ELECTRO-OPTICAL IMAGING, INC.

SERIES 7000
AUTOMATIC VIDEO TRACKER
USER MANUAL

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Date: 8 July 2015

Revision: B

 P/N 336069

Revision Log

Revision	Description	Pages	Date
-	First Draft (preliminary)	All	25-Nov-09
-	First Release	All	23-Feb-10
A	Updates to all sections and appendices	All	10-Mar-14
B	Updates to appendices	All	8-Jul-15

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1 Introduction to Video Tracking

1.1 General

The Series 7000 Video Trackers process information from a video source to derive azimuth and elevation coordinates for a target of interest. The coordinates are referenced to the field-of-view center or from a user-defined offset point within the field-of-view. Control is provided via RS-232/422 serial, VMEbus, PCI, PCI Express and gigabit Ethernet communication buses. Target coordinate and track quality status information is derived by the tracker and output in both digital and analog formats for flexible system integration. The tracker will operate with RS-170, RS-170A, NTSC and PAL analog video sources and Camera Link, HD-SDI or DVI-D digital video sources based on tracker model. The source may be a standard visible television camera (CCTV), Forward Looking Infrared (FLIR) camera, videotape, DVD or compatible video playback device.

1.2 Video Tracker Theory

Analog video camera systems scan an image of a scene. The scene is transformed into a pattern of voltages defined relative to the time domain. The storing of the scene becomes a matter of marking time (called syncs) vertical for the field time and horizontal for the line time.

The scanning process (and reproduction and analysis) proceeds through the scene called the field-of-view (FOV). The process begins in the upper left portion and proceeds in a left-to-right motion on a per line basis, each line being marked by a horizontal sync pattern. The process continues through the scene line to line, down through the scene until the last line is processed. One scan of the scene is defined to be a video field, which is typically 16.6 milliseconds in length (for 60 Hz video).

In a conventional 525-line TV system (RS-170), approximately $25x10^4$ picture elements (pixels) are processed in the construction of a TV picture (485 active lines by 522 horizontal elements). The total process requires two scans of the scene to construct the complete image. Each scan is one TV field. In one scan, the sensor records or displays the even numbered lines, and in the next scan all the odd numbered lines are scanned. This process is known as interlacing and is utilized to reduce “flicker” of the image. The two TV fields making one picture are called a video frame. Because the two scans were made at a different time, the two fields represent unique pictures, unless the image remained totally unchanged during the scanning process of the two fields. This assumption can only be made if a shuttered TV camera technique is utilized or the image actually did remain constant. The latter assumption can only be made if the video source is providing a fixed image, such as from a photographic film device or a high resolution CCD sensor memory.

The Series 7000 Trackers process each video field independently, since each field represents a discrete and unique image. Target status and location are derived from each field and are provided at a 50/60 Hz rate (TV field rates). Horizontal and vertical scanning processes are controlled by the synchronization signals contained within the input video. An internal clock controls the horizontal sampling rate. By utilizing the input sync signals and the internal horizontal pixel clock, the X and Y coordinates of a selected target of interest can be determined. The X and Y coordinates of the point of interest (target) are translated from the time domain of the coordinate system from which they were derived into the coordinate system required for the devices utilizing the tracker information.

The target information contained within the window is defined by the relationship between the relative input video (gray) levels and the user-controlled threshold levels and mode. The information selected by the threshold process is called “enhanced data” and represents that data which will be utilized by the target position determination process. The actual point of interest, the track point, is derived from the enhanced data based on the track mode the user has selected. The track errors output by the tracker represent the location of the track point. The track point coordinates are translated to be relative to the current boresight position prior to output.

1.3 Video Tracker Applications

Due to the versatility provided by the nature of high-speed video processing components and microprocessor controller, the Series 7000 Trackers may be readily integrated into a variety of video mensuration and tracking applications. Analog outputs are provided for legacy closed loop servo system control applications. Equivalent digital outputs provide the facility for ease of integration of the tracker as a digital mensuration device for a computer system application.

New technology and techniques of video systems have voided many of the advantages formerly held by photographic techniques. Higher resolution video standards (line rates), shuttered video and CCD sensors have advanced video processing into a higher resolution environment, formerly an exclusive arena of cinetheodolite base tracking/mensuration systems.

The advantages of applying video tracking techniques to tracking range environments include track error computation for real-time target information assessments. In a localized, closed loop tracker/servo system, the computed analog track error signals may be routed to the servo system to command a change in the mount position to keep the desired target within the field-of-view of the optical system.

The Series 7000 Trackers have also been utilized in precision mensuration systems. When integrated with video playback or film viewing systems, the Series 7000 Trackers have provided track error and target position information with precision, surpassing operator-oriented film reduction systems. The automatic tracking capability provides a vast increase in the throughput of the film or video data reduction processing. The digital interface and remote control capabilities of the microprocessor-based tracker make it an ideal device with which to integrate into digital image processing applications.

1.4 Tracker Features

The Series 7000 Trackers provide the user with a variety of track point determination algorithms. The three primary modes are as follows:

- Centroid (mass or intensity)
- Edge (left, right, top, bottom and vector)
- Correlation

The input video is decoded based on user defined and controlled threshold processing. The levels are automatically adjusted to account for intensity level changes in the scene. The threshold levels, white, black and gray band, provide the user with many different threshold selections with which to identify the information to be utilized as the target. Manual and automatic settings are available for these levels.

A track window defines the area of the FOV to be searched. Both the window size and position are adjustable by manual or automatic means. The window is used to eliminate unwanted background areas that might affect the target tracking process.

Graphical display elements are mixed with the video scene to provide operational feedback information to the user. The operator may monitor the target status and tracker state directly from the video monitor without front panel or console interaction.

1.5 Series 7000 System Configuration

Figure 1.5.1 shows a fully configured video tracking system using a Series 7000 Video Tracker and customer-supplied peripherals.

