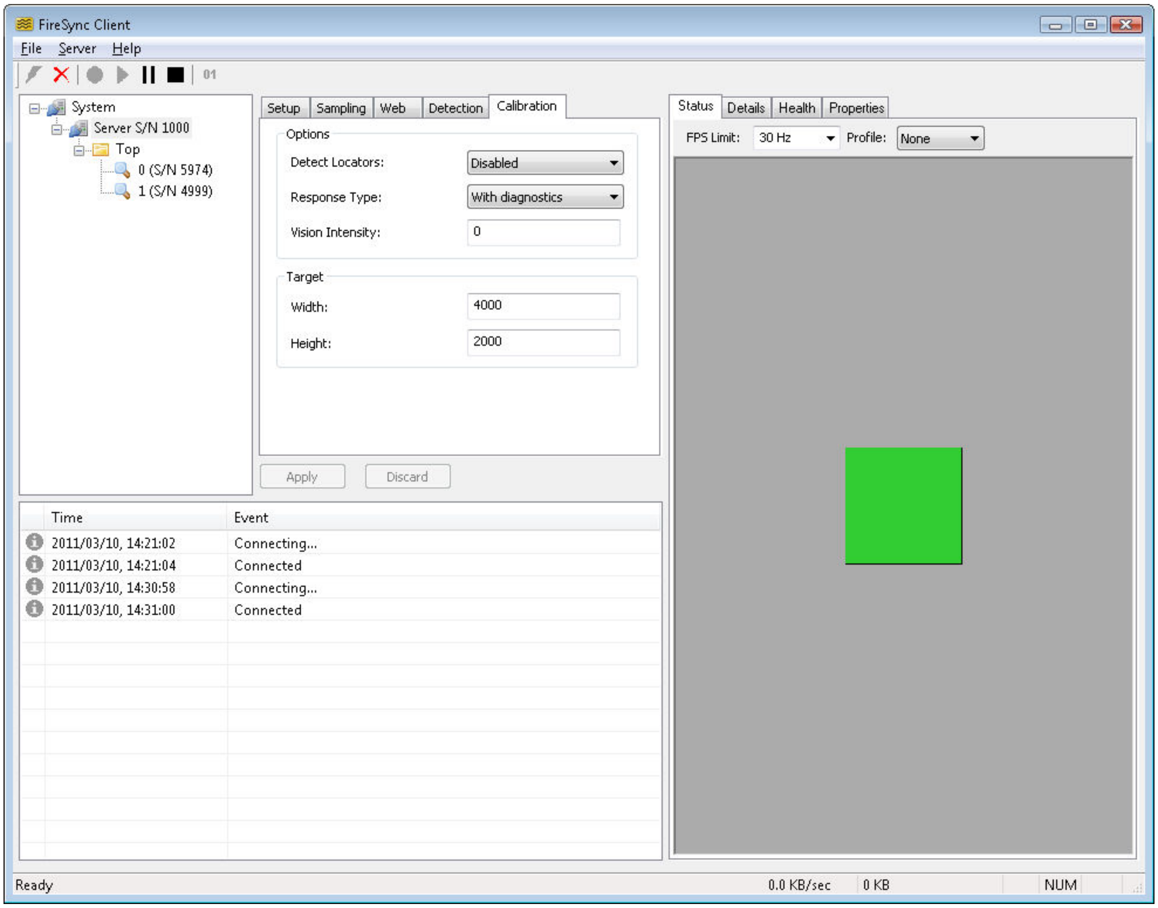
Trigger Length — The length (in mils) of material used to trigger board on/off events, not including material inside obstructions.

Data from different Sections can be viewed by selecting the Section's tab in the display window. kClient only displays up to 12 Sections, but your system can be designed to include more than 12 Sections.

7.1.4.5 Server Calibration Tab

The *Server Calibration* tab, shown below, contains settings that affect the operation of *Calibration* mode. When selected, this tab enables *Calibration* mode; the *Play*, *Pause*, and *Stop* buttons can be used to run the system. If calibration is successful, a green status indicator will be shown in the *Status* visualization tab.

Note: The system should be recalibrated after any settings changes (server, group, or sensor), in order to ensure correct behaviour in Web mode or Detection mode.



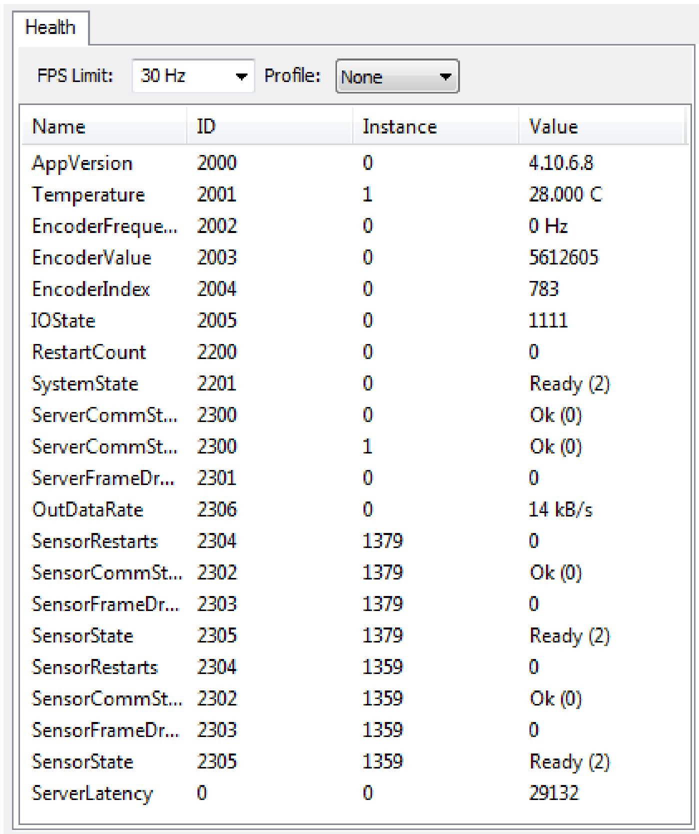
Detect Locators	Vision-enabled systems (e.g. chroma+scan 3300) can make use of drilled reference holes, or *locators*, in order to precisely align vision and profile data between adjacent sensors. See Section 6.8 System Calibration Target for more details. This behaviour can be disabled if *locators* are not present.
Response Type	Determines the type of message returned by the system. Result Only returns a message which indicates whether or not calibration files were created. With Diagnostics returns a message with additional information to identify faulty sensors. Versions of the firmware which do not support this feature return Result Only messages.
Vision Intensity	Defines the desired calibration bar vision intensity (0 - 255). If this value is zero, then the *average* vision intensity along a top or bottom section is not affected by calibration. If this value is not zero, then the average vision intensity reported for the

