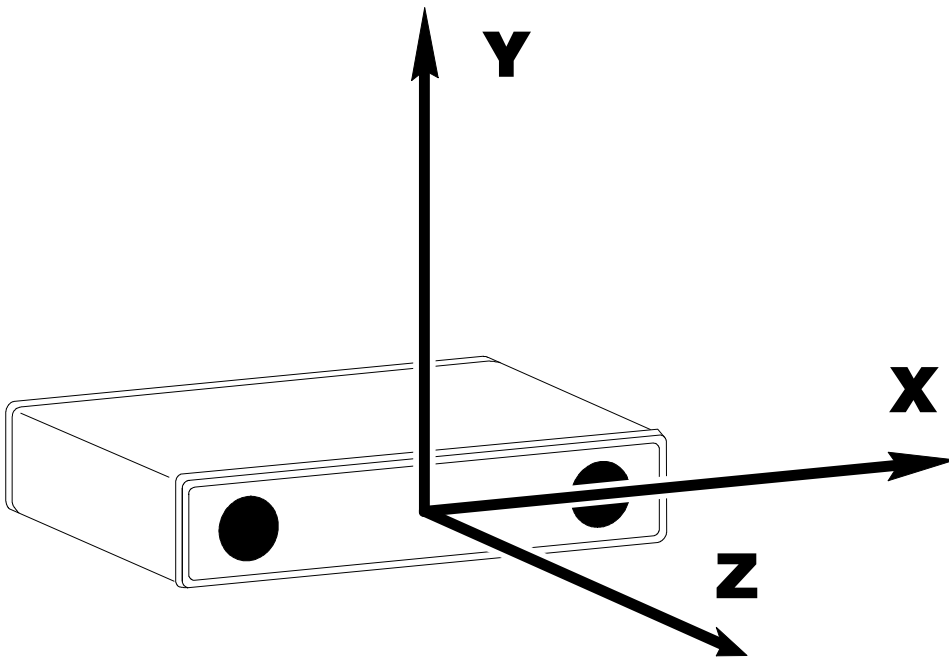


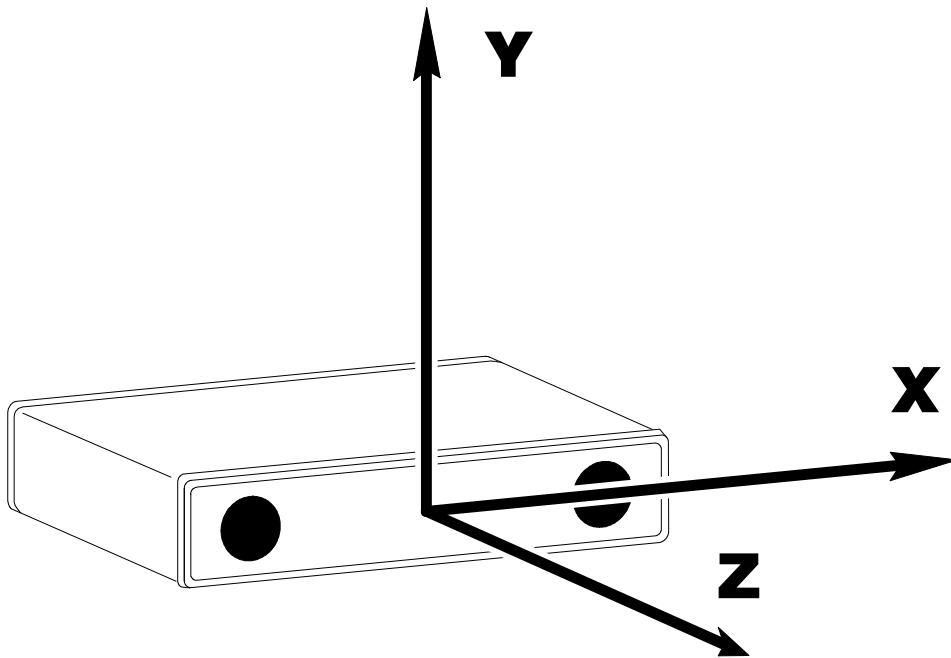
The DynaSight™ Sensor

User Manual



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APPLICATION DISCLAIMER

The DynaSight sensor is designed to provide high resolution tracking performance in most environments. However, it should not be used in an application where personal injury or property loss could occur if tracking failed. **Origin Instruments products are *not* authorized for use as surgical aids or as part of a system intended to support or sustain life.** The user assumes full responsibility for determining the suitability of the DynaSight sensor for the intended application. **Origin Instruments will not be responsible for direct or consequential damages associated with any use of the DynaSight sensor.**

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Introduction

The *DynaSight User Manual* is a guide to the use and operation of the DynaSight 3-D optical radar. Before using the DynaSight sensor please read and study this manual, paying special attention to the description and installation section.

Please note, there may be additional documentation shipped with your DynaSight in the form of hard copy or machine readable addenda.

User Registration

Please complete and return the enclosed user registration form. This will ensure that you receive application software updates following your DynaSight purchase. In addition you will be on the list to receive follow-on product information and new product announcements. This registration is especially important if your company's ship to address is different than your (user's) first class mail address.

DynaSight Sensor Warranty

Origin Instruments warrants to the Customer that the products it manufactures will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period Origin Instruments, at its option, will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under the foregoing warranties, the Customer must notify Origin Instruments of the defect before the expiration of the warranty period. The Customer shall be responsible for packaging and shipping the defective product, with shipping prepaid, to:

Attn: Customer Service
Origin Instruments Corporation
854 Greenview Drive
Grand Prairie, TX 75050-2438
USA

Telephone: (214) 606-8740
FAX: (214) 606-8741

Origin Instruments will pay for the return of the product to the Customer if the shipment is to a location within the United States. The Customer will be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to other locations.

The foregoing warranties will not apply to any defect, failure, or damage caused by improper use, or improper or inadequate maintenance and care. Origin Instruments will not be obligated to furnish service under these warranties (a) to repair damage resulting from attempts by unauthorized personnel to install, repair, or service the product; (b) to repair damage resulting from improper use or connection to incompatible equipment; or (c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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Chapter 1, Hardware Description

The DynaSight is a self-contained 3-D optical radar. The very low power eye safe device operates using light energy in the near infrared frequency band.

The DynaSight is an instrument that contains an optical transmitter, an optical receiver and a RISC (Reduced Instruction Set Computer) based signal processor. The instrument communicates with the host computer over a standard serial port and for most applications requires no set-up. After power is applied the device will perform built in self test and inform the user of any problems by flashing the status LED. The LED can communicate several failures with different flash codes. For a description the user is referred to appendix B.

Refer to Figure 1, for the following description. The DynaSight has two optical apertures that must stay free of any debris or obstructions. Care must be exercised in relation to the sensor apertures which are covered by infrared windows that are subject to damage. For best results and long term sensor operation do not touch the windows and do not clean them unless absolutely required. They should *not* be cleaned as part of a regular maintenance program. If cleaning does become necessary, refer to sensor maintenance in Chapter 6.

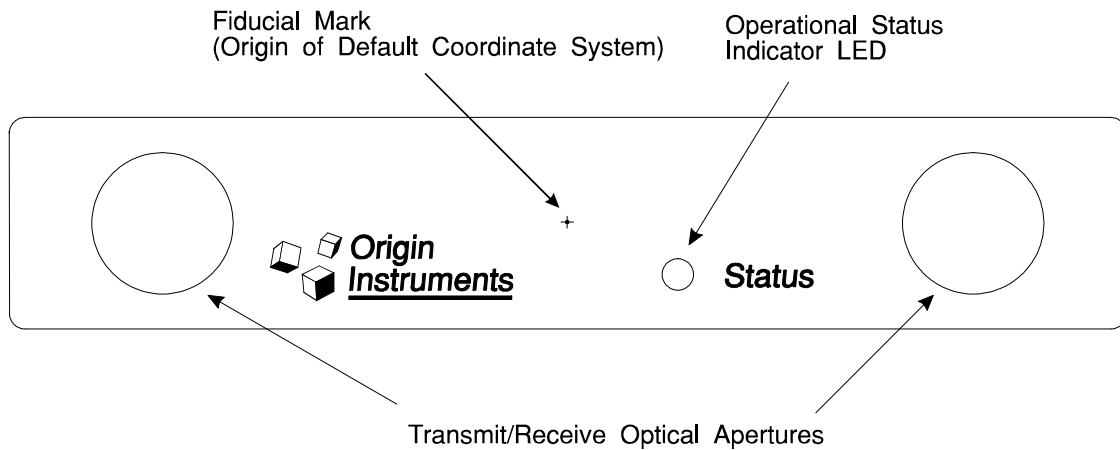


Figure 1. Front view of the DynaSight Sensor.

As delivered, the sensor reports target positions in three dimensions relative to the fiducial mark indicated in Figure 1. This fiducial mark is the origin of the default coordinate system and Figure 2 is an illustration that shows its orientation and origin. The coordinate system is right-handed with positive X to the right, positive Y toward the top of the sensor and positive Z toward the user (given directions are referenced facing the DynaSight sensor as illustrated in Figure 1). This default coordinate system can be modified by Origin Instruments for custom requirements.