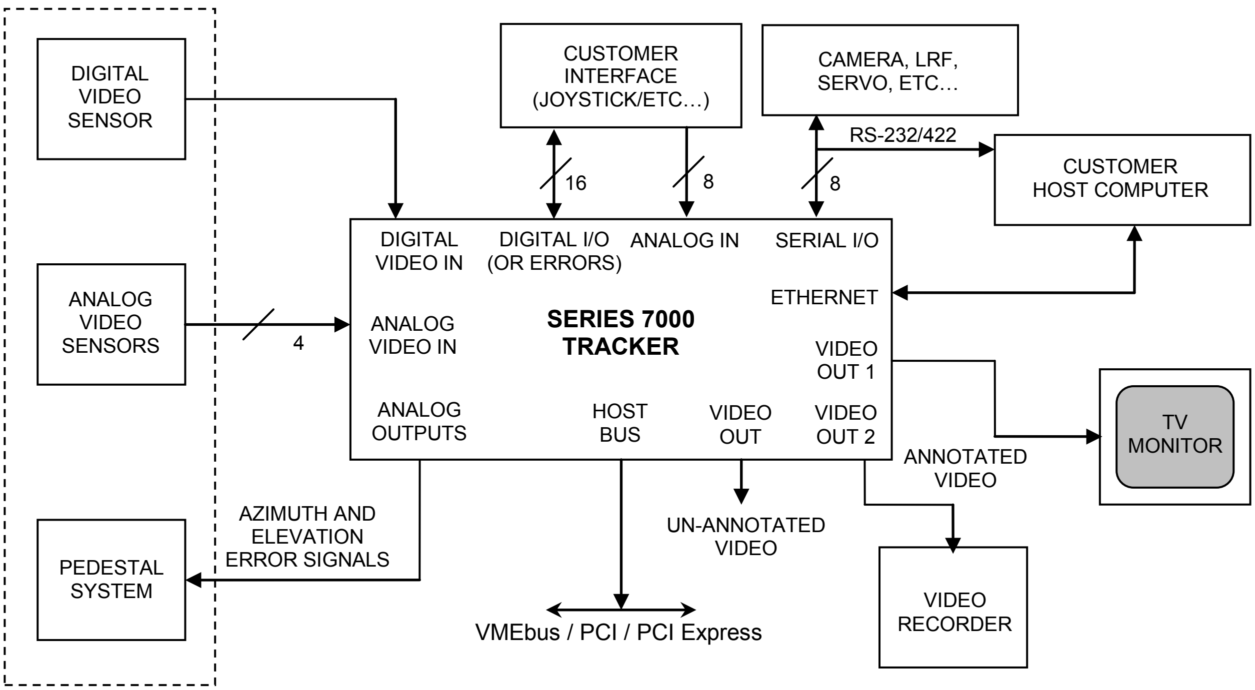


Figure 1.5.1. Standard Series 7000 System Configuration

1.6 Series 7000 Video Tracker

The tracker derives target information from input video. Based on this information, the tracker generates azimuth and elevation error signals for use by a camera positioning servo system. The servo system then positions the video camera to retain tracking of the target.

1.7 Tracker Quick Start

This Quick Start gives a high level description of the basic steps that are required to operate a Series 7000 Tracker.

1.7.1 Quick Start – System Setup

The tracker is shipped with a high density DB-15 pigtail cable with BNC connectors for analog video I/O and a pair of high density VHDCI break-out cables, which provide connectivity for all other I/O (RS-232/422, digital I/O, analog I/O, etc). Figure 1.7.1 depicts a minimal tracker configuration with one video input.

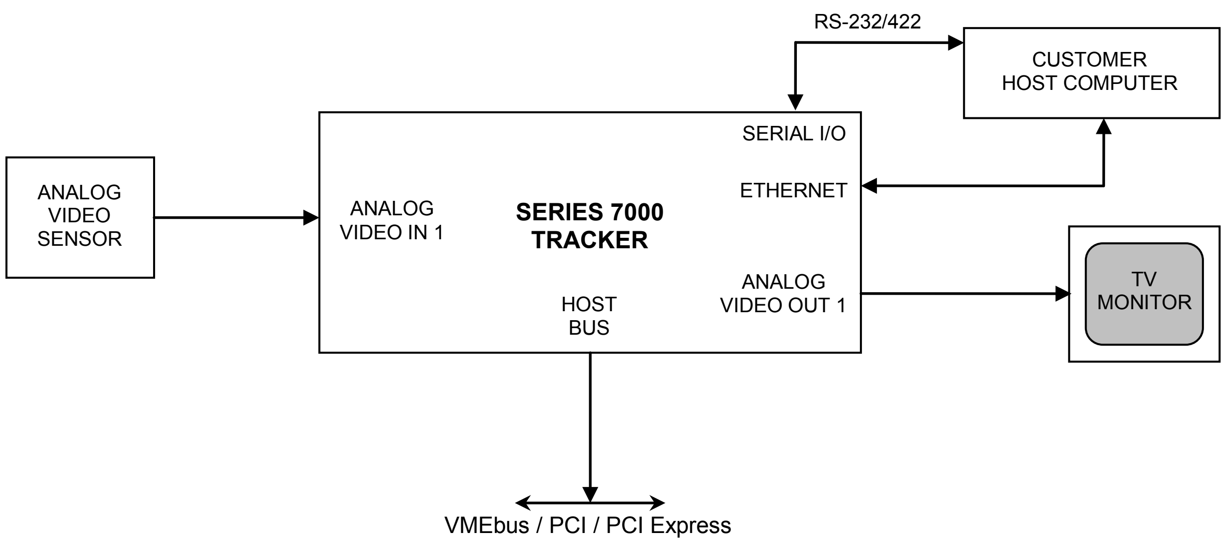


Figure 1.7.1. Basic Tracker Configuration

Tracker commands may be sent over the UART0 serial interface (RS-232/RS-422, 115200, Odd, 8,1), the host computer bus (VMEbus/PCI/PCI Express) or gigabit Ethernet. The tracker sends status over all connected interfaces.

1.7.2 Quick Start – Apply and OK Buttons

The Graphical User Interface (GUI) control program provided with the Series 7000 Tracker sends the same messages to the tracker as those described in the interface control section of this manual (Appendix B). When using the GUI program to control the tracker, many of the control panels have an “Apply” button as well as an “OK” button. Pressing “Apply” transmits the message and the system remains in the current screen. Pressing “OK” transmits the message and the system returns to the previous screen.

1.7.3 Quick Start – Configuration

Install the tracker in your chassis and install the Tracker GUI on the host computer. Start the Tracker GUI and from the main menu select “Setup” then “Communication...” to select the communication path. The default is "Use Serial Port" and may be changed to either VMEbus or PCI bus, as appropriate. Note that you will have to set up the VMEbus address before you can communicate with the tracker over this interface. Also, you will need to first setup the IP address of the tracker using another interface before communicating over the Ethernet interface.

You will see two green dots illuminated in the "Comm Activity" pane of the main GUI screen once communication has been established.

1.7.4 Quick Start – Target Acquisition

Target acquisition modes must be considered. Will the operator trigger the transition to track when the target is within the track gate? Is it necessary for the tracker to automatically detect and track the target? The answers to these questions determine whether or not the various automatic functions are enabled.

If the auto functions are not enabled, when the track gate is positioned over a target (a target has been identified if pixels are enhanced if enhancement is enabled or the track flag is displayed if the track flag is enabled), the tracker will acquire data about the target. When track error output is desired, the operator should click on the Track button on the Run-Time control panel. Appendix C, sections C1 through C2 describe the Run-Time features.

If Auto Track is enabled, when a target is identified the tracker automatically transitions into track mode. This provides a more instantaneous track but less operator control. The desirability of this feature must be determined by the situation.

If Multi-Target is enabled, the operator can pre-configure a set of parameters that will be used during Acquisition mode. A more extensive description of the Multi-Target function is provided with the GUI control descriptions contained in Appendix C, starting at Section C3.3.

1.7.5 Quick Start – Loss of Target

During track, when a target is lost due to being obscured or low image intensity levels, the tracker's response will be determined by the settings that were made prior to the loss. If Coast mode was enabled, the tracker will use the selected coast settings to attempt to recover the target. ***If Coast is not enabled, the tracker will return to Acquire mode.*** Appendix C, Section C3.3.4 describes the Coast features.