calibration bar will match this value after calibration.

Target Width	The width of the calibration target, in mils.
Target Height	The height of the calibration target, in mils.

7.1.4.6 Server Health Indicators

When a server node is selected in the FireSync Client device tree, health indicators are displayed in a visualization tab, as shown below. Health indicators can be used to help diagnose a wide variety of conditions. Note that some indicators are updated constantly, while others are only updated while the system is running (*Play* button).


Health

FPS Limit: 30 Hz Profile: None

Name	ID	Instance	Value
AppVersion	2000	0	4.10.6.8
Temperature	2001	1	28.000 C
EncoderFreque...	2002	0	0 Hz
EncoderValue	2003	0	5612605
EncoderIndex	2004	0	783
IOState	2005	0	1111
RestartCount	2200	0	0
SystemState	2201	0	Ready (2)
ServerCommSt...	2300	0	Ok (0)
ServerCommSt...	2300	1	Ok (0)
ServerFrameDr...	2301	0	0
OutDataRate	2306	0	14 kB/s
SensorRestarts	2304	1379	0
SensorCommSt...	2302	1379	Ok (0)
SensorFrameDr...	2303	1379	0
SensorState	2305	1379	Ready (2)
SensorRestarts	2304	1359	0
SensorCommSt...	2302	1359	Ok (0)
SensorFrameDr...	2303	1359	0
SensorState	2305	1359	Ready (2)
ServerLatency	0	0	29132

7.1.5 Group Setup

A chroma+scan 3xxx server can support *Top* and/or *Bottom* sensor groups. For each group in the device tree, click the group's device tree node and enter the settings described in the following sections.

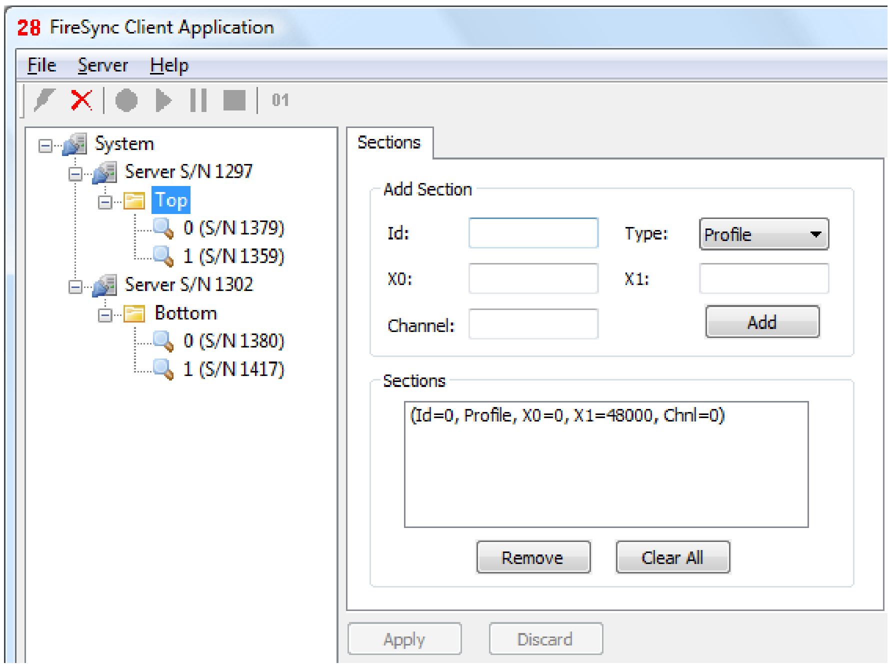
7.1.5.1 Group Sections Tab

The *Group Sections* tab, shown below, is used to divide the profile and vision data within a *Top* or *Bottom* sensor group into lengthwise sections that can be transmitted to attached Client devices in Web mode or Detection mode. To add a section, enter the section parameters (described below), and click the *Add* button.

Note: if no vision sections are defined, vision cameras and lights (if present) will be disabled, and if no tracheid sections are defined, tracheid cameras will be disabled. If no sections of any kind are defined, profile cameras and lasers will remain enabled, but Web mode or Detection mode will not produce any output messages.

Note: each output section can be transmitted on only a single data channel. However, output sections can overlap arbitrarily, limited only by network bandwidth and Station CPU utilization.

Note: The Station assumes that the first sensor in its top and bottom groups starts at X0=0, regardless of their actual physical placement on the frame.



Id	A user-defined identifier for this section. When using FireSync Client, this field determines the index of the visualization tab in which a section will be displayed.
Type	Profile, Vision, or Tracheid.
X0	Start of section along the x-axis (length), in system coordinates (mils).
X1	End of section along the x-axis (length), in system coordinates (mils). Must be greater than X0.
Channel	Numeric identifier of the TCP output channel to which this section will be routed. For more information on configuring TCP/IP data channels, see the FireSync Host Protocol User's Manual.