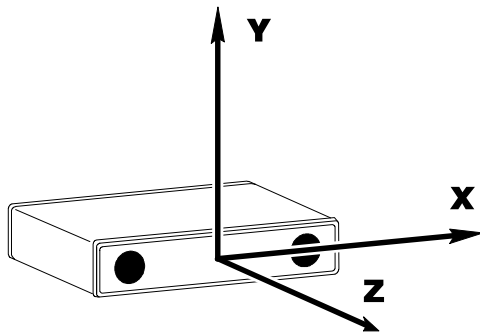


Figure 2. Drawing illustrating the default coordinate system with origin centered at the fiducial mark on the sensor's front panel.

The LED status indicator has a dual purpose, to indicate the results of built in self tests and to indicate the tracking status to the user. Table 1, describes status LED codes associated with tracking.

The signal I/O connectors, the power connector, the power switch, and the mode switch are located on the sensor's rear panel. The power connector, indicated in Figure 3, is for the AC wall transformer or power converter shipped with each unit. Application of power to the device is controlled by the main power toggle switch.

Table 1. LED tracking status key.

LED Color	DynaSight Status
Green	Tracking
Yellow	Tracking but conditions are marginal
Red	Searching

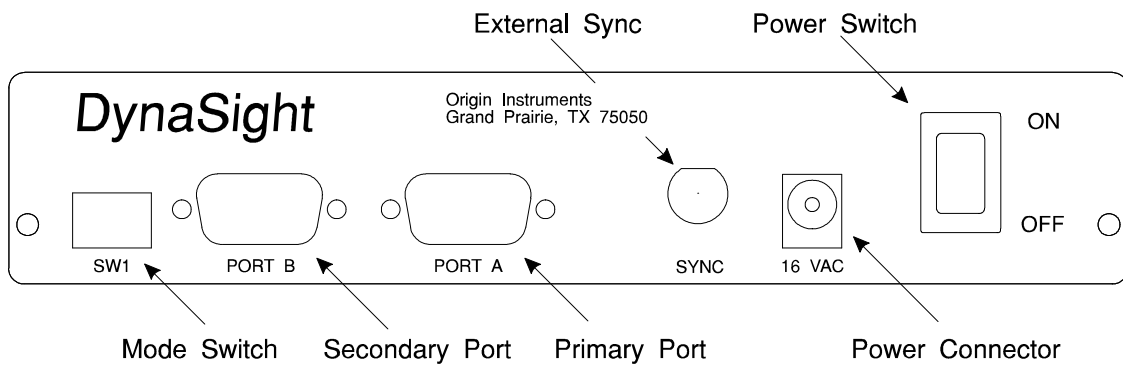
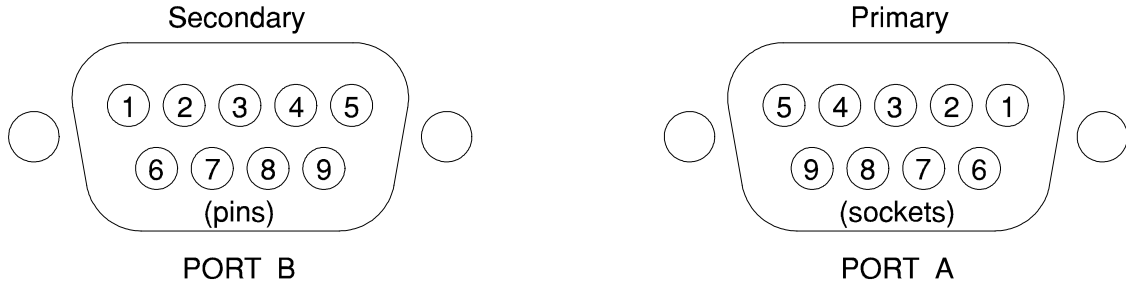


Figure 3. Rear view of the DynaSight Sensor.

There is a four position mode control switch that has the first two positions from the left (facing the rear panel as illustrated in Figure 3) available for user manipulation. The other two positions should remain off, a switch lever in the up position is considered to be off. The modes associated with each position of this switch are described in the operation section of this manual.

Signal I/O consists of two EIA RS-232C ports using DB-9 connectors and an external multipurpose input/output port ("Sync") using a BNC connector. A function table and pin

out of the two DB-9 connectors is contained in Figure 4. For a description of the operation of these ports and the default data format see Appendix D.



Pin	Secondary Port		Primary Port	
	Function	Flow from DynaSight	Function	Flow from DynaSight
1	No Connect		No Connect	
2	RXDB	input	TXDA	output
3	TXDB	output	RXDA	input
4	+12 VDC*	output	No Connect	
5	Ground		Ground	
6	No Connect		RTSA†	output
7	RTSB	output	CTSA	input
8	CTSB	input	RTSA†	output
9	No Connect		No Connect	

* Maximum current draw is 20 milliamps.

† These pins physically connected.

Figure 4. Function and pin outs of the primary and secondary EIA RS-232C ports.

Chapter 2, Installation

EMI Considerations

Warning: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his or her expense will be required to take whatever measures may be required to correct the interference.

If the DynaSight is suspected of causing interference to a radio or television receiver, cycle it's power on and off to determine whether it is the cause of the disturbance. If a problem exists, the user is encouraged to try and correct the problem by one of the following measures:

1. Reorient the antenna of the affected receiver.
2. Relocate the equipment with respect to the receiver.
3. Move the equipment away from the receiver.
4. Plug the equipment into a different AC outlet so that the equipment and receiver are on different branch circuits.
5. Ensure that the equipment data cables and cover are properly installed and tight.
6. Reorient the equipment cables.
7. Consult Origin Instruments for additional suggestions.

Origin Instruments is not responsible for any problems caused by unauthorized modification of this equipment.

Set-up

No user alignment or adjustments are required before the sensor can measure and report target locations relative to the default coordinate system. The sensor can report positions relative to an origin other than the default, by performing a custom transformation procedure. The embedded signal processor can translate and rotate the default coordinate system used to report position measurements. Contact Origin Instruments for more information about this capability.

For communicating position information to an application program the DynaSight sensor is connected to a host computer equipped with a serial port (EIA RS-232). In addition, the host must also have a driver program installed to interface the DynaSight to the application program. This driver program can be provided by the specific software application package, your system integrator or Origin Instruments. Contact Origin Instruments for information on developing a driver for your custom application.

Power is input to the DynaSight by the supplied power converter or wall transformer which is connected to the AC mains. Tracking information from the sensor is transferred to the host computer using the sensor's Primary serial port (Port A). These connections are made to connectors, illustrated in Figure 3, on the sensor's rear panel.

Head Tracking

Illustrated in Figure 5, is the set-up in an application of the DynaSight for interactive viewing of 3-D computer generated models and/or head control of the mouse pointer. The DynaSight is placed on top of the workstation display with the sensor's front plate aligned with the display's CRT screen. Port A of the DynaSight is connected to the workstation's serial port using the included cable (and adapter if required). The sensor placement should be such that it's field-of-view is approximately centered on the viewer's nominal head position. It is also very important that the sensor be positioned such that it's front panel is approximately even with the front edge of the monitor. This will eliminate self induced interference associated with reflections from the monitor's top surface.

To accurately render the perspective of a displayed 3-D image either the workstation or the DynaSight must account for the offset associated with the origin of the screen coordinate system and that of the sensor. This transformation is best handled by software operating on the host computer.

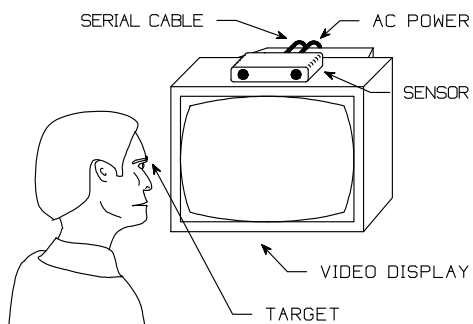


Figure 5. Typical installation using the DynaSight for interaction with a 3-D computer workstation.

With the appropriate software driver installed, the DynaSight will provide the real time 3-D position of the user's head for use in the interactive rendering of a computer model.

Suitable Environments

The user is reminded that proper target selection and installation along with the sensor's operating environment can affect tracking performance. Therefore, the reader should be familiar with both of these user manual sections before attempting to set-up an application.

The DynaSight operates using near infrared light energy; therefore, the user should avoid situations where bright sources of infrared light are within the field of view of the DynaSight or which illuminate the user. This does not mean that the DynaSight will not operate correctly while in one or both of these situations but that there may be system

performance degradation. The two most common sources of near infrared light are the sun and incandescent lamps. Light sources based on fluorescent lamps do not radiate a significant amount of near infrared light and therefore pose no interference problem.

The user should also avoid highly reflective objects placed adjacent to the DynaSight target. In most cases there will be no problems associated with these objects (clutter) unless they are placed in the immediate vicinity of the target. Some users who wear eye glasses may have problems with spurious reflections off the lenses or metal frame. These problems are best handled by moving the target away from the glasses frame, or providing a diffuse mask behind the target. Spurious reflections from jewelry are usually not a problem because these objects are typically located some distance away from the target. As a final resort to dealing with interference problems the interfering objects, where feasible, should be removed from the immediate area.