2 Series 7000 Tracker I/O

The Series 7000 Video Tracker has the following interfaces:

- Bus-Level Interface
  - VMEbus (Model 7005/7006)
  - PCI (Model 7007/7008)
  - PCI Express (Model 7010/7011)
- Gigabit Ethernet Interface (10/100/1000)
- Video Inputs
  - (4) Analog Video Inputs (single-ended or differential switch selectable)
  - Optional – (1) Camera Link Base or Full
  - Optional – (2) HD-SDI
  - Optional – (1) DVI-D
- Video Outputs
  - (3) Analog Video Outputs (2 with symbology and 1 without)
  - Optional – (1) Camera Link Base or Full
  - Optional – (2) HD-SDI
  - Optional – (1) DVI-D
- (8) Serial Ports (RS-232/RS-422 user selectable)
  - UART0 – GUI / Tracker Control
  - UART1 – Hand Controller (Model 702)
  - UART2 – Servo/Mount Control
  - UART3 through UART7 (user defined for lens/LRF/etc…)
- (8) Analog Inputs (±10 volts, user defined for joystick/lens/etc…)
- (2) Analog Error Outputs (±5 or ±10 volts switch selectable)
- (16) Digital I/O, configured as either:
  - Digital Azimuth and Elevation Error Outputs
  - User Defined Digital I/O (for tracker functions/joystick buttons, etc…)

The details of these interfaces are covered in Appendixes A and B.

3 Tracker Operations

3.1 General

The Series 7000 Video Trackers derive target information from the input video. The user is required to define various tracker parameters and modes of operation. These parameters and mode selection decisions should be based on the target and background characteristics to obtain the best possible track information. A general knowledge of video tracking techniques and the functions provided by the tracker are required to make the selection decisions.

This section provides a description of the tracker functions and their associated applications. Detailed descriptions of the status feedback displays and operational controls are also provided within this section.

3.1.1 Tracking Operation

The input video signal is processed as it is received by the tracker. The area of the image defined by the track window is analyzed by the thresholding process and data collection components on a per line basis. The hardware analyzes and stores the video line data during each video line. When the last video line contained within the track window has been processed, the track point, error signals and status are computed. The error signals are output following the last line of video contained within the track window. Automatic processes, such as window size and position, are also serviced prior to the beginning of vertical sync so that new parameters are utilized during the next video field/frame.

3.1.2 Thresholding

The tracker operates by detecting the different pixel intensity levels contained within the input video, within a range of 0 to 4095 (12-bit resolution). Reference or threshold levels are generated by the tracker for use in the digitization process. The threshold levels are generated as a function of the average video level in order to maintain a relative relationship with the input scene. Other factors utilized in the generation of the thresholding levels are dependent on the mode of threshold generation selected. In a manual threshold mode, the threshold values are controlled by the manual threshold settings. In the automatic threshold mode, the white and black peaks derived from the input video are utilized to generate the thresholds. The thresholds, along with the average, are used to separate the input pixels into multiple video levels, white, black and gray bands. The user may select which level is to be considered as target information by the use of the target select functions. The selected level is digitally passed to the data collection processor. This data is also enhanced and mixed into the output video to provide a visual display of the selected target information. Only the enhanced video data is utilized as target information. In area correlation mode, 256 gray levels are utilized in determining the target’s signature.

In manual thresholding mode, the thresholding levels may be adjusted by the user to maximize tracker performance in special situations, such as extremely noisy environments or low contrast conditions. Reference Appendix C, Section C2.2.

3.1.3 Track Error Generation

The track errors, azimuth and elevation, are generated based on the enhanced target data. The track errors are defined as the distance (horizontal and vertical) between the track point on the target and the tracker boresight (crosshair position). Figure 3.1.1 graphically illustrates the azimuth and elevation track errors. The maximum possible error value would be the field-of-view and the analog track error signals are switch selectable with ranges of ±5 volts or ±10 volts. A maximum voltage signal represents an error of half the field-of-view. By enabling the offset track function, it is possible to generate a distance greater than half the field-of-view. Although the analog signals are limited, the digital outputs reflect true error values and are not limited.

Digital errors are provided in two's complement form with sixteen bits of data at $^{1}/_{32}$ of a pixel and line resolution. For analog RS-170/NTSC analog 60 Hz video sources, azimuth errors are resolved to ±1024 pixels and elevation errors are resolved to ±256 lines. For analog CCIR/PAL analog 50 Hz video sources, azimuth errors are resolved to ±1024 pixels and elevation errors are resolved to ±306 lines. For digital video sources, the azimuth and elevation errors are provided at the resolution of the detected video input. The error information is supplied in two words of information via the parallel digital output as well as over all the tracker's communication interfaces.

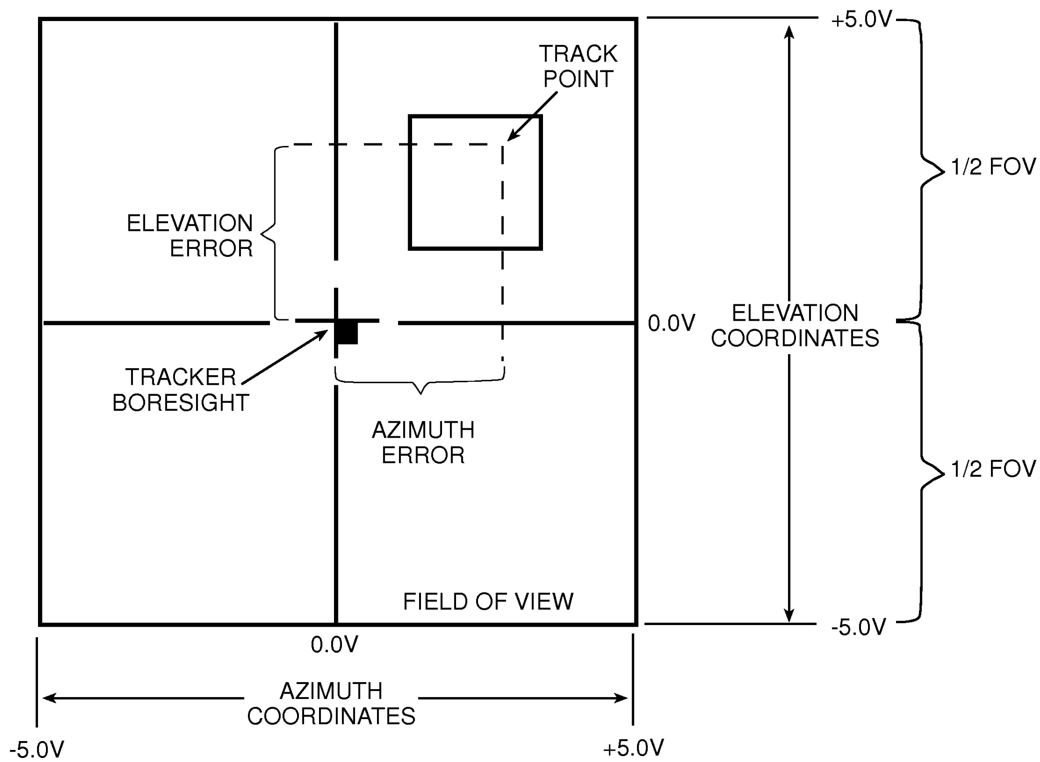


Figure 3.1.1. Track Error Coordinates

3.1.4 Coast Function

The coast function provides the capability to maintain tracker operation during momentary interruptions of valid track data. During coast, the coast discrete is asserted. The duration of the coast is specified through configuration. If enabled, track gate functions, such as gate growth, become active during coast. After the configured coast duration has expired, the tracker transitions to off track and asserts the breaklock discrete. The receipt of valid track data while the tracker is in the coast state will cause a transition into track mode and reset the coast duration counters.