7.1.6 Sensor Setup

A chroma+scan 3xxx sensor group consists of one or more adjacent sensors. For each sensor listed in the device tree, right-click the device tree node to assign a serial number, and then left-click the device tree node and enter the settings described in the following sections.

7.1.6.1 Sensor Setup Tab

[*Note: these settings have no effect in the current release.*]

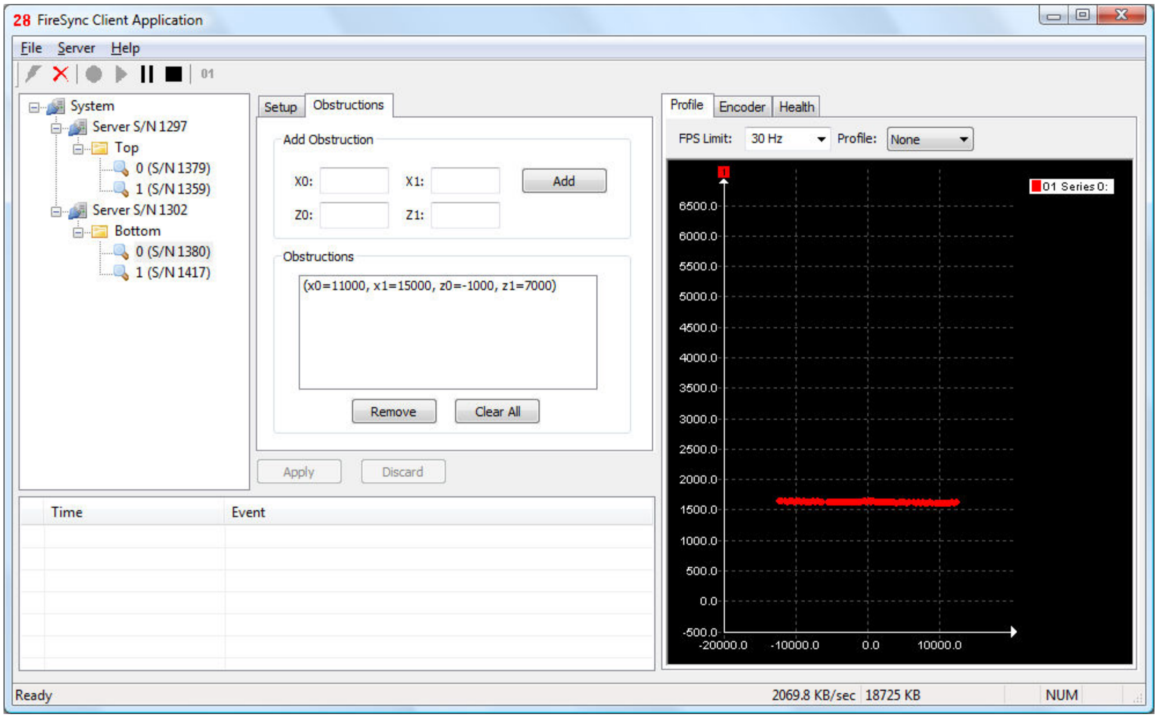
7.1.6.2 Sensor Obstructions Tab

The *Sensor Obstructions* tab, shown below, is used to define regions that should be excluded from profile and vision measurement. This is typically done to remove obstructing conveyor hardware from board measurement data. To add an output section, enter the section parameters (described below), and click the *Add* button.

When selected, this tab enables *Free* mode; the *Play*, *Pause*, and *Stop* buttons can be used to run the system and profile data will be shown in a FireSync Client *Visualization* tab. In conjunction with a static target and/or a running conveyor, the displayed profile data can be used to determine the regions that should be excluded from measurement.

Note: Obstructions should be specified for each sensor before using *Calibration*, *Web*, or *Detection* modes.

Note: Profile data is displayed in sensor coordinates, with the Z-axis (range/height) rendered vertically and the X-axis (length) rendered horizontally. Z=0 is close range, and X=0 is the lengthwise centre of the sensor.



X0 — Start of obstruction zone along the x-axis (length), in sensor coordinates (mils).

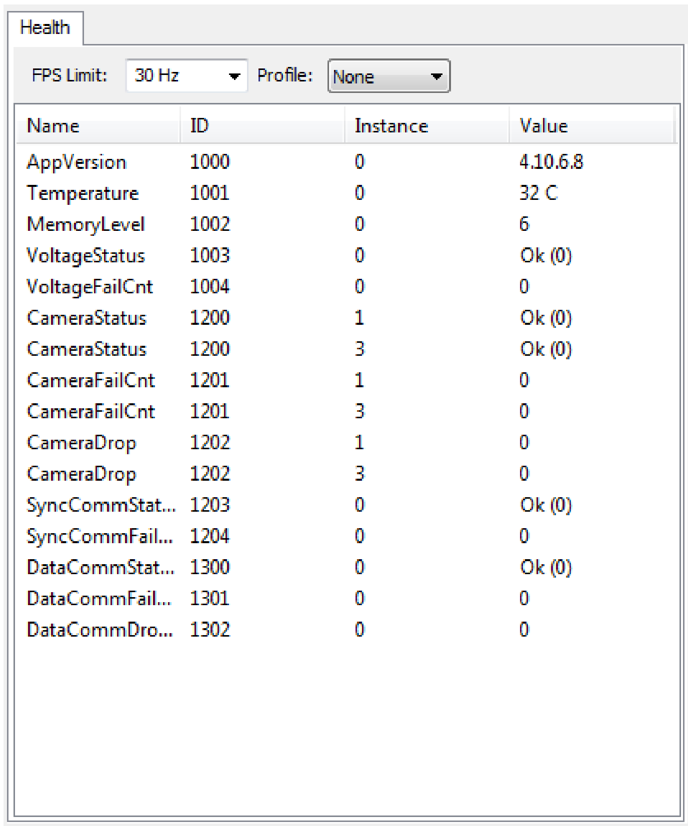
X1 — End of obstruction zone along the x-axis (length), in sensor coordinates (mils).