For tracking applications where the object to be tracked is itself highly reflective a dark and (or) diffuse background mask should be applied under the target. The mask diameter should be approximately four or five times the target diameter. An example of this situation might be the tracking of a shiny metallic object.

Multiple sensors may be used in the same neighborhood as long as the sensors do not radiate *directly* into each other's field-of-view. If the sensors are facing each other and are closer than about 10 meters there will probably be interference. However, multiple sensors can have overlapping fields-of-view as long as one doesn't radiate directly into the receiver of another one. For instance, an installation could be set up such that four sensors, one per side, looked down into a ten foot square cube from above, see Figure 6. As long as the sensors were oriented so that none radiated directly into the receiver of another, each would operate as if the others weren't there. This technique is employed to track a person over 360 degrees within this cube which typically would be a four wall display system for a virtual reality cave.

Finally, the user should eliminate the possibility of the DynaSight's line-of-sight to the target being obscured. Items that typically interfere with the sensor's line-of-sight are: people, parts of the user's body especially hands and hair, wiring, DynaSight mounting fixtures, mounting fixtures associated with the tracked object, and furniture.

Another potential interference source is self induced and is almost always associated with reflections from objects very close to the DynaSight. The most common object encountered is the top of a user's CRT monitor. This problem shows up when the DynaSight is improperly positioned back from the front edge of the monitor. In this position, the monitor's front ledge is in the DynaSight's field-of-view and because it is so close the transmitted energy is reflected back at very high power levels. This will not damage the sensor; however, it will often prevent it from operating properly. Another situation that can cause self induced interference occurs when the sensor's front panel is oriented approximately parallel to a highly reflective and flat surface (e.g. mirror or plate glass).

Target Installation

The user is reminded that proper target selection and installation along with the sensor's operating environment can affect tracking performance. Therefore, the reader should be familiar with both of these user manual sections before attempting to set-up an application.

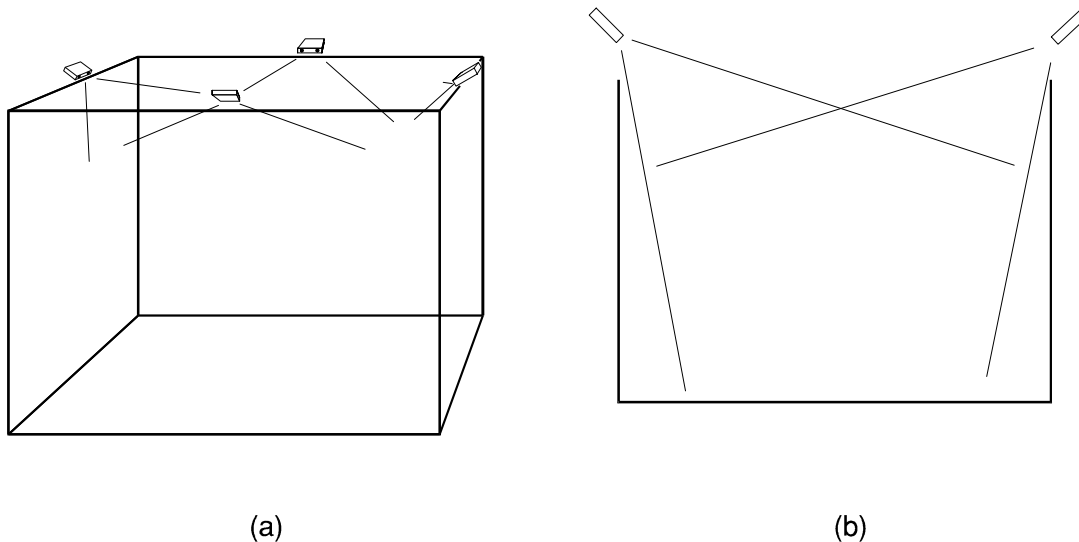


Figure 6. Multiple sensor installation for 360 degree tracking within a Virtual Reality Cave is illustrated in (a). A cross section of two opposing sensors showing alignment to eliminate direct line-of-sight is illustrated in (b).

To cue the sensor, a target must be attached to the object being tracked. Depending on the application, one of several target types can be used. For short range head tracking a 7 millimeter adhesive-backed disposable target, weighing less than 10 milligrams, is placed on the user's forehead, nose bridge, or glasses. Shown in Figure 7(a) is a typical user with a 7 millimeter target attached to her forehead while (b) shows a 7 millimeter target attached to standard or polarized glasses for stereo displays. For stereo displays that incorporate active stereo glasses the target is placed as shown in Figure 8.

For best head tracking performance the target should be placed as near the midpoint on an imaginary line drawn between the users eyes as possible. Proper target placement can have a dramatic affect on the illusion-of-realism for a dynamic stereo display.

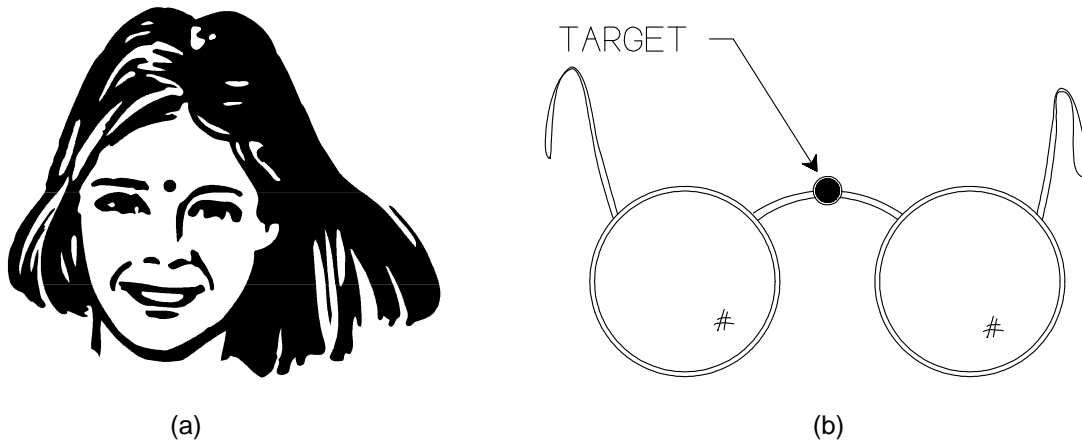


Figure 7. Typical target installation for head tracking: (a) target attached to user's forehead (b) target attached to polarized stereo glasses.

During operation the DynaSight must maintain a clear line of sight-to-the target. The user is referred to the discussion about suitable environments for more information regarding line-of-sight issues.

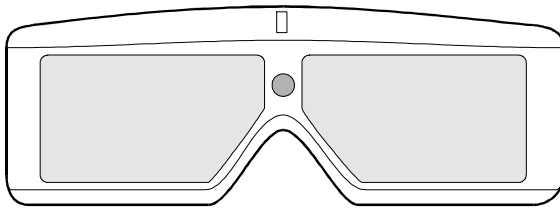


Figure 8. DynaSight target attached to the nose bridge of active stereo glasses.

Another equally important consideration regarding proper target selection and use is the acceptance angle of the specific target. The target's orientation relative to the DynaSight's line-of-sight should be maintained in as near a normal (perpendicular) orientation as possible. However, the target will typically operate at orientation angles up to approximately 50 degrees off normal.

For long range tracking applications there are other target types available, contact Origin Instruments for more information.

Transformation of the Sensor's Coordinate System

The default coordinate system used to reference the position measurements has as its origin the fiducial mark located at the center of the front plate between the two sensor apertures. The coordinate system is right-handed and is defined such that, for a user facing the sensor, rightward head movement is in the direction of positive X, upward head movement is in the direction of positive Y, and movement away from the sensor is in the direction of positive Z. Refer to Figure 9, for a drawing that illustrates the origin and orientation of the three orthogonal axes. For some applications it may be necessary to have the origin of the reporting coordinate system translated and (or) rotated to a new position. For more information about custom configurations contact Origin Instruments.

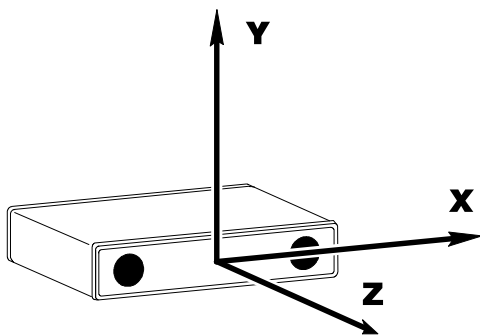


Figure 9. Drawing illustrating the default coordinate system with origin centered at the fiducial mark on the sensor's front plate.

Chapter 3, Operation

In general the DynaSight operates in the following manner. Immediately after the application of power the sensor goes into a self test mode with negative results indicated by a status LED flash code (LED error flash codes are described in Appendix B). If the sensor successfully completes self test it immediately transitions into the search mode and begins looking for a target. The typical time required to acquire a valid target is 0.3 sec. If no target is in the field of view the sensor will continually search until one is acquired or until the power is turned off. There is one exception regarding the continuous search process and that is the DynaSight transmitter can be turned off using the external sync input while operating in one of the stereo sync modes.