Track quality outputs are provided. The first indicates the current track state: acquire, track, pending track, coast or off track. The track state may alternate between track and coast during a period of intermittent track. Once the coast duration has expired, a minimum number of consecutive fields of valid track data must be received before the coast function will again be allowed to operate. The duration of track data is used to establish a confidence level that a valid target is being tracked and to obtain target history data to aid in reacquisition of the target following a period of coast.

3.2 Tracker Symbology

The Series 7000 Tracker provides graphical display elements, called symbology, that are mixed with the actual video signal. The symbology can then be viewed on a video monitor to aid in the operation of the system. Figure 3.2.1 illustrates the available symbology. The following paragraphs describe the function of each of the symbology elements. The individual display elements can be enabled or disabled by controls available to the user over the tracker's various communication interfaces.

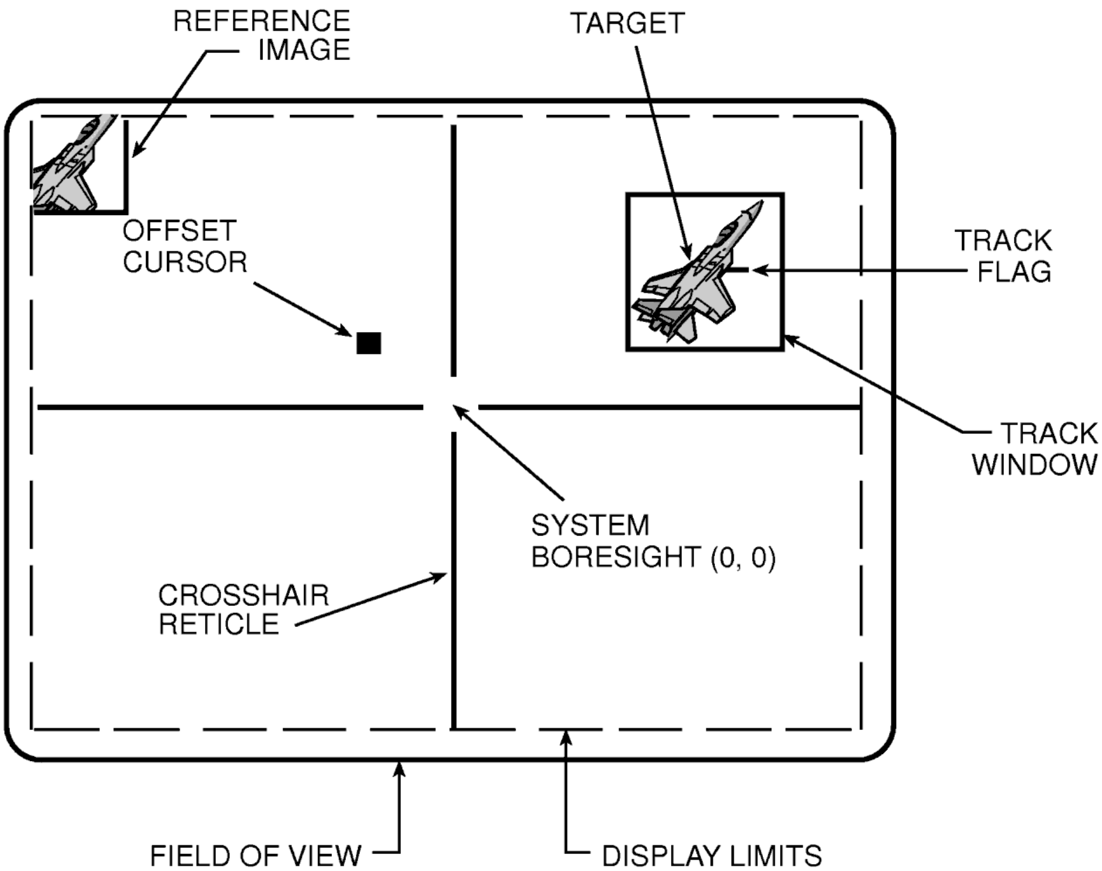


Figure 3.2.1. Tracker Symbology

3.2.1 Offset Aim Cursor

The offset aim symbology is a small dot that represents the (0, 0) or null point of the track error values. The cursor is only displayed when the offset track function is enabled. During offset tracking operations, the cursor may be positioned at an offset from the tracker null point. At all other times, the cursor is returned to the crosshair center, which represents the tracker null point during normal track error computations.

3.2.2 Crosshair (Boresight) Reticle

The crosshair reticle represents the configured center (also known as line-of-sight or null point) of the tracker target error computations during non-offset track operation. The crosshair display can be enabled or disabled by the user. The position of the crosshair center defaults to the center of the video field-of-view.

3.2.3 Display Limits

The display limits are not a visible/displayable symbology element. The limits represent the area within the field-of-view where the symbology may be positioned. This also represents the area in which the tracker will process data and a target may be tracked. The gate position limits are configuration settings adjustable by the user. Reference Appendix C, Section C3.5.2.

3.2.4 Target

The target is the data selected through threshold control for use by the tracker to determine the track point. The target data is displayed as enhanced shading of those areas of the input video that satisfy the thresholding requirements. During correlation mode, a target is tracked by its gray pattern levels and enhancement is not utilized.

3.2.5 Track Flag

The track flag is used to indicate the computed track point of the target. The track error signals are generated based on the location of the track point. The left end of the track flag is positioned at the track point. The track point is selectable by the various tracker modes (centroid, edge, etc). The track flag will not be displayed if target data is not available (loss of target condition).

3.2.6 Track Window

The track window (also called the track gate) represents the area of the video in which the tracker will search for a target. The size and position of the track window are determined by input message or by automatic means based on input video target data. The track window maximum size is limited to approximately 90 percent of the field-of-view in each axis. The minimum size is also limited depending on the input video type. The minimum and maximum window size is user configurable within these limits (Reference Appendix C, Section C3.5.2). The correlation track window (search area) is fixed at a 64-pixel by 64-line size during correlation track mode.

3.2.7 Reference Image Display

The reference image display provides a visual feedback of the correlation target data for which the correlation process is searching. The image displayed represents the current reference data and is dynamically updated during correlation processing. The reference image display is allowed only during correlation mode processing. The reference image display may be enabled or disabled by a configuration setting (Reference Appendix C, Section C3.3.7).

The reference image display will change size based on the current reference window size. The location of the upper left corner of the display remains fixed at the configured point while size changes cause the display to increase down and to the right.

The reference display position can be set by the user. Reference Appendix C, Section C3.5.1.

3.2.8 Reference Window

The reference window is utilized only during the correlation acquire mode of operation. The reference window is displayed as a series of four dots centered within the search area window.

These four dots represent the corners of the area which encompass the reference target data. Controls are utilized to set the size of the reference window. The size of the reference window is independent in each axis. Each axis size may be set to one of four sizes, 8, 16, 24 or 32. ***It is necessary to transition through or into acquire mode to have reference window size changes take effect.*** Reference Appendix C, Section C3.3.7.

3.3 Tracker Controls

All tracker functions are controlled via the serial, bus level and/or Ethernet interfaces. Tracker status and track errors are also supplied over these interfaces. Appendix B provides a detailed description of the input and output data format.

3.3.1 Symbology Display Controls

The symbology display controls allow the operator to enable or disable the presentation of various graphical elements on the annotated video output of the tracker. A separate control permits switching the color (black or white) of the displayed elements. The symbology controls do not affect any of the tracker modes of operation. Reference Appendix C, Section C3.2.