Z0 — Start of obstruction zone along the z-axis (height), in sensor coordinates (mils).

Z1 — End of obstruction zone along the z-axis (length), in sensor coordinates (mils).

7.1.6.3 Sensor Health Indicators

When a sensor node is selected in the FireSync Client device tree, health indicators are displayed in a visualization tab, as shown below. Health indicators can be used to help diagnose a wide variety of conditions. Note that some indicators are updated constantly, while others are only updated while the system is running (*Play* button).



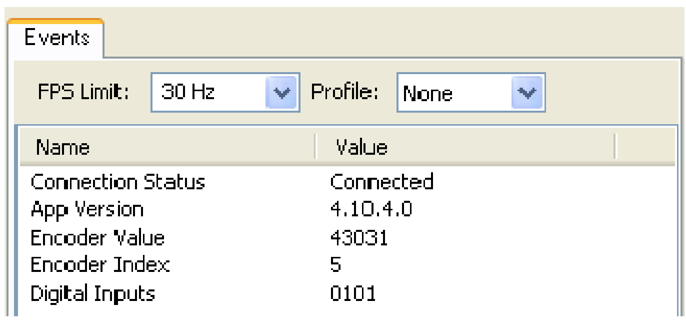
Name	ID	Instance	Value
AppVersion	1000	0	4.10.6.8
Temperature	1001	0	32 C
MemoryLevel	1002	0	6
VoltageStatus	1003	0	Ok (0)
VoltageFailCnt	1004	0	0
CameraStatus	1200	1	Ok (0)
CameraStatus	1200	3	Ok (0)
CameraFailCnt	1201	1	0
CameraFailCnt	1201	3	0
CameraDrop	1202	1	0
CameraDrop	1202	3	0
SyncCommStat...	1203	0	Ok (0)
SyncCommFail...	1204	0	0
DataCommStat...	1300	0	Ok (0)
DataCommFail...	1301	0	0
DataCommDro...	1302	0	0

7.1.7 Event Channel

If kClient detects a connection on the host PC to the sensor network (ie 90.X.X.X subnet) it will enable use of the Event channel. To make this connection, use a Station cordset to connect an available Ethernet port on the host PC to an available sensor port on the Master (or Slave).

Once this connection has been established, click on the *Event Channel* icon 

(next to the stop button). Click on the *System* tab, and the Event indicators will be displayed in a visualization tab, as shown below. Note that these indicators are identical to some of those in the Health channel; however, these update at a rate of 100Hz versus 2Hz in the Health channel.



7.2 File Formats

7.2.1 Server Settings

Server settings are stored in a file named “Settings.xml” on each Station and can be accessed or modified using the FireSync Host Protocol *Read File* and *Write File* commands. The following example illustrates the format of the "Settings.xml" file:

```
<?xml version="1.0" ?>
<SensorGroup schemaVersion="2">
  <Name>Server</Name>
  <Setup>
    <EncoderResolution>4.165</EncoderResolution>
    <EncoderOffset>0</EncoderOffset>
    <XOrientation>1</XOrientation>
    <YOrientation>1</YOrientation>
  </Setup>
  <Sampling>
    <ProfileXResolution>200</ProfileXResolution>
    <ProfileYResolution>20</ProfileYResolution>
    <VisionXResolution>40</VisionXResolution>
    <VisionYResolution>40</VisionYResolution>
    <TracheidXResolution>200</TracheidXResolution>
    <TracheidYResolution>100</TracheidYResolution>
  </Sampling>
  <Web>
    <BlockWidth>1000</BlockWidth>
  </Web>
  <Detection>
    <TriggerLength>5000</TriggerLength>
    <EdgeMargin>1000</EdgeMargin>
    <MaximumWidth>24000</MaximumWidth>
    <EdgeFilter>0</EdgeFilter>
  </Detection>
  <Calibration>
    <DetectLocators>1</DetectLocators>
    <ResponseVersion>2</ResponseVersion>
    <VisionIntensity>0</VisionIntensity>
  </Calibration>
  <Video>
    <ProfileStyle>0</ProfileStyle>
    <VisionStyle>0</VisionStyle>
  </Video>
  <Capture>
    <Enabled>0</Enabled>
    <Source>0</Source>
    <Divisor>1</Divisor>
  </Capture>
  <Members>
    <SensorGroup>
      <Name>Top</Name>
      <TracheidBlackGlobalOffset>0</TracheidBlackGlobalOffset>
      <Sections>
        <Section>
          <Id>0</Id>
          <Type>0</Type>
          <X0>0</X0>
          <X1>48000</X1>
          <Channel>0</Channel>
```

```
      </Section>
      <Section>
        <Id>1</Id>
        <Type>1</Type>
        <X0>0</X0>
        <X1>48000</X1>
        <Channel>0</Channel>
      </Section>
    </Sections>
    <Members>
      <Sensor>
        <Name>0</Name>
        <SerialNumber>1380</SerialNumber>
        <Enabled>1</Enabled>
        <XCentre>12000</XCentre>
        <Obstructions>
          <Obstruction>
            <X0>-15000</X0>
            <X1>-11500</X1>
            <Z0>4500</Z0>
            <Z1>7000</Z1>
          </Obstruction>
        </Obstructions>
      </Sensor>
      <Sensor>
        <Name>1</Name>
        <SerialNumber>1359</SerialNumber>
        <Enabled>1</Enabled>
        <XCentre>36000</XCentre>
      </Sensor>
    </Members>
  </SensorGroup>
  <SensorGroup>
    <Name>Bottom</Name>
    <TracheidBlackGlobalOffset>0</TracheidBlackGlobalOffset>
    <Sections>
      <Section>
        <Id>2</Id>
        <Type>0</Type>
        <X0>0</X0>
        <X1>48000</X1>
        <Channel>0</Channel>
      </Section>
      <Section>
        <Id>3</Id>
        <Type>1</Type>
        <X0>0</X0>
        <X1>26000</X1>
        <Channel>0</Channel>
      </Section>
      <Section>
        <Id>4</Id>
        <Type>1</Type>
        <X0>22000</X0>
        <X1>48000</X1>
        <Channel>0</Channel>
      </Section>
    </Sections>
    <Members>
      <Sensor>
        <Name>0</Name>
        <SerialNumber>1379</SerialNumber>
        <Enabled>1</Enabled>
```

```
          <XCentre>12000</XCentre>
        </Sensor>
        <Sensor>
          <Name>1</Name>
          <SerialNumber>1383</SerialNumber>
          <Enabled>1</Enabled>
          <XCentre>36000</XCentre>
        </Sensor>
      </Members>
    </SensorGroup>
  </Members>
</SensorGroup>
```