Operating Modes

The DynaSight has twelve operating modes available to the user. Ten of these modes are embedded in the sensor firmware and two are typically available for custom configurations (contact Origin Instruments for details). The operating modes are listed in Table 2.

Table 2. DynaSight Operating Modes.

Mode "Number"	Mode
0*	Retro
1*	MsoftFltr2D
2*	StereoSync
3	MsoftMouse2D
4	RetroPolled
5	MoSysFltr2D
6	Laser
7	MoSysMouse2D
8	RetroHD
9	SSyncHD38kb
U	(User Mode-1)
V*	StereoSync60 (User Mode-2)

(* - Can be selected with the mode switch.)

An operating mode may be selected by either using software or the mode selection switches on the rear of the sensor. The mode switches allow the user to choose between the first three modes listed in Table 2. The remaining modes must be selected via the serial port using the DynaSight mode change software protocol, see Appendix C. If custom configurations have been loaded into the DynaSight they replace two of the four selections on the mode switch. See Table 3, for the switch settings associated with each mode (NOTE: The switch state is only read when power is applied to the DynaSight).

Retro: In this mode, the DynaSight sensor generates data packets that describe the instantaneous three dimensional position of a passive infrared target. The "Retro" mode is intended to provide the best compromise between data latency and false-target rejection for typical applications in head-tracking stereo displays. The signal processing algorithms provide an excellent level of false target rejection. Real-time measurements are encoded in the NATIVE0 data format and are transferred at 19,200 baud over serial port A. Measurements are performed at a 30 Hz update rate.

Table 3. Mode selection switch key.

Mode "Number"	Mode	Switch Setting *			
		1	2	3	4
0	Retro	U	U	U	U
1	MsoftFltr2D	D	U	U	U
2	StereoSync (or USER-1)	U	D	U	U
V	StereoSync60 (or USER-2)	D	D	U	U

* The left most switch (facing the rear panel as illustrated in Figure 3) is number 1. Switch state is *only* read at power-up.

MsoftFltr2D: In this mode, the DynaSight sensor can operate as a keyboard-activated head-controlled mouse emulator, or as a filter for an existing Microsoft serial mouse. When operating as a head-controlled mouse, the sensor generates Microsoft-compatible 2-D serial mouse data packets in direct proportion to a user's up-and-down and side-to-side head movements. When operating in pass-through mode, the sensor re-transmits data packets from a desktop serial mouse.

Two techniques are available to cause the switch from mouse-based pointing to head-controlled pointing. One technique involves providing a switch closure on the DynaSight sensor's external SYNC connector. The other involves sending an appropriate command byte from the host computer to the sensor by means of the serial interface.

The host computer can send additional command bytes to the sensor that cause mouse button press indications to be inserted into the sensor-generated mouse packets. With suitable host-based keyboard hook software, a workstation user can activate head-controlled pointing and perform selections through the use of keyboard hot-keys.

For sensor operations in this mode, a mouse is connected to DynaSight serial port B, and serial port A is connected to the RS-232 mouse port on the host computer. The DynaSight sensor transmits

standard Microsoft 2-D mouse data packets at 1200 baud. For a description of the communication protocol used by the DynaSight in mouse filter modes see Appendices F and H.

Many workstations do not load the mouse driver software if a mouse is not attached to the appropriate port at boot time. If the DynaSight is connected to the proper workstation port, with power applied and in the appropriate mouse mode, it will cue the computer to load the mouse driver.

For a description of controlling the mouse pointer using head movements see the section describing head mouse applications in Chapter 4.

StereoSync:

This mode is similar to the "Retro" mode except that measurements are made synchronous to a signal input to the sensor by means of the external SYNC connector. While in the StereoSync mode, the DynaSight sensor synchronizes to an external stereo drive signal that conforms to a format established by StereoGraphics Corporation, see Appendix E. While in the StereoSync mode, the DynaSight responds to an external synchronization signal as described in Table 4.

Table 4. DynaSight response to an external synchronization signal while in the StereoSync mode.

External Synchronization Input	Response
Logic High or Open (TTL Levels)	DynaSight tracks and reports target positions at 37 Hz.
Logic Low (TTL Levels)	DynaSight <i>transmitter disabled</i> , reports last good position
Stereo Drive (50 - 70 Hz)	Synchronizes with stereo drive and reports target position at 1/2 the frequency.

The StereoSync mode is designed to allow the sensor to operate in conjunction with active stereo glasses that perform left/right synchronization by means of a remote infrared transmitter. In this mode, the DynaSight sensor will not generate interfering transmissions during time windows that the glasses are listening for a synchronization signal.

The data is encoded and transferred in the default NATIVE0 format at 19,200 baud over serial port A. Complete 3-D measurements are made at a rate established by the external synchronization input. The DynaSight will synchronize to input wave forms with frequencies from 50 to 70 Hz, corresponding to display vertical refresh rates from 100 to 140 Hz. If no connection is made to the sensor's SYNC connector, the sensor will report measurements at a 37 Hz update rate. *If the sensor's SYNC input is grounded (or TTL zero level), the sensor's infrared transmitter will be disabled.* In every other respect, this operating mode is similar to the Retro mode.

StereoSync60: This mode is similar to the "Retro" mode except that measurements are made synchronous to a signal input to the sensor by means of the external SYNC connector. While in the StereoSync60 mode, the DynaSight sensor synchronizes to an external stereo drive signal that conforms to a format established by StereoGraphics Corporation, see Appendix E. While in the StereoSync60 mode, the DynaSight responds to an external synchronization signal as described in Table 5.

Table 5. DynaSight response to an external synchronization signal while in the StereoSync60 mode.

External Synchronization Input	Response
Logic High or Open (TTL Levels)	DynaSight tracks and reports target positions at 64 Hz.
Logic Low (TTL Levels)	DynaSight <i>transmitter disabled</i> , reports last good position
Stereo Drive (45 - 62 Hz)	Synchronizes with stereo drive and reports target positions at that frequency.

The StereoSync60 mode is designed to allow the sensor to operate in conjunction with active stereo glasses that perform left/right synchronization by means of a remote infrared transmitter. In this mode, the DynaSight sensor will not generate interfering transmissions during time windows that the glasses are listening for a synchronization signal.

The data is encoded and transferred in the default NATIVE0 format at 19,200 baud over serial port A. Complete 3-D measurements are made at a rate established by the external synchronization input. The DynaSight will synchronize to input wave forms with frequencies from 45 to 62 Hz, corresponding to display vertical refresh rates from 90 to 124 Hz. If no connection is made to the sensor's SYNC connector, the sensor will report measurements at a 64 Hz update rate. *If the sensor's SYNC input is grounded (or TTL zero level), the sensor's infrared transmitter will be disabled.* In every other respect, this operating mode is similar to the Retro mode.

MsoftMouse2D: This mode provides direct, head-controlled mouse emulation using a data format compatible with the Microsoft serial mouse. While in this mode the DynaSight sends out Microsoft 2-D data packets in direct proportion to target movements in azimuth and elevation. A switch closure on the sensor's external SYNC connector is used to emulate a press of the left mouse button. Mouse data packets are transmitted in RS-232 format at a data rate of 1200 baud.

For a description of controlling the mouse pointer using head movements see the section describing head mouse applications in Chapter 4. For a description of the communication protocol used by the DynaSight, in this mode, see Appendices F and H.

RetroPolled: This operating mode is identical to the "Retro" mode except that 3-D position data packets are not continuously transmitted. The DynaSight stores the data packets and waits for the host command to transmit. Upon receiving a transmit command, Ctl-Q (11hex), the most recent position measurement is immediately transmitted. The DynaSight is constantly tracking the target during this time only the transmission of data to the host is controlled by the polling process.

MoSysFltr2D: This mode is identical to the "MsoftFltr2D" mode except that the data packets are formatted to emulate a Mouse Systems mouse instead of a Microsoft mouse. Mouse data packets are transmitted in RS-232 format at a data rate of 1200 baud. For a description of the communication protocol used by the DynaSight, in this mode, see Appendices **Error! Bookmark not defined.** and H.

Laser: This mode is designed to allow the DynaSight sensor to modulate and operate with an active electro-optic target, such as an external laser designator. Tracking algorithms and measurement dynamics are similar to the RetroHD mode. 3-D measurement data is encoded and transferred in the default NATIVE0 format at 19,200 baud . Contact Origin Instruments for more information on the use of the "Laser" operating mode.

- MoSysMouse2D:** This mode is identical to the “MsoftMouse2D” mode except that the data packets are formatted to emulate a Mouse Systems mouse instead of Microsoft mouse. Mouse data packets are transmitted in RS-232 format at a data rate of 1200 baud. For a description of the communication protocol used by the DynaSight, in this mode, see Appendices **Error! Bookmark not defined.** and H.
- RetroHD:** This mode is designed for use in high dynamic tracking scenarios where good dynamic precision and very low measurement latency are important. Clutter rejection has been reduced somewhat to allow a reduction in measurement latency. In all other respects, this mode is similar to the “Retro” mode. Data packets are formatted in the NATIVE0 3-D data format and are transmitted to the host computer at 19,200 baud.
- SSyncHD38kb:** This mode is designed for use in high dynamic tracking scenarios where very low measurement latency is important. Clutter rejection has been reduced somewhat to accommodate this reduction in measurement latency. With no external synchronization signal, measurements are performed at 37 updates per second. 3-D data packets are formatted in the NATIVE0 format and are transmitted to the host computer at 38,400 baud. In all other respects this mode is identical to the “StereoSync” mode. While in the SSyncHD38kb mode, the DynaSight responds to an external synchronization signal as described in Table 6.