3.3.1.1 Symbology Color Control

The symbology color control is utilized to maintain the visibility of the graphical elements during varying shades of the target and background video.

3.3.1.2 Enable Symbology Control

The symbology enable capability permits the display of various graphical elements. When the symbology is enabled, the display elements will be visible. Each symbology element can be independently enabled or disabled.

3.3.1.3 Crosshair Symbology Control

The crosshair control provides the capability of individually enabling and disabling the crosshair display without affecting the display states of other symbology elements. When active, the crosshair will be displayed on the monitor. Crosshair format is user selectable and customizable, with three standard types available.

3.3.1.4 Reference Image Symbology Control

The reference image symbology control provides the capability of individually enabling or disabling the reference image display without affecting the display states of the other elements. When active, the correlation reference image will be actively displayed on the monitor.

The reference image display function is automatically enabled whenever the tracker is initially placed into the correlation acquire mode of track. The reference image display function is disabled during all other track modes.

3.3.2 Threshold Control

The threshold controls allow the operator to select and control the video information to be considered by the tracker as target data relative to the background, i.e., enhanced. Threshold controls have no effect during the correlation track mode. The threshold controls set the levels of the two thresholds (BLACK and WHITE) that are used to determine the video levels that will be enhanced based upon the target shade selected. Figure 3.3.1 illustrates the target data enhanced and their relationship with the two thresholds. White and black threshold control values are sent to the tracker where the levels are applied to the incoming video.

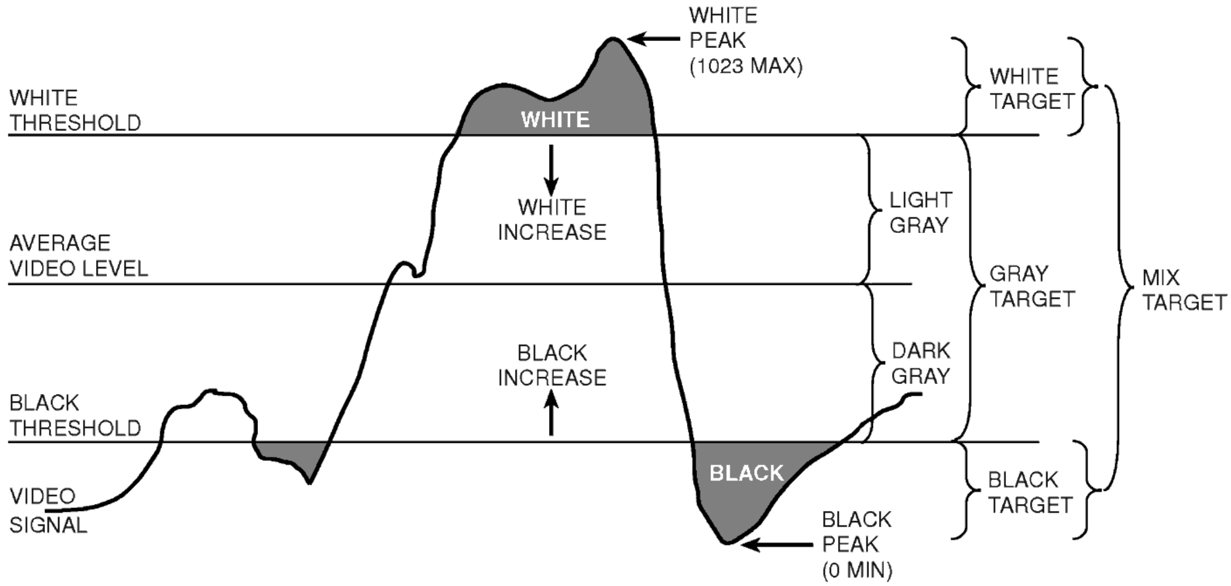


Figure 3.3.1. Target Threshold Areas

3.3.2.1 WHITE Threshold Control

The white threshold control selects target data from the video input that exceeds (is above) the WHITE threshold level. White should be selected when the desired target information is higher (lighter) in intensity than the background against which it is to be tracked.

3.3.2.2 BLACK Threshold Control

The black threshold control selects target data from the video input that exceeds (is below) the BLACK threshold level. Black should be selected when the desired target information is lower (darker) in intensity than the background against which it is to be tracked.

3.3.2.3 GRAY Threshold Control

The gray (not white/not black) threshold control selects video levels that fall in gray bands that contrast with the background levels. Gray may be used to track targets that are themselves of a gray level when tracked against a background of both intense dark and intense light colored objects.

3.3.2.4 MIX Threshold Control

The mix (white and black) threshold control selects video levels that exceed either the BLACK or WHITE threshold levels. The MIX may be useful when tracking an object consisting of both intense black and intense white colors. For example, this condition may arise when the desired target is a white (or light colored) object with dark markings against a gray or neutral background.

3.3.2.5 Threshold Level Control

The AUTO/MANUAL threshold level control determines the manner in which the BLACK and WHITE threshold levels are established. During AUTO threshold level operations, the thresholds are set based on the input video information. The WHITE threshold level is based on the white peak-to-average video levels and the BLACK threshold level based on the black peak-to-average video levels. ***MANUAL threshold values are neither used nor affected by AUTO threshold mode.***

During MANUAL threshold operations, the operator may manually adjust the threshold levels using remotely input digital values. The WHITE threshold level is set at a level above the current threshold value. The BLACK threshold level is set at a level below the input threshold value. MANUAL threshold is a count value with a range of 0 (black) to 1023 (white).

3.3.2.6 Auto Polarity

The Auto Polarity threshold selection turns the thresholding controls over to the tracker for the automatic setting of one or more thresholded bands that are determined through analysis of the video image. Target video levels are distinguished from background levels and the gray bands are set at target levels. ***When Auto Polarity is selected, no other threshold settings are utilized.***

3.3.3 Coast Enable Control

Coast enable is used to activate or terminate the tracker coast function. The coast function, when enabled, can maintain the status and selected track error outputs during periods of no target information. Track error outputs are user selectable. Coast mode allows the user to configure the tracker for reacquisition of the target (Reference Appendix C, Section C3.3.4).

3.3.4 Acquire/Track Control

The acquire/track function defines whether the tracker is acquiring a target or is to track the target.

The acquire mode is not an active track mode; error signals and the ON-TARGET status are not generated. The correlation acquire mode is utilized to capture or define the target image to be used by the correlation matching process. When the acquire mode is activated during correlation track mode, the reference image display is shown (if enabled), the track window size is set to 64 by 64, and the reference window is displayed at the same size at which it was previously set. ***During the acquire mode, the reference window size may be adjusted. The track window size is not adjustable during correlation mode of operation.*** Reference Appendix C, Sections C1, C2 and C3.3 for a description of the acquire/track functions.

3.3.4.1 Multi-Target Acquire/Track

The multi-target engine allows separation of various targets contained within the track window. When multi-target acquire is enabled, the tracker's configuration settings control the filtering and sorting of the various targets found. Up to ten (10) targets can be marked using the multi-target symbology cross hairs. When multi-target track is enabled, the tracker will use the multi-target engine after transitioning into track mode and continue to separate target data inside the track window. If multi-target track is disabled, the tracker will transition into single target mode during track. Reference Appendix C, Section C3.3.

3.3.5 Video Source Control

The video source control is utilized to select which of the video inputs are to be processed by the tracker. The tracker is initialized on power-up or reset to accept the analog video 1 source as input.