The example above specifies the settings for a server with four attached sensors. Server-level settings include the following entries:

Setting		**Description**
Setup		
	EncoderResolution	Distance (mils) per encoder pulse. This value will be positive if the encoder count increases when the board travels in the forward direction. 4x quadrature decoding is assumed.
	EncoderOffset	This optional field can be used to specify an encoder offset (pulses) that will be added to the encoder stamp on outgoing data messages. The purpose of this field is to compensate for offsets between separate servers; accordingly, this value is applied only when sending calibrated data. **Note:** FireSync Client will automatically determine this value based on the encoder stamps received from each server during *Calibration* mode.
	XOrientation	Is the x-axis (length) increasing from left-to-right (1) or right-to-left (0)? In a left-to-right system (as viewed from the front of the sensors), the zero reference is on the left and sensor indices (defined by the sensor "Name" tag) increase left-to-right. In a right-to-left system, the zero reference is on the right and sensor indices increase right-to-left.
	YOrientation	Are boards scanned in the forward (1) or reverse (0) direction? If boards move toward an observer located in front of the sensors, then the direction of travel is forward.
Sampling		
	ProfileXResolution	The x-resolution (mils per profile value, along board length) of the profile data that is sent to the client in *Detection* mode. The following values are supported: 200, 250, 500, and 1000.
	ProfileYResolution	The y-resolution (mils per profile value, across board width) of the profile data that is sent to the client in *Detection* mode. The following values are supported: 20, 25, 40, 50, 100, and 200.
	ImageXResolution	The x-resolution (mils per pixel, along board length) of

		the image data that is sent to the client in *Detection* mode. The following values are supported: 40, 100.
	ImageYResolution	The y-resolution (mils per pixel, across board width) of the image data that is sent to the client in *Detection* mode. The following values are supported: 40, 100.
	TracheidXResolution	The x-resolution (mils per tracheid value, along board length) of the tracheid data that is sent to the client in *Detection* mode. The following values are supported: 200, 250, 500, and 1000.
	TracheidYResolution	The y-resolution (mils per tracheid value, across board width) of the tracheid data that is sent to the client in *Detection* mode. The following values are supported: 20, 25, 40, 50, 100, and 200.
Web		
	BlockWidth	The width of the data (mils) included in each profile, vision, or tracheid web message. The following values are supported: 200, 400, 1000, and 2000.
Detection		
	EdgeMargin	The size of the margins (mils) that will be added to the leading and trailing edge of each detected board.
	MaximumWidth	The maximum width of a board output (mils), including margins. When boards exceed this width, they will be segmented into multiple output messages. **Note:** the maximum width is currently limited to 40000 mils.
	EdgeFilter	Should the server attempt to remove or correct edge measurement anomalies (1) or leave them unaltered (0).
	TriggerLength	The length (mils) of material used to trigger board on/off events, not including material inside obstructions.
Calibration		
	DetectLocators	Should the server attempt to detect calibration reference holes (1), or assume that sensors are mounted at correct locations along the x-axis (0). This setting applies to vision-enabled systems only (e.g. chroma+scan 3300).
	VisionIntensity	Defines the desired calibration bar vision intensity (0 - 255). If this value is zero, then the *average* vision intensity along a top or bottom section is not affected by calibration. If this value is not zero, then the average vision intensity reported for the calibration bar will match this value after calibration.
Capture		These elements determine the behaviour of the system when capturing data for diagnostic analysis by LMI Technologies. To use the system normally, please ensure that data capture is disabled by setting Capture/Enabled to *0*. [**Note:** these settings may be replaced by an improved capture interface in the future.]
Members		This element lists the groups that are defined for this system.

Group-level settings include the following entries:

Setting	Description
Name	"Top" or "Bottom"
TracheidBlackGlobalOffset	Adjusts the tracheid sensitivity to knots of the group. A value of 0 is neutral, positive values increase the size of reported knots, while negative values decrease the size of reported knots. The suggested range of values for this setting is [-10, 10].
Sections	This element contains a list of *Section* elements (described below). Sections are used to define *Detection* mode outputs that can be routed to separate destinations.
Members	This element lists the individual sensors that are contained in this group.

Each section in a group's section list contains the following entries:

Setting	Description
Id	A user-defined identifier for this section. When using the FireSync Client application, this field determines the user interface tab in which a section will be displayed.
Type	Profile (0) or Vision (1).
X0	Start of section along the x-axis (length), in system coordinates (mils).
X1	End of section along the x-axis (length), in system coordinates (mils). Should be greater than X0.
Channel	Numeric identifier of the TCP output channel to which this section will be routed. See the FireSync Host Protocol User's Manual for details on enabling/disabling data channels.