Table 6. DynaSight response to an external synchronization signal while in the SSyncHD38kb mode.

External Synchronization Input	Response
Logic High or Open (TTL Levels)	DynaSight tracks and reports target positions at 37 Hz.
Logic Low (TTL Levels)	DynaSight <i>transmitter disabled</i> , reports last good position
Stereo Drive (50 - 70 Hz)	Synchronizes with stereo drive and reports target position at 1/2 the frequency.

Chapter 4, Applications

Dynamic Perspective

Users are conditioned by everyday experience to expect that head movements will result in changes to the visual perspective. In fact, small changes in head position and orientation are constantly, if unconsciously, employed to provide spatial context and reveal obscured details. The dynamic perspective display is a technique for emulating this intuitive behavior on computer graphics workstations. With such a display, the perspective for displayed graphics is adapted in real time to be geometrically appropriate for the instantaneous positions of the viewer's eyes. Thus, the video screen becomes a "virtual window" into the geometry of a real or modeled environment. Such displays can add a pleasing dynamic presence to an otherwise static presentation. More importantly, such displays are rich and intuitive in spatial communication.

Stereo Dynamic Perspective

Dynamic-perspective is particularly attractive for stereoscopic displays, including those employing active or passive stereoscopic goggles. The perceived image warping associated with fixed perspective, stereoscopic displays is eliminated with the addition of dynamic perspective. In fact, the counter-intuitive fixed perspective of non-tracking stereoscopic displays is a major source of user fatigue.

One way to think of a head tracking, stereoscopic display with dynamic perspective, is as a computer generated color hologram for one viewer. It provides most of the features of the idealized volumetric display:

- 3-D Look-Around Capability
- Fully Saturated Color Display
- Very High Resolution Images
- Real Time Image Generation

These features combine in a synergistic manner to create a display system that is very close to providing the viewer with *suspension-of-disbelief*. The ultimate goal of many researchers in the field of display development is to trick the viewer into forgetting he is looking at an artificially generated display. This state can be described as the user suspending his disbelief that he is viewing a computer generated, virtual world.

Head Mouse

Most of the pointing and selection functions commonly performed by mouse movement on modern workstations can be similarly performed by head movement. Head-controlled pointing systems are conveniently used after a brief period of training and familiarization. Head-controlled pointing offers a high degree of precision relative to touch screens, and it

allows graphical, random-access selection to be performed without removing the hands from the keyboard. However, head-controlled pointing is less convenient than mouse-based pointing for extensive operations of precision manipulation. As such, it is most attractive for use in mouse augmentation rather than for mouse replacement. The DynaSight is extremely sensitive to differential head movements in three dimensions, and provides a convenient and cost-effective implementation for head-controlled pointing.

In a typical implementation, a common cursor is shared between the mouse and the head. As a default, the mouse controls the cursor, but the head can be given control by pressing a thumb-activated keyboard "hot-key". When the hot-key is pressed, the coordinate system is initialized such that the current head position corresponds to the current cursor position. The cursor can then be positioned by means of two-dimensional head translation and/or rotation. The head maintains cursor control until the hot-key is released. Additional hot-keys can be defined to emulate mouse button presses. A slight extension of this concept is a workstation that switches between dynamic-perspective and head-activated pointing at the press of a keyboard hot-key.

An attractive feature of head-activated pointing is the capability for intuitive cursor positioning in *three* dimensions. Such positioning is particularly attractive in the context of a stereoscopic display system. Also, head-activated pointing is an especially useful interface for persons who lack motor control in their arms or hands due to physical disability.

Industrial Automation

There are several applications associated with an industrial environment. Inexpensive targets are attached to items on a conveyor belt to cue a pick and place system, or cue a system for diverting items onto different belt paths. During path programming of a robot a target is applied to a portion of the robot, such as the end effector, to allow an independent measure of the robot's actual path. It's even possible to close a control loop using the DynaSight as a position feedback transducer.

Independent robot carts can be tracked and managed using a DynaSight. For instance one problem with independent robot carts is conflict resolution. When several independent carts converge on an intersection a central controller utilizing several DynaSights can independently track the carts and thereby resolve the conflict. A tracking system of this type can also provide a redundant conflict avoidance system for more traditional cart control techniques.

General Tracking

The key aspect of the DynaSight sensor is it's ability to track a small, passive target. These targets can be applied to any object of interest with minimal interference and without the confines associated with batteries or wires. This capability allows many small, low mass items to be tracked that were previously tracked, if at all, utilizing complex, custom and expensive video systems.

Chapter 5, Problem Solving

The DynaSight sensor is a permanently aligned and factory calibrated optical radar. The sensor requires no user alignment or calibration for proper operation. The sensor contains a microprocessor which performs a Built-In-Test (BIT) immediately after the application of power. This test checks the major on-board subsystems and reports any test failures with coded flashing of the status LED, see Appendix B for a description of these “flash codes”. After reporting any BIT failures the DynaSight will attempt normal tracking operations. It is possible for the sensor to operate normally because the failed subsystem may not be used in the selected operating mode. For instance, if the user mode EEPROM failed the DynaSight would load the default factory operating parameters and begin tracking operations.

In the questions and answers that follow several issues associated with operation of the DynaSight are discussed.

Frequently Asked Questions:

Q: Why does the status light indicate the DynaSight is tracking when there is no target in the sensor’s Field-Of-View (FOV)?

A: There are several possibilities:

1. There really is a target in the sensor’s FOV, maybe one inadvertently stuck to something in your work area.
2. There is a mirror (or window) in the sensor's FOV oriented approximately parallel to the DynaSight’s front panel. The transmitted light is being reflected directly back into one of the receivers.
3. There is some reflective and concave item in the sensor’s FOV.
4. There is a *very* bright infrared source within the sensor’s FOV. This is unlikely because the sensor can reject all but the most intense infrared sources.
5. There is an object *very* close to, and in the field-of-view of, the DynaSight’s transceivers. This object is reflecting transmitted light back into the receiver at a very high level and causing interference. This reflected light will not harm the sensor; however, it may impair it’s proper operation. Often this problem is associated with misplacement of the sensor on the user’s CRT monitor. Typically the misplaced sensor is positioned so that the top ledge of the monitor’s case is in the sensor’s field-of-view. These near field reflections then cause self induced interference. To correct this problem, position the DynaSight so that it’s front panel is approximately even with the monitor’s front edge.

Q: Why does the status light sometimes change from red to green and back to red when an un-targeted object transits the sensor's FOV?

A: By passing through the sensor's FOV the object has masked and unmasked an infrared source and the DynaSight momentarily investigated to see if the source was clutter or a valid target. The sensor is constantly searching for valid targets whenever it isn't tracking. It sometimes will momentarily transition into track mode on a piece of clutter until it has had more time to investigate the validity of the source.

Q: Why do active stereoscopic glasses (e.g. StereoGraphics CrystalEyes or Tektronix StereoTek) sometimes lose sync when they are close to the DynaSight?

A: There are two possible explanations:

1. The DynaSight's transmitter is not synchronized with the glasses' infrared transmitter. While in the stereo viewing mode, the DynaSight should be synchronized to the glasses transmitter by connecting a "stereo drive" signal to the DynaSight's external sync input; see Appendix E.
2. The DynaSight's radiated power is higher than your glasses can handle and is driving the receiver into saturation. This problem can be easily solved by placing a neutral density filter over the glasses receiver. This will reduce the total power that the glasses' detector receives and keep it out of saturation. This neutral density filter can be as simple as a piece of paper or even a post-it note. This problem only occurs at short ranges.

Q: While the DynaSight is in one of the stereo synchronization modes and is connected to a circuit that generates the appropriate stereo drive signal (see Appendix E) it sometimes doesn't track, why is this happening?

A: Usually the DynaSight is doing exactly what it is being told and that is to turn off its transmitter when the stereo drive signal is held low. The reason the transmitter is disabled is because some stereo glasses transmitters use a constant logic low to instruct them to stop transmitting. The glasses use the loss of signal to indicate that they should make both lenses transparent (operate in monoscopic mode). Finally, the DynaSight's infrared transmitter is disabled so that the stereo glasses receiver does not confuse DynaSight transmissions as a stereo glasses transmitter signal and attempt to synchronize to them. This attempted synchronization could cause the stereo glasses to "blink" randomly. Disconnecting the stereo drive signal from the DynaSight "SYNC" input will enable the transmitter and the sensor will operate normally.