3.3.6 Offset Tracking Controls

The offset tracking controls allow the user to enable and position the tracker boresight used in the computation of the azimuth and elevation track errors. When the offset track function is not enabled, the tracker boresight is defined to be the crosshair center.

3.3.6.1 Offset Enable Control

The offset enable switch enables/disables the offset tracking feature of the tracker. With the offset enabled, target track errors are computed relative to the offset display element rather than the crosshair center. When enabled, the offset symbology is displayed at the crosshair center coordinate. The position of the boresight may then be modified by the use of the boresight offset controls. When disabled, the offset position is returned to the crosshair center coordinate at a gradual rate. Once at the crosshair center position, the display of the offset symbology is disabled. Track errors continue to be computed from the offset position until the crosshair center coordinate is reached. At this point, errors become referenced from the crosshair center coordinate.

3.3.7 Window (Gate) Size Controls

The window size controls allow the user to set the size of the track window for optimum tracking conditions. During correlation modes, the size controls allow the user to set the reference window size for the same purpose. In non-correlation modes, the size of the window should only be large enough to account for target positional and size changes on a video field-to-field basis. Typically, 1.5:1 or 1.75:1 gate-to-target ratio is recommended; for small targets a fixed gate size or a limited minimum gate size can improve trackability. ***During correlation processing, the reference window size should be set to only include target data so that background clutter is not sampled.***

The correlation track window size (Search Area) is fixed at 64 pixels by 64 lines. The reference window sizes step through the allowable size increments. The increments are 8, 16, 24 and 32. The reference window sizes are independent in each axis (azimuth and elevation). The window size controls are disabled during active correlation operation and any size change entry is ignored until the tracker re-enters acquire mode. Reference Appendix C, Section C3.3.7.

3.3.7.1 Auto/Manual Window (Gate) Size

The auto/manual window size function controls the method by which the track gate (window) is sized. The automatic window size function causes the gate (window) to be continuously resized, based upon the target data found inside the window. The ratio of target-to-gate size is set under the system parameter's screen. Automatically sizing the window has the advantage of eliminating as much of the background as possible from inside the gate (window). The disadvantage to clamping down on the gate or window size is that when the target is moving rapidly or erratically, it could move enough to leave the window in one field time causing loss of track. Manual window size allows the gate or window size to be defined and the size is fixed. Reference Appendix C, Section C2.4.

If enabled, automatic window size parameters may be configured. Reference Appendix C, Section C3.5.6.

3.3.8 Window (Gate) Position Controls

The track window position controls allow the user to define the location within the field-of-view at which the track window will be located. The operator may also choose to allow the window to be positioned automatically over the target on each field.

3.3.8.1 Auto/Manual Window (Gate) Position

The auto/manual window position function controls the method by which the track window is positioned within the field-of-view. The automatic window position function causes the window to be continuously centered over the target track point. Automatic window positioning is limited by a maximum rate-of-change value to prevent the window from moving off the target due to noise or random intrusions. The manual window position mode of operation allows the window position to be controlled exclusively by remote control input where digital values denoting position are provided. Reference Appendix C, Section C2.3.

3.4 Track Modes

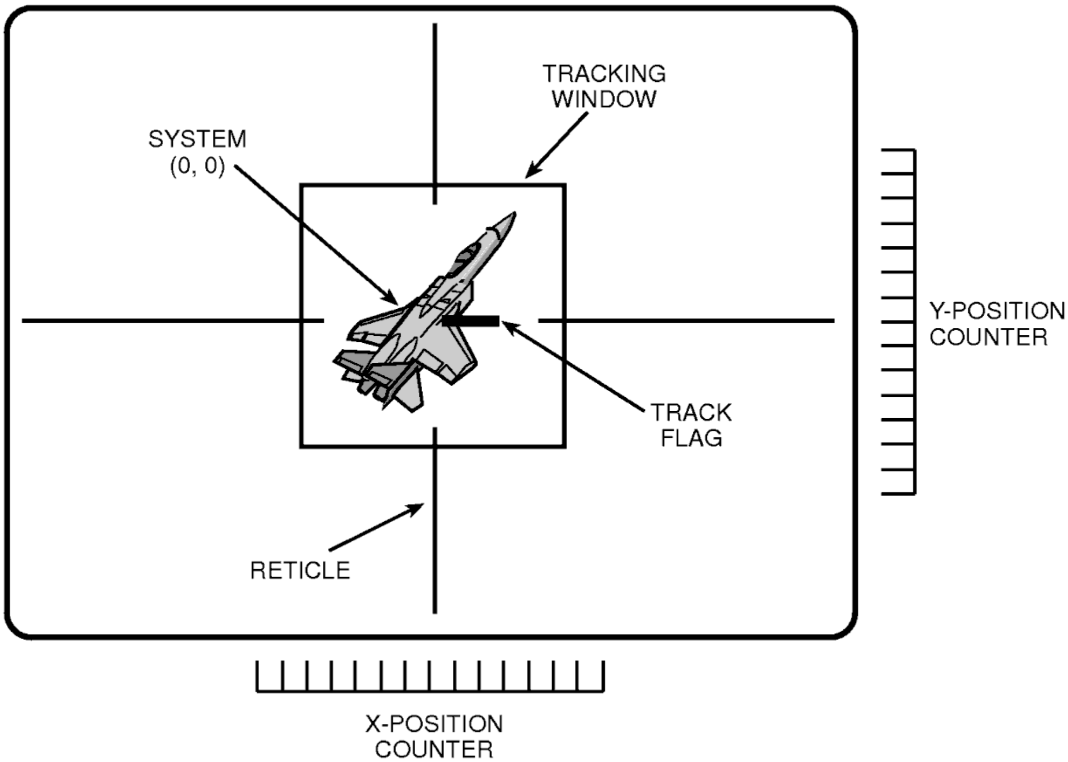
The Series 7000 Trackers support three primary modes of the track; centroid, edge and correlation. The track mode controls are interlocked so that the activation of one mode will automatically deactivate the current mode. The operation of each of these modes is described below.

3.4.1 CENTROID Track Mode

The centroid track mode tracks the center of the mass of target pixel information. All thresholded data is summed and the computed center of the target data becomes the track point. The track errors are calculated and maintained internally in a fixed decimal point format. Five fractional bits are maintained throughout all track error computations. The results yield a two's complement 16-bit value. The lower five bits represent the fractional portion of the computed centroid coordinate. The format of the internally-maintained digital coordinate parameters are as follows:

Bit Position	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Power of 2	S	9	8	7	6	5	4	3	2	1	0	-1	-2	-3	-4	-5
Weighting	Sign	512	256	128	64	32	16	8	4	2	1	$^1/_2$	$^1/_4$	$^1/_8$	$^1/_{16}$	$^1/_{32}$

Figure 3.4.1. Track Error Output



$$\frac{\sum_{i=0}^{m} X_i POS}{\sum_{i=0}^{n} N_j} = X\ CENTROID + REMAINDER$$

$$\frac{\sum_{i=0}^{m} Y_i POS}{\sum_{i=0}^{n} N_j} = Y\ CENTROID + REMAINDER$$

N = Data Point Above Threshold
X_i = X – Position Of Target
Y_i = Y – Position Of Target
n = Total Number Of Data Points
m = Total Number Of Position Coordinates