Sensor-level settings include the following entries:

Setting	Description
Name	A numeric index that defines the order of a sensor within its group.
SerialNumber	The manufacturing serial number of the sensor, which can be seen on the sensor housing.
Enabled	Enables or disables the sensor.
XCentre	Defines the mounting location of the sensor, in system coordinates (mils). [**Note:** this setting has no effect in the current release.]
Obstructions	Obstructed zones, described below.

If there are any objects that regularly appear within the field of view of the sensors, such as chain runners, the zones in which those objects appear must be identified before the system will operate correctly in *Calibration*, *Web*, or *Detection* modes. Accordingly, each sensor has a list of *obstructions*, where each obstruction defines a zone that will be ignored by the system.

Setting	Description
X0	Start of obstruction zone along the x-axis (length), in sensor coordinates (mils).
X1	End of obstruction zone along the x-axis (length), in sensor coordinates (mils).
Z0	Start of obstruction zone along the z-axis (height), in sensor coordinates (mils).
Z1	End of obstruction zone along the z-axis (length), in sensor coordinates (mils).

7.2.2 Calibration Target

A description of the calibration target can optionally be stored in a file named "CalibrationTarget.xml" on each FireSync Station and can be accessed or modified using the FireSync Host Protocol *Read File* and *Write File* commands. The following example illustrates the format of the "CalibrationTarget.xml" file:

```
<?Xml version="1.0" ?>
<CalibrationTarget schemaVersion="1">
  <Width>4000</Width>
  <Height>2000</Height>
</CalibrationTarget>
```

If this file is not present, the chroma+scan 3xxx server will assume a default width of 4000 mils and a default height of 2000 mils.

Settings include the following entries:

Setting	Description
Width	The width of the calibration target, in mils.
Height	The height of the calibration target, in mils.

7.2.3 Calibration Output

System calibration output is stored in a file called "Calibration.klab" on each FireSync Station and can be accessed or modified using the FireSync Host Protocol *Read File* and *Write File* commands. The system calibration file may not exist if system calibration has not been successfully completed.

The format of this file is subject to change when improvements are made to the system calibration process or algorithms. As such, LMI does not recommend interacting with this file programmatically. The format is documented in this manual to assist with troubleshooting and to support advanced scenarios that require a higher degree of integration between client software and the system calibration process.

If you are using firmware version 4.10.12.0 or higher, then this file contains XML content. The file name ("Calibration.klab") is unchanged for backwards compatibility with older client software.

Deleting this file from the FireSync Station clears the current system calibration.

The following example illustrates the format of the "Calibration.klab" file:

```
<?xml version="1.0" ?>
<Calibration schemaVersion="3">
  <Views>
    <View>
      <SensorId>2098</SensorId>
      <BankId>0</BankId>
      <XOffset>0</XOffset>
      <ProfileYOffsets>...</ProfileYOffsets>
      <ProfileZOffsets>...</ProfileZOffsets>
      <VisionYOffsets>...</VisionYOffsets>
      <VisionGains>
        <Row>...</Row>
        <Row>...</Row>
        ...
      </VisionGains>
    </View>
    ...
  </Views>
</Calibration>
```

A "view" in the calibration file refers to a profile/vision camera set. A single chroma+scan 3150 sensor would yield 2 view entries because there are 2 profile cameras per sensor, each covering a 12 inch field. A single chroma+scan 3300 sensor would also yield 2 view entries because there are 2 profile/vision camera pairs per sensor, each covering a 12 inch field. The following settings are defined for each view:

Setting	Description
SensorId	Serial number of the sensor that contains this view.
BankId	Index of view within sensor's reference frame (0 or 1).
XOffset	X-offset for this view, in mils.
ProfileYOffsets	Array of profile y-offsets as signed 16-bit hex values. Each value is expressed with 4 characters (e.g. "FFAA"), and represents a y-offset (width) in mils. The number of array elements is given by the view width divided by the profile x-resolution (e.g. 12000 / 200 = 60 elements).
ProfileZOffsets	Array of profile z-offsets as signed 16-bit hex values. Each value is expressed with 4 characters (e.g. "FFAA"), and represents a z-offset (height) in mils. The number of array elements is given by the view width divided by the profile x-resolution (e.g. 12000 / 200 = 60 elements).
VisionYOffsets	Array of vision y-offsets as signed 16-bit hex values. Each value is expressed with 4 characters (e.g. "FFAA"), and represents a y-offset (width) in mils. The number of array elements is given by the view width divided by the vision x-resolution (e.g. 12000 / 40 = 300 elements). This setting applies to vision-enabled systems only (e.g. chroma+scan 3300).
VisionGains	List of "row" elements, where each row is an array of vision gains as unsigned 8-bit hex values. Each value is expressed with 2 characters (e.g. "FA"), and represents a $\log_{10}$ gain value (0x00=0.01, 0xFF=10.00). The number of row elements and the width of each row correspond to the vision camera region of interest.

7.3 Modes and Messages

The system can operate in different modes, each of which has a specialized purpose. The client should use the FireSync Host Protocol *Set Operation Mode* command to set the current mode before sending the *Start* or *Run* command.

As the system runs, data will be transmitted in a platform-independent binary format. The general rules for this format are described in the FireSync Host Protocol Reference Manual, in the section entitled *FireSync Result Format*. However, it is not necessary to consider the FireSync result format; chroma+scan 3xxx messages are described below as an independent data format. Note that fields that pertain to FireSync result details are marked reserved in this document where those fields are not strictly required to understand chroma+scan 3xxx messages.

Message specifications in this document use a shorthand notation for data types, shown below. All values are little-endian (least significant byte transmitted first).