- Q: Why do I need to input a stereo drive signal to the DynaSight “SYNC” connector?
- A: When using infrared controlled active stereoscopic glasses, the stereo drive signal is usually required to allow the DynaSight to interleave infrared transmissions with the stereo glasses transmitter and prevent interference. This interference is usually indicated by the stereo glasses “blinking” randomly or intermittently losing synchronization.
- Q: What does it mean when the status LED flashes immediately after the application of power?
- A: It means that the sensor’s Built-In-Test (BIT) has detected a problem. Appendix B describes the LED flash codes associated with a specific test failure. You should record the code and call Origin Instruments with the information. After reporting the BIT failure the sensor, if possible, will attempt to begin tracking.
- Q: Do the targets wear out?
- A: Yes, with repeated handling (rubbing, deposition of debris, and application and removal) the efficiency of the targets will degrade. Replacement targets are available at a nominal charge from Origin Instruments.
- Q: What happens when the DynaSight is tracking and then quits tracking because it loses sight of the target.?
- A: The DynaSight continues looking, for a brief period, in the immediate vicinity of the last known target position and if it doesn’t recapture, it begins searching over it’s entire FOV.
- Q: What happens when two valid targets are in the FOV at the same time?
- A: The DynaSight begins searching over it’s FOV and captures the target with the best return. The best return is usually from the target closest to the sensor. If the DynaSight is tracking a target and another valid target enters the FOV the DynaSight will ignore the second one. If the DynaSight loses track of the first target, for any reason, it will begin searching over it’s entire FOV and capture the target with the best return. If the second target is brought very close (within two to three target diameters) to the first target the tracking performance will be unpredictable. If the targets are brought very close together and then separated the DynaSight will capture and track the one with the best return.
- Q: What happens when two DynaSights are tracking (irradiating) the same target; is there interference?

A: No, each sensor will reject radiation from the other as if it were any other infrared clutter source. There is a discussion about using multiple sensors in Chapter 2.

Q: How long does it take the sensor to find a valid target?

A: Nominally the sensor can search it's FOV and begin tracking within a third of a second.

Q: Should I turn off the DynaSight when it isn't in use?

A: Yes, even though the system is designed for a long life, the transmitter's maximum radiated power will slowly degrade with use. The amount of degradation is very small, the transmitter will typically provide 80% of its initial power after 20,000 hours of use.

Chapter 6, Maintenance

Cleaning the Optics

Warning: The optical assembly is a factory aligned and calibrated unit. Field disassembly of the optical front end is *not* possible and if attempted will void the warranty.

Caution: The DynaSight apertures are covered with a plastic window and as such are subject to damage. Use extreme care while attempting to clean the windows.

To remove dust use a common lens brush or blower available from your local photographic supply store. Be sure to remove all grit before wiping the window with lens paper. Use clean, soft lens paper moistened with mild soap and water or reagent alcohol and gently rub in a circular motion until the debris is removed. One should use the least amount of force required to remove the debris. Do not soak the sensor, use only enough liquid to lightly moisten the windows. If the debris is firmly attached or if damage to the window has occurred, return the sensor to Origin Instruments for prompt repair.

User Serviceable Parts

There are no user serviceable parts within the DynaSight sensor. All service is performed by Origin Instruments or an authorized agent of Origin Instruments. *Service attempted by unauthorized personnel will void the warranty.*

Appendices

Appendix A. DynaSight Sensor Specifications

Size:	18.6 x 14.5 x 3.9 cm (7.3 x 5.7 x 1.5 in)
Operating Wave Band:	Near Infrared
Field of Regard:	75° Azimuth x 75° Elevation
Measurement Update Rate:	64 Hz Maximum
Measurement Latency	16 to 31 milliseconds (Operating mode dependent)
Lock-on Delay:	0.3 Second Typical
Operating Range:	0.1 to 1.5 meters for 7 mm Target 0.3 to 4 meters for 25 mm Target 1 to 6 meters for 75 mm Target
Measurement Resolution:	0.1 mm Cross Range Typical* 0.4 mm Down Range Typical*
Absolute Accuracy:	2 mm Cross Range Typical* 8 mm Down Range Typical*
Power Requirements:	9 watts, 14 to 16 VAC or 16.5 VDC
Signal Interface:	Dual RS-232C With DB-9 Connectors
Default Data Format:	8 Bytes per Measurement Update X, Y, Z in 16-bit Two's Complement Format (0.05 mm per Least Significant Bit)
External Synchronization Range:	TTL Levels, 45 to 70 Hz., 50 ± 3% Duty Cycle.

*Measurement parameters are RMS values and are quoted for 7mm target at 80cm range under normal florescent room lights. Values will vary with operating range and target diameter, and to some extent with ambient illumination and target position in the field of regard. Measurement resolutions of 0.05mm in three axes are achieved at 40cm range, and resolution is significantly reduced at range extremes.

Appendix B. LED Error Flash Codes

After applying power to the DynaSight the onboard processor initiates a Built In Test (BIT). Problems detected by this test are communicated to the user via the front panel status LED.

If a problem is detected by the BIT the status LED will flash the appropriate code and then the DynaSight will attempt to begin operating in the selected mode. If no problems are found by the BIT, the DynaSight will immediately begin searching for a target to track. Some failures may not affect subsystems associated with the selected operating mode, allowing the sensor to function properly. Some failures may affect customized configuration information associated with a user mode, in which case the DynaSight will load default configuration values. There are several subsystems that are exercised during this BIT, the LED flash code associated with each subsystem is described in Table 7.

Table 7. Built in self test flash codes.

Code	Detected Problem
4 Green Flashes	Checksum error in user mode configuration tables
TBD	EPROM Checksum Failure
TBD	Memory Failure
TBD	Loop back test failure on serial port A
TBD	Loop back test failure on serial port B

Appendix C. Software Protocol for DynaSight Commands

The DynaSight can respond to commands sent to it from the host. The set of presently defined commands fall under two categories: operating mode control and sensor house keeping. As discussed in Chapter 3 the DynaSight has twelve operating modes. Four of the modes are accessible from the four position mode switch on the rear of the DynaSight. The remaining modes are only accessible using the RS-232 serial port. The DynaSight can be configured for custom applications and these custom modes can be assigned to two states of the external mode switches. These two custom modes are also accessible by sending the appropriate command character over the serial port. For more information about generating a custom user mode, contact Origin Instruments.

A control command consists of an attention signal followed by a command character. The attention signal can be either of the following:

- BREAK
- CTL-C

The command character is an ASCII encoded byte with the functions listed in Table 8.

Table 8. Command characters for host control of the DynaSight using the RS-232 port.

Command Character (ASCII Format)	Function Description
0*	Change to "Retro"
1*	Change to "MsoftFltr2D"
2*	Change to "StereoSync"
3	Change to "MsoftMouse2D"
4	Change to "RetroPolled"
5	Change to "MoSysFltr2D"
6	Change to "Laser"
7	Change to "MoSysMouse2D"
8	Change to "RetroHD"
9	Change to "SSyncHD38kb"
A	Restart tracking operations with current configuration
Q	Query for current operating mode and sensor information (reports in human readable form, see Figure 10.)
r	Warm boot, cold boot without power-up Built-In-Tests (BIT)
R	Cold boot, same as power-up
U	Change to custom "User-1" mode, if implemented. Factory default loads "StereoSync" mode.
V	Change to custom "User-2" mode, if implemented. Factory default loads "StereoSync60" mode.

(* - Can be selected with the mode switch)

```
DynaSight (TM) Optical Radar      Copyright 1992, Origin Instruments Corp.  
Model: OIC-100 Rev. A             Firmware Release: 1.0  
Serial Number: DYSTX00001         Calibration Date: 8 Sept 1992  
  
Current Operating Configuration:   Retro  
  
*** Press any key to return to sensor operations ***
```

Figure 10. Typical human readable report returned by a DynaSight after the 'Q' (query) command.

Example Host to DynaSight Command:

A properly formatted command to cold boot the DynaSight is to send a BREAK character followed by an ASCII upper case 'R' as follows:

```
BREAK 'R'
```

An alternative message with the same result is to replace the BREAK character with a CTL-C character:

```
CTL-C 'R'
```


Appendix D. 3-D Data Format for the DynaSight Serial Interface

The DynaSight sensor employs an efficient binary-encoded format for real-time reporting of three-dimensional measurements. This default format is referred to as the NATIVE0 format in the delivered documentation and software utilities. The NATIVE0 format is guaranteed to be selected at sensor power-up, if all of the user configuration switches are up (open). The configuration switches are located at the lower left of the sensor's rear panel. With all switches up, three-dimensional measurements are reported in a Cartesian coordinate system with an origin at the fiducial mark on the front center of the sensor.

The default communication parameters for 3-D measurements are asynchronous serial EIA RS232 with the following settings:

Parameter	Setting
Data Bits	8
Stop Bits	1
Parity	None
Baud Rate	19,200

The period between updates is dependent upon the sensing and reporting modes selected. However, a typical rate is thirty updates per second. Eight bytes are transferred per measurement update, and high order bytes are transferred first:

	Byte 0 High Order Byte	Byte 1 Low Order Byte
Word 0	1000TTEE	1000LRSS
Word 1	XXXXXXXX	XXXXXXXX
Word 2	YYYYYYYY	YYYYYYYY
Word 3	ZZZZZZZZ	ZZZZZZZZ

Word 0 contains synchronization fields, a two-bit message type field, a two-bit binary exponent for data scaling, a single-bit field related to the SYNC input/output connector, a single-bit reserved field, and a two-bit sensor status field. If the receiving system loses synchronization with the data stream, it can always identify Word 0 by looking for the bit pattern "1000" in the high order bits of successive bytes. This pattern can occur in the low-order byte of X, Y, or Z values, but it is guaranteed not to occur in the high-order byte of those values. Thus, the synchronization word can always be identified as the last two bytes in a run of two or three bytes that have the bit pattern "1000" in the high order nibble (4 bits).