Figure 3.4.2. Centroid Algorithm

3.4.2 LEFT EDGE Track Mode

The left edge track mode tracks the leftmost portion of the thresholded target data (see Figure 3.4.3). The thresholded data is scanned on a pixel-by-pixel basis. The first encountered leftmost coordinate is saved, i.e., if two or more video lines have equal left edge coordinates, only the first one (topmost) is utilized as the track point. When edge mode is active, any correlation displays are disabled and the manual window size operation is forced active. ***In edge mode, output error resolution is 1 pixel and 1 line.***

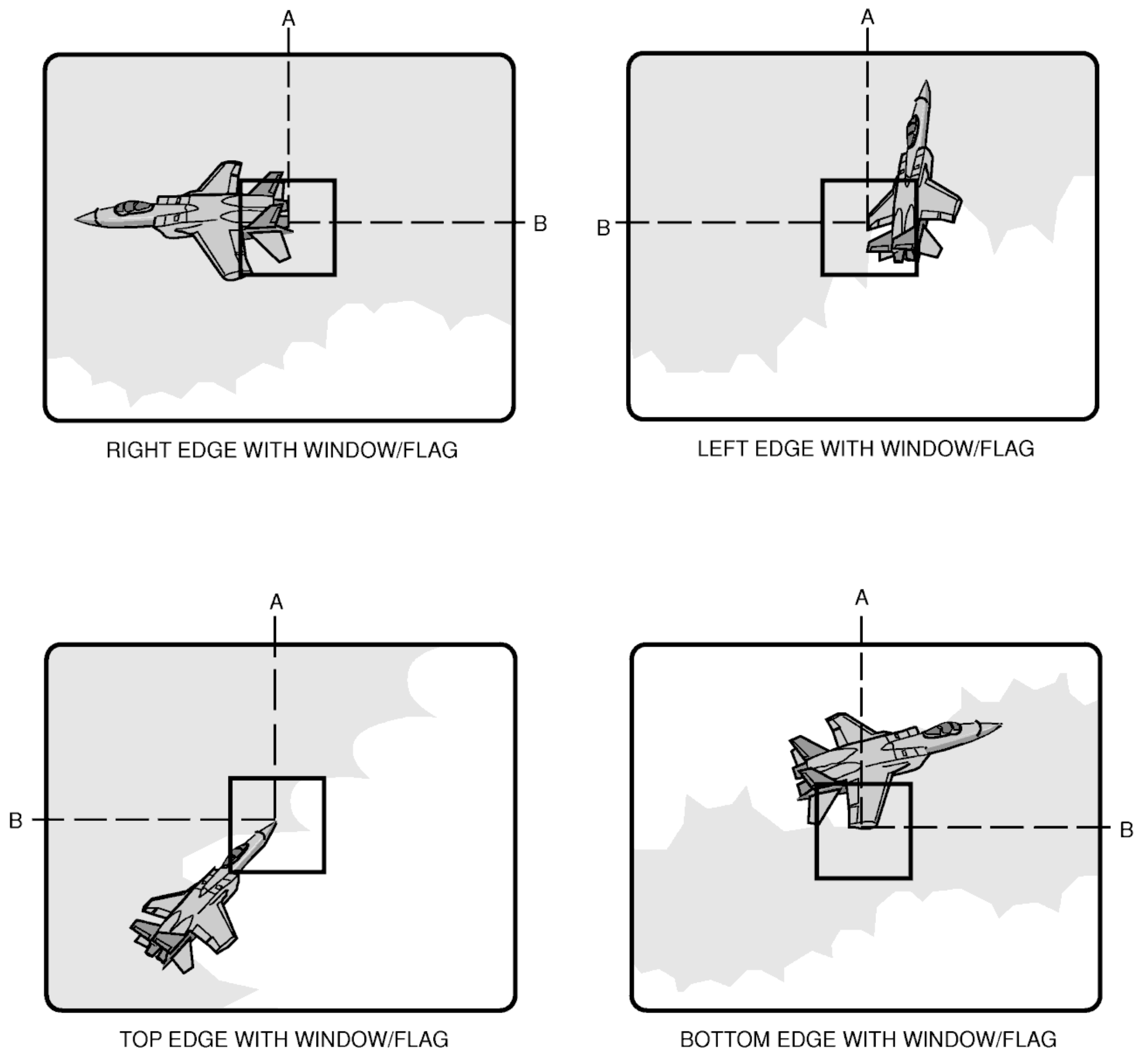


Figure 3.4.3. Selectable Edge Tracking

3.4.3 RIGHT EDGE Track Mode

The right edge track mode is utilized to track the right side of the target (see Figure 3.4.3). The thresholded target data is scanned on a pixel-by-pixel basis and the last rightmost coordinate is utilized as the track point. When edge mode is activated, the correlation displays are disabled and the manual window size function is forced active. ***In right edge mode, the output error resolution is 1 pixel and 1 line.***

3.4.4 TOP EDGE Track Mode

The top edge track mode is utilized to track the extreme top edge of the target. The left coordinate of the first video line that contains thresholded target data is utilized as the track point. When edge mode is activated, the correlation displays are disabled and the manual window size function is forced active. ***In top edge mode, the output error resolution is 1 pixel and 1 line.***

3.4.5 BOTTOM EDGE Track Mode

The bottom edge track mode is used to track the extreme bottom edge of the target. The right coordinate of the last video line containing thresholded data is utilized as the track point. When edge mode is activated, the correlation displays are disabled and the manual window size function is forced active. ***In bottom edge mode, the output error resolution is 1 pixel and 1 line.***

3.4.6 VECTOR Track Mode

Vector track mode utilizes mount position feedback to determine a target motion vector from the mass centroid of the target. The target vector is then used to determine the leading edge (where the vector crosses the track window) to track. The aim point of the mount will transition from the last edge to the new edge filtered by a user-defined number of fields using a proportionally weighted method. ***In vector mode, the output error resolution is 1 pixel and 1 line.***

3.4.7 INTENSITY CENTROID Track Mode

The intensity centroid mode computes the target's spatial coordinates based on following algorithm:

$$\frac{\sum_{i=0}^{m} X_i I_i}{\sum_{j=0}^{m} I_j} = X\ \ Intensity\ \ Centroid$$

$$\frac{\sum_{i=0}^{m} Y_i I_i}{\sum_{j=0}^{m} I_j} = Y\ \ Intensity\ \ Centroid$$

I_j	=	Sum of Intensity Value of each pixel above threshold
X_i	=	X - Position of Valid Target Pixel
Y_i	=	Y - Position of Valid Target Pixel
m	=	Total Number of pixels within the tracking window
j	=	A Threshold is determined which establishes the gray level above which pixels are processed at their gray level value and below which the pixels are set to zero.