Data Type	Size (bytes)	Description
8s	1	Signed 8-bit integer
8u	1	Unsigned 8-bit integer

16s	2	Signed 16-bit integer
16u	2	Unsigned 16-bit integer
32s	4	Signed 32-bit integer
32u	4	Unsigned 32-bit integer
64s	8	Signed 64-bit integer
64u	8	Unsigned 64-bit integer

7.3.1 Free Mode

In *Free* mode, raw profile data and vision data (for vision-enabled systems) are transmitted without any attempt to resample data, apply system calibration information, or detect objects. Two different types of message can be transmitted by the server: *Free Mode Profile Message* (1) and *Free Mode Vision Message* (2). Profile messages contain geometric measurements captured using lasers and profile cameras. Vision messages contain image pixels captured using LEDs and vision cameras. There are no guarantees regarding the order in which data from separate sensors will arrive at the client.

Messages formats are defined below. Note that invalid profile points are represented by the value (-32768).

Note: The current release does not generate Free Mode Vision Messages.

Free Mode Profile Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (1)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Sensor serial number
reserved[4]	k64s	Reserved for internal use
count	k64s	Count of profiles in message
width	k64s	Count of points per profile
reserved[2]	k64s	Reserved for internal use
attributes[count][4]	k64s	Profile attributes (defined below)
points[count][width][2]	k16s	Profile points (x, z)

Free Mode Profile Message - Profile Attributes

Field	Type	Description
viewIndex	k64s	View index (0 left, 1 right)
frameIndex	k64s	Sequence index
timestamp	k64s	Capture time (microseconds)
encoder	k64s	Capture position (encoder pulses)

Free Mode Vision Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (2)
reserved[2]	k64s	Reserved for internal use

deviceId	k64s	Sensor serial number
viewed	k64s	View index (0 left, 1 right)
frameIndex	k64s	Sequence index
timestamp	k64s	Capture time (microseconds)
encoder	k64s	Capture position (encoder pulses)
height	k64s	Image height
width	k64s	Image width
channels	k64s	Image channels (1)
reserved[1]	k64s	Reserved for internal use
pixels[height][width][channels]	k8u	Image pixels

7.3.2 Calibration Mode

In *Calibration* mode, the server assumes that the first scanned object is the system calibration bar. All objects after the first scanned object are ignored. Calibration algorithms are applied to the data and a *Calibration Completed* message is sent to indicate that calibration data has been successfully updated on the server. The actual message that is sent is dependent on the Calibration Response Type setting – all versions of the firmware support Result Only messages, and newer firmwares also support With Diagnostic messages.

Calibration information is stored in a file named "Calibration.klab" that can be accessed using the FireSync Host Protocol *Read File* and *Write File* commands. The format of this file is described in Section 7.2.3 Calibration Output.

Note: In multi-server installations, the encoder value included in the *Calibration Completed* message can be used in conjunction with the *Setup/EncoderOffset* setting to establish encoder offsets for each server. This task is performed automatically by FireSync Client.

Calibration Completed Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (3)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Server serial number
timestamp	k64s	Capture time (microseconds)
encoder	k64s	Capture position (encoder pulses)
result	k64s	Calibration status: Success (1)

With Diagnostics Calibration Completed Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (10)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Server serial number
timestamp	k64s	Capture time (microseconds)
encoder	k64s	Capture position (encoder pulses)

result	k64s	Calibration status: Success (1)
topProfileStatus	k64u	Bit mask of possible camera failures
bottomProfileStatus	k64u	Bit mask of possible camera failures
topVisionStatus	k64u	Bit mask of possible camera failures
bottomVisionStatus	k64u	Bit mask of possible camera failures

7.3.3 Web Mode

[**Note:** Web mode is presently under development and should not be used in production. Web mode message formats are subject to change until this notice is removed.]

In *Web* mode, the server applies calibration transformations and resamples data to the requested output resolutions, but does not attempt to detect discrete objects. Three different types of message can be transmitted by the server: *Web Mode Profile Message* (11), *Web Mode Vision Message* (12), and *Web Mode Tracheid Message* (13). Profile messages contain geometric measurements captured using lasers and profile cameras. Tracheid messages contain angle and scatter measurements captured using lasers and tracheid cameras (if available). Vision messages contain image pixels captured using LEDs and vision cameras (if available). Each message contains measurement data for a fixed interval along the y-axis, determined by the Web/BlockWidth setting.

Message formats are defined below. Note that invalid profile points are represented by the value (-32768).

Web Mode Profile Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (11)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Server serial number
groupId	k64s	Group identifier: Top (0), or Bottom (1)
sectionId	k64s	Section identifier (from XML Section/Id)
sequenceIndex	k64s	Web sequence index
timestamp	k64s	Capture time
encoder	k64s	Capture position (encoder pulses)
yOrigin	k64s	Leading edge y-position (mils)
xOrigin	k64s	Section x-offset (from XML Section/X0)
yResolution	k64s	Pixel height (mils)
xResolution	k64s	Pixel width (mils)
height	k64s	Profile array height
width	k64s	Profile array width
reserved[2]	k64s	Reserved for internal use
values[height][width]	k16s	Profile (z) values (mils)

Web Mode Vision Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (12)
reserved[2]	k64s	Reserved for internal use

deviceId	k64s	Server serial number
groupId	k64s	Group identifier: Top (0), or Bottom (1)
sectionId	k64s	Section identifier (from XML Section/Id)
sequenceIndex	k64s	Web sequence index
timestamp	k64s	Capture time
encoder	k64s	Capture position (encoder pulses)
yOrigin	k64s	Leading edge y-position (mils)
xOrigin	k64s	Section x-offset (from XML Section/X0)
yResolution	k64s	Pixel height (mils)
xResolution	k64s	Pixel width (mils)
height	k64s	Image height
width	k64s	Image width
channels	k64s	Image channels (4 – b, g, r, x)
reserved[1]	k64s	Reserved for internal use
pixels[height][width][channels]	k8u	Image pixels