Bits 2 and 3 of Byte 0, Word 0 are a message type field ("TT"). Currently only one message type is defined (the NATIVE0 message type) and these bits are transferred as all zero. For compatibility with future firmware releases, current device drivers should check these bits to ensure that they are zero and, if not, the data contained in the packet should be ignored.

Bits 1 and 0 of Byte 0, Word 0 are a base-2 exponent field ("EE"). The 16-bit X, Y, and Z values should be left-shifted by the count contained in this exponent for proper scaling. This approach provides a wide dynamic range without sacrificing the very high measurement resolution that is available at short sensor-to-target ranges. The X, Y, and Z values should be sign extended to 32-bits before the shift to prevent overflow.

A Sync Input/Output field is defined for Bit 3 of Byte 1, Word 0:

SYNC I/O Field "L"	Message Meaning
0	The SYNC input/output line is high or undriven (50 msec debounce delay). In StereoSync modes: Internal synchronization.
1	The SYNC input/output line is driven low (50 msec debounce delay). In StereoSync modes: External synchronization.

The "R" field in Bit 2 of Byte 1, Word 0, is reserved. It is transferred as 0 by current DynaSight firmware.

A Sensor Status field is defined for Bits 1 and 0 of Byte 1, Word 0:

Status Field "SS"	Message Meaning
00	SEARCH: Target not in track, Search in progress
01	COAST: Target lost, Attempting to reacquire
10	CAUTION: Track in progress, Conditions are marginal, Eminent loss-of-track possible
11	TRACK: Track in progress, Signal-to-noise satisfactory

If the sensor status field is TRACK ("11") or CAUTION ("10"), then the X, Y, and Z values correspond to current, updated measurements. If the sensor status field is COAST ("01") or SEARCH ("00"), then the X, Y, and Z values and the "EE" exponent are unchanged from the most recent TRACK or CAUTION packet.

Measurements are reported in a Cartesian coordinate system with X, Y, and Z formatted as 16-bit integer twos-complement values, each encoded as two successive bytes. The X, Y, and Z values are nominally scaled at 0.05mm per least significant bit when the "EE" exponent field is zero. The default coordinate system is right-handed and is defined such that, for a user facing the sensor, rightward head movement is in the direction of positive X, upward head movement is in the direction of positive Y, and movement away from the sensor is in the direction of positive Z.

Appendix E. Stereo Drive Signal Format

For synchronizing stereo displays and stereo glasses StereoGraphics Corporation has defined a signaling format. A stereo ready display system should provide a Stereo Drive Signal with the following characteristics:

1. TTL/CMOS logic compatible levels and fan-out.
2. While the display is in stereoscopic mode, the signal should be zero (0) volts during right eye fields, and five (5) volts during left eye fields, see Figure 11. below. This signal should be approximately 60 Hz., so that each eye sees a flicker-free image. Duty cycle of the wave form should be: $50 \pm 3\%$. The vertical synchronization input to the monitor is two times the Stereo Drive Signal (approximately 120 Hz.), so that the left and right eye images are superimposed.
3. While the display is in monoscopic mode, the signal should be at zero (0) volts. This may be used by the stereo viewing hardware to stop separating images, and allow both eyes to always view the monitor. While the monitor is in the monoscopic display mode it's vertical synchronization input should be approximately 60 Hz. Usually during this state the stereo glasses infrared transmitter is inactive, signaling the glasses to switch both lenses to their transparent state.

Please note that the DynaSight infrared transmitter is disabled when the stereo drive signal is in state three above (indicating monoscopic display mode). The reason is that if the stereo glasses infrared transmitter is inactive the DynaSight transmitter will typically confuse the infrared receiver in the active stereo glasses. The glasses will attempt to synchronize to the DynaSight transmitter and this may cause the glasses to "blink" randomly. This signal is also used by the DynaSight to control interleaving DynaSight transmissions with those of the stereo glasses and eliminate interference.

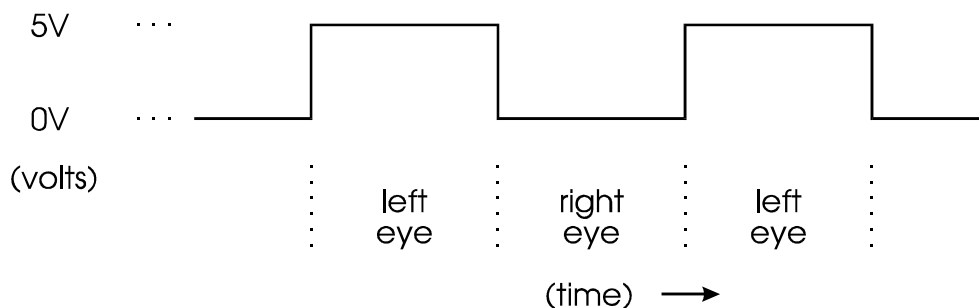


Figure 11. Stereo Drive Signal format.

Appendix F. Microsoft Mouse Data Packet Format

The Microsoft mouse is a relative two dimensional (2-D) measurement device. The Microsoft mouse measures movement since the last report and transmits this information to the host computer.

To decode the mouse data packets the host must have a mouse driver installed. The Microsoft mouse driver checks to see if the host has a mouse attached before loading. This check is made by driving the RTS pin from inactive to active and waiting for the proper mouse response code. If a Microsoft mouse (or proper Microsoft mouse emulator) is present it will send the three byte data packet shown in Table 9. The Microsoft mouse only uses seven data bits and if the eighth bit in each byte is masked off the code is the ASCII character code for "M" followed by two NULL characters.

Table 9. Proper response code to indicate a Microsoft compatible mouse is attached to the port. Microsoft mouse only uses seven data bits and always sets the eighth bit in each byte high.

Name	Value (hex)
Byte1	0xCD
Byte2	0x80
Byte3	0x80

The mouse does not report any information until it measures an event such as mouse movement or a button state change. The position information and button state are collectively combined into a mouse data packet. Each report consists of a complete data packet. Table 10 describes the Microsoft mouse data packet format.

Table 10. Microsoft Mouse Data Packet Format.

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte1	1	L	R	Y7	Y6	X7	X6
Byte2	0	X5	X4	X3	X2	X1	X0
Byte3	0	Y5	Y4	Y3	Y2	Y1	Y0

L = Left Button, "1" = pressed

R = Right Button, "1" = pressed

X7 .. X0 = X movement since last report expressed as an 8-bit 2's complement value (-128 to +127); positive east.

Y7 .. Y0 = Y movement since last report expressed as an 8-bit 2's complement value (-128 to +127); positive south.

Polarity of the reported mouse movements is easily described by using a map metaphor. Assume the mouse is moving over a surface covered with a map which is in the north up

and east to the right orientation. The mouse is oriented with its “tail” stretching off the north edge of the map. Polarity of the reported measurements are then as described in Table 11.

Table 11. Using a map metaphor (north up and east to the right) to describe mouse movement and the associated polarities in the mouse data packet.

Polarity	Direction
Positive X	East
Negative X	West
Positive Y	South
Negative Y	North

The Microsoft mouse transmits the mouse packets using either the EIA RS-232 or the PS-2 communication format. The DynaSight uses the EIA RS-232 communication format; with the specific characteristics described in Table 12.

Table 12. EIA RS-232 communication port parameters for the Microsoft mouse.

Parameter	Setting
Data Bits	7
Stop Bits	1
Parity	None
Baud Rate	1200

Appendix G. Mouse System Mouse Data Packet Format

The Mouse System mouse is a relative two dimensional (2-D) measurement device. The Mouse System mouse measures movement since the last report and transmits this information to the host computer. The mouse does not report any information until it measures an event such as mouse movement or a button state change. The position information and button state are collectively combined into a mouse data packet. Each report consists of a complete data packet. Table 13 describes the Mouse System mouse data packet format.

Table 13. Mouse System Mouse Data Packet Format as used by the DynaSight sensor.

Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte1	1	0	0	0	0	L	M	R
Byte2	X7	X6	X5	X4	X3	X2	X1	X0
Byte3	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0
Byte4*	0	0	0	0	0	0	0	0
Byte5*	0	0	0	0	0	0	0	0

* - Mouse systems mouse sends incremental X and Y values in bytes 4 and 5 respectively. The DynaSight sets these bytes to zero.

L = Left Button, "0" = pressed

M = Middle Button, "0" = pressed

R = Right Button, "0" = pressed

X7 .. X0 = X movement since last report expressed as an 8-bit 2's complement value (-128 to +127); positive east.

Y7 .. Y0 = Y movement since last report expressed as an 8-bit 2's complement value (-128 to +127); positive south.