Web Mode Tracheid Message

Field	**Type**	**Description**
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (13)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Server serial number
groupId	k64s	Group identifier: Top (0), or Bottom (1)
sectionId	k64s	Section identifier (from XML Section/Id)
sequenceIndex	k64s	Web sequence index
timestamp	k64s	Capture time
encoder	k64s	Capture position (encoder pulses)
yOrigin	k64s	Leading edge y-position (mils)
xOrigin	k64s	Section x-offset (from XML Section/X0)
yResolution	k64s	Pixel height (mils)
xResolution	k64s	Pixel width (mils)
height	k64s	Value/scatter array height
width	k64s	Value/scatter array width
reserved[6]	k64s	Reserved for internal use
values[height][width]	k8u	Tracheid angles, 0-179
scatter[height][width]	k8u	Scatter – ratio of the minor axis to the major axis of the best fit ellipse of the spot, scaled from 0-255

7.3.4 Detection Mode

In *Detection* mode, the Server monitors incoming sensor data to detect the presence of a board. When a board is detected, board data is accumulated by the server. After a complete board has been captured, board data is transmitted by the server to the client. Three different types of message can be transmitted by the server: *Detection Mode Profile Message* (6), *Detection Mode Vision Message* (7), and *Detection Mode Tracheid Message* (9). Profile messages contain geometric measurements captured using lasers and profile cameras. Vision messages contain image pixels captured using LEDs and vision cameras (if available).

Message formats are defined below. Note that invalid profile points are represented by the value (-32768).

Detection Mode Profile Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (6)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Server serial number
groupId	k64s	Group identifier: Top (0), or Bottom (1)
sectionId	k64s	Section identifier (from XML Section/Id)
sequenceIndex	k64s	Board sequence index
timestamp	k64s	Capture time
encoder	k64s	Capture position (encoder pulses)
yOrigin	k64s	Leading edge y-position (mils)
xOrigin	k64s	Section x-offset (from XML Section/X0)
yResolution	k64s	Pixel height (mils)
xResolution	k64s	Pixel width (mils)
height	k64s	Profile array height
width	k64s	Profile array width
reserved[2]	k64s	Reserved for internal use
values[height][width]	k16s	Profile (z) values (mils)

Detection Mode Image Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (7)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Server serial number
groupId	k64s	Group identifier: Top (0), or Bottom (1)
sectionId	k64s	Section identifier (from XML Section/Id)
sequenceIndex	k64s	Board sequence index
timestamp	k64s	Capture time
encoder	k64s	Capture position (encoder pulses)
yOrigin	k64s	Leading edge y-position (mils)
xOrigin	k64s	Section x-offset (from XML Section/X0)
yResolution	k64s	Pixel height (mils)
xResolution	k64s	Pixel width (mils)
height	k64s	Image height
width	k64s	Image width
channels	k64s	Image channels (4 – b, g, r, x)
reserved[1]	k64s	Reserved for internal use
pixels[height][width][channels]	k8u	Image pixels

Detection Mode Tracheid Message

Field	Type	Description
messageSize	k64s	Total size of message (bytes)
messageId	k64s	Type of message (9)
reserved[2]	k64s	Reserved for internal use
deviceId	k64s	Server serial number
groupId	k64s	Group identifier: Top (0), or Bottom (1)
sectionId	k64s	Section identifier (from XML Section/Id)
sequenceIndex	k64s	Board sequence index
timestamp	k64s	Capture time
encoder	k64s	Capture position (encoder pulses)
yOrigin	k64s	Leading edge y-position (mils)
xOrigin	k64s	Section x-offset (from XML Section/X0)
yResolution	k64s	Pixel height (mils)
xResolution	k64s	Pixel width (mils)
height	k64s	Value/scatter array height
width	k64s	Value/scatter array width
reserved[10]	k64s	Reserved for internal use
values[height][width]	k8u	Tracheid angles, 0-179
scatter[height][width]	k8u	Scatter – ratio of the minor axis to the major axis of the best fit ellipse of the spot, scaled from 0-255
area[height][width]	k8u	Area of each spot, in units of 4 pixels

7.4 Health Indicators

Chroma+scan 3xxx servers emit diagnostic messages containing health indicators at a regular interval. The message format is described in the FireSync Host Protocol User's Manual, in the section entitled *FireSync Health Data Channel*. The following sections describe the health indicators specific to chroma+scan 3xxx sensors and servers.

Note: currently, there are no custom indicators for chroma+scan 3xxx sensors or servers. Consult the FireSync Host Protocol User's Manual for the complete lists of standard indicators.

7.5 Sample Code

Source code for a sample client application is included with the FireSync Client distribution ('sample' folder). This sample application, written in C and targeted for Windows or Linux on Intel x86, demonstrates the use of the FireSync Host Protocol to communicate with a chroma+scan 3xxx server.

7.6 Server Simulation

The FireSync Server Simulator application is included with the FireSync Client distribution ('bin\kServerSim.exe'). The purpose of this simulator is to allow Client applications to be tested in the absence of FireSync hardware. Note that the data files and settings files required simulate a chroma+scan 3xxx system are also provided in the FireSync Client distribution (‘data’ folder). See the FireSync Server Simulator User’s Guide for further details.

8 Warranty

8.1 Warranty policies

The sensor is warranted for a predetermined number of years from the date of purchase from LMI Technologies Inc. This warranty period is defined by your business agreement in place with LMI Technologies. For exact warranty periods by product, please contact your Business Development Manager. Products that are found to be non-conforming during their warranty period are to be returned to LMI Technologies Inc. The sensor must be properly handled, installed and maintained, as described in Section 2: Proper Handling and Precautions. LMI will void the warranty of the sensor if the sensor has been improperly installed or mishandled.

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.

8.2 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.

9 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:

U.S. Food and Drug Administration
Center for Devices and Radiological Health
WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002