Polarity of the reported mouse movements is easily described by using a map metaphor. Assume the mouse is moving over a surface covered with a map which is in the north up and east to the right orientation. The mouse is oriented with it's "tail" stretching off the north edge of the map. Polarity of the reported measurements are then as described in Table 14.

Table 14. Using a map metaphor (north up and east to the right) to describe mouse movement and the associated polarities in the mouse data packet.

Polarity	Direction
Positive X	East
Negative X	West
Positive Y	South
Negative Y	North

Mouse data packets are transmitted to the host from the DynaSight using the EIA RS-232 communication format. The specific port characteristics are described in Table 15.

Table 15. EIA RS-232 communication port parameters for the Mouse System mouse.

Parameter	Setting
Data Bits	8
Stop Bits	1
Parity	None
Baud Rate	1200

Appendix H. Mouse Data Format Extensions

The DynaSight has four operational modes where it emulates the Microsoft or Mouse System mouse. In two modes the DynaSight operates as a filter to the desktop mouse. The desktop mouse is connected to the secondary port and the host is connected to the primary port. The DynaSight passes unchanged desktop mouse data packets until instructed to operate as a head mouse. In the filter modes the DynaSight can be told to take over the pointer in two ways: via a host command or via the DynaSight's external sync line. In the non-filter operating modes the DynaSight always has control of the mouse pointer. A description of the mouse emulation modes is contained in Chapter 3.

The standard Microsoft mouse is primarily a one way communication format and the Mouse Systems mouse is a one way communication format. In order to use the DynaSight as a head mouse in combination with a desktop mouse and use the standard mouse drivers, data transmission from the host to the DynaSight is necessary. To provide for this additional capability the mouse data formats have been extended. The extensions allow the host to send mouse button events and house keeping information to the DynaSight. An alternative method of handling mouse button events is to write custom mouse drivers and handle these issues on the host. This would be the cleanest solution except for compatibility issues with future versions of the mouse drivers and the problems associated with loading and unloading different drivers during the course of a computing session.

Mouse button events can be emulated using "hot-keys" on the host's standard keyboard. Typical hot-keys for right handed people are the "j" and "k" keys for left and right mouse buttons respectively. For left handed people the typical "hot-keys" are the "d" and "f" keys. The host transmits "hot-key" events to the DynaSight using the data format extensions and they are inserted into the emulated mouse data packets.

While operating in one of the filter modes, the host can be alerted that an event, at the DynaSight, has occurred by sending a signal to the host. The signal must be sent around the standard mouse driver for reasons of compatibility. The communication method chosen is by driving the RTS line. The RTS line was chosen because it is not used by the Microsoft and Mouse System mouse drivers. The event that is represented by the RTS line is the state of the DynaSight's external synchronization line. This signal can be used as an indicator for the host to command the DynaSight to stop passing desktop mouse packets and begin generating head mouse packets.

For all operating modes the DynaSight gain can be adjusted by sending a single byte message with a value from 0 to 15 (0 to F hex). This value is relative in nature because the X and Y head movement that corresponds to a specific X and Y cursor movement is dependent on range to the head. Since most people vary their head to screen working distance over the course of a computing session, an absolute value has little meaning. In addition, the non-linear (ballistic) gain in most mouse drivers tends to reduce the necessity of setting the exact gain.

A description of the mouse data format extensions is contained in Table 16.

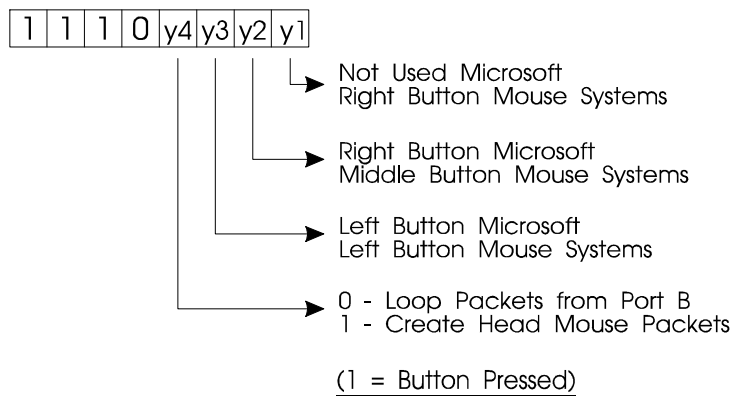
Table 16. Summary of the mouse data format extensions.
Where "Y" is a bit mapped, 4-bit control field described below.

Value (hex)	Byte Description
0x0Y	TBD
0x1Y	TBD
0x2Y	TBD
0x3Y	TBD
0x4Y	TBD
0x5Y	TBD
0x6Y	TBD
0x7Y	TBD
0x8Y	TBD
0x9Y	TBD
0xA Y	TBD
0xB Y	TBD
0xC Y	Mouse Gain Command
0xD Y	TBD
0xE Y	Mouse Button Event Communication
0xF Y	TBD

In the Mouse Filter Mode:

1. RTS line on Port A is pulled active when DynaSight Sync input is Low.
2. Button Events are communicated by sending a byte:

0xEY, where Y is a bit mapped 4-bit field:



In Head Mouse and Mouse Filter Mode:

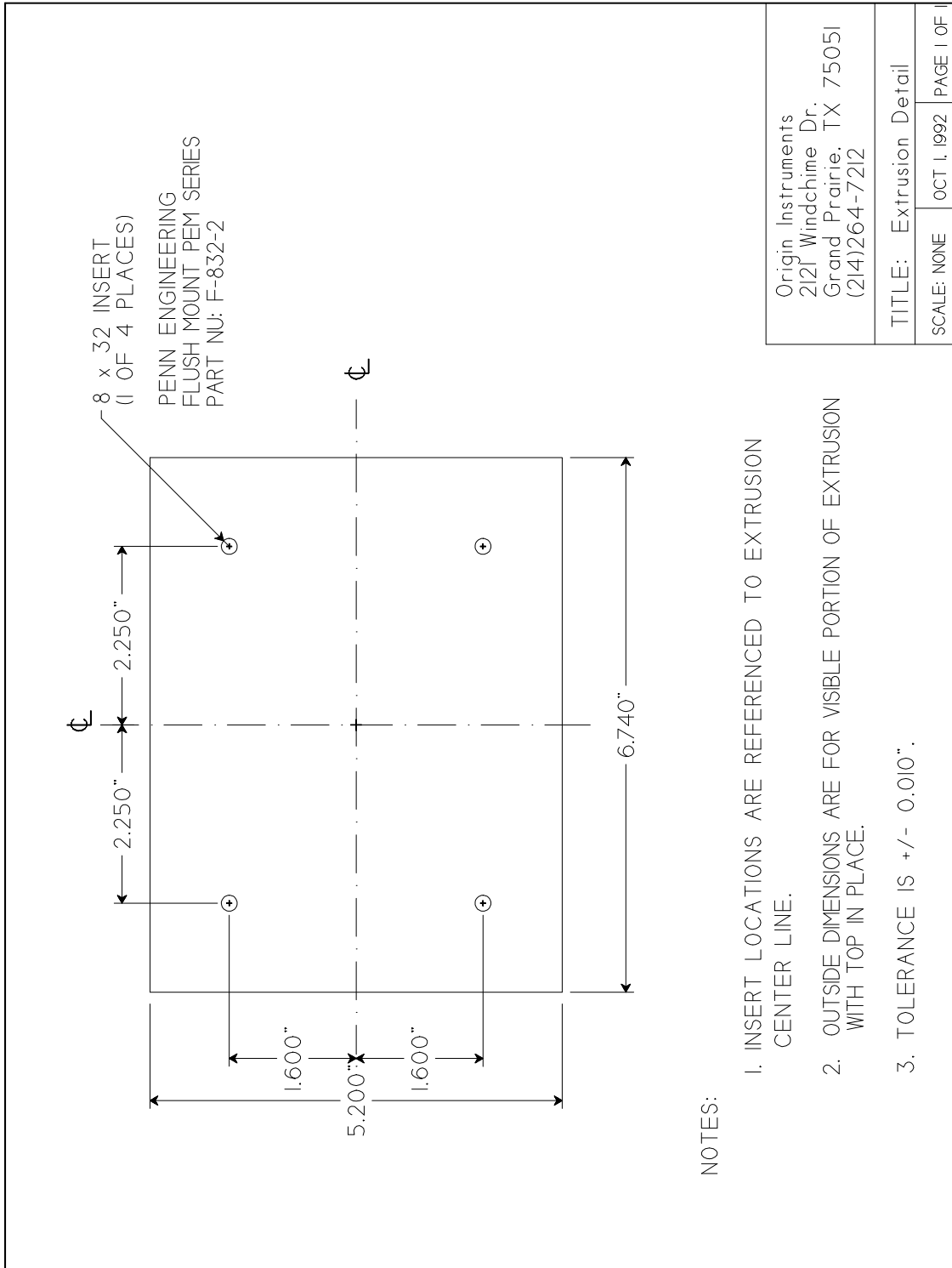
1. Gain is controlled by sending a byte:

0xCY, where $0 \leq Y \leq F$

0 = Lowest Gain

F = Highest Gain

Appendix I. Optional Mounting Plate Details



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