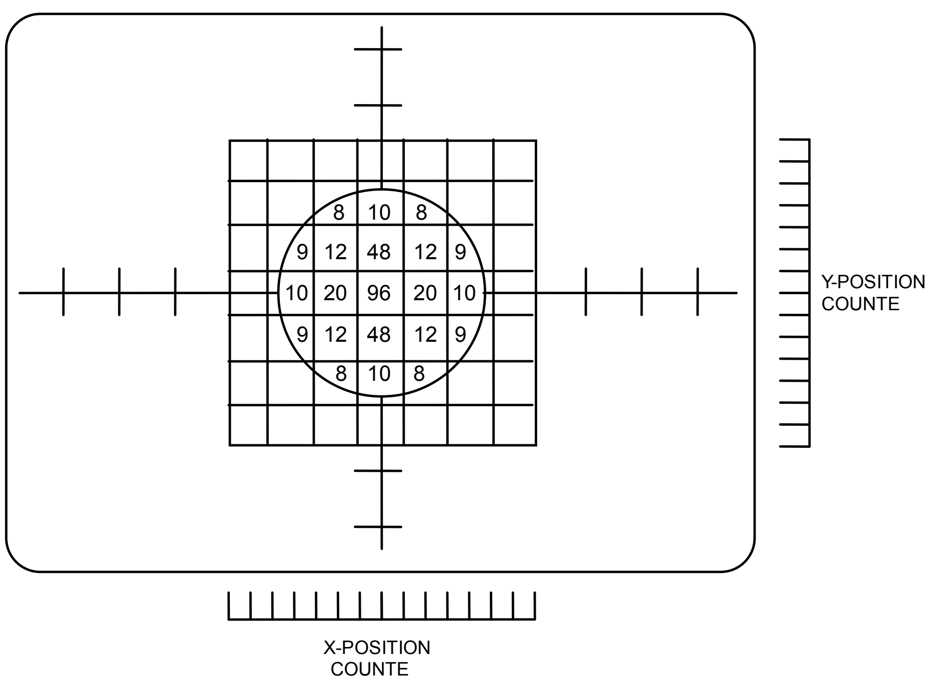


Figure 3.4.4. Intensity Centroid Algorithm

3.4.8 CORRELATION Track Mode

The correlation mode is the active tracking mode of the correlation process (see Table 3.4.8.1). During correlation, the target image captured during the acquire mode is searched for in the track window. When an acceptable match is detected, the center of the image that was matched becomes the track point. If more than one acceptable match is encountered, the best match to the target image will be utilized. The correlation mode must be initiated from the acquire mode of operation. ***The initiation of the correlation mode will cause the reference window symbology dots and the manual window size controls to be disabled.***

Table 3.4.8.1. Correlation Mode

CORVAL(SX SY)	=	$\sum_{j=1}^{r_x}\sum_{i=1}^{r_y}\sum_{n=0}^{63} s_n(i+s_x, j+s_y) \pm R_n(i,j)$		
CORVAL(SX SY)	=	$\sum_{j=1}^{r_x}\sum_{i=1}^{r_y}\sum_{n=0}^{63} s_n(i+s_x, j+s_y) \pm R_n(i,j)$		
rx	=	Reference Image Size Horizontal		
ry	=	Reference Image Size Vertical		
sx	=	Horizontal Shift (0, 1,…, 63 - rx)		
sy	=	Vertical Shift (0, 1, …, 63 - ry)		
S0 – S255	=	Search Area Gray Levels		
		S0	=	Darkest
		S255	=	Lightest
R0 – R255	=	Reference Area Gray Levels		
		R0	=	Darkest
		R255	=	Lightest
Search Area	=	64 x 64 Elements		
Reference Area	=	(8, 16, 24, 32) Elements Horizontally and Independently Variable Vertically		

3.4.9 Initial Tracker States

These are the factory default settings for the tracker set by the factory. These settings can be customized using the tracker's communication ports. The custom configuration may be saved as the default setting for the tracker. Custom configurations may also be cleared and the system will default to the factory default settings. Reference Appendix C, Section C3.5.5.

Table 3.4.9.1 depicts the initial tracker states.

Table 3.4.9.1. Initial Tracker States

Target Color	=	WHITE
Auto/Manual Threshold	=	MANUAL
Symbology Enable	=	ENABLE
Reference Image	=	ENABLED
Crosshair	=	ENABLED
Acquire/Track	=	ACQUIRE
Video Source	=	ANALOG IN 1
Coast	=	DISABLED
Offset	=	DISABLED
Auto/Manual Window Size	=	MANUAL
Auto/Manual Window Position	=	MANUAL
Track Mode	=	CENTROID

4 Theory of Operation

4.1 Introduction

This section describes the system block diagram. The tracker operational and control software is not detailed here. All tracker software is proprietary.

4.2 Series 7000 Video Trackers

The Series 7000 are edge/centroid/correlation video trackers consisting of one 6U VMEbus (7005/7006), PCI (7007/7008) or PCI Express (7010/7011) full length board. This board provides all processing and control capabilities of the tracker. It generates all display functions and gathers target data within the track gate from the video stream. Figure 4.2.1 is the block diagram for the tracker.

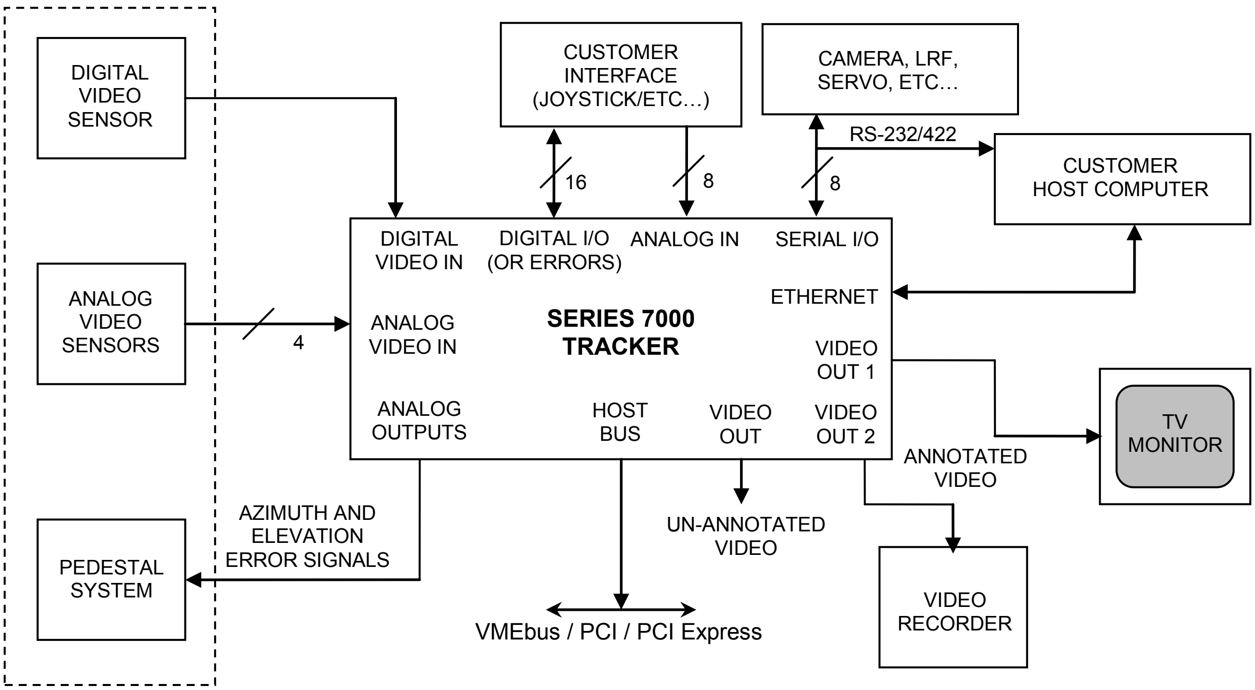


Figure 4.2.1. Series 7000 Block Diagram

4.2.1 External I/O

Tracker commands may be sent over the UART0 serial interface (RS-232/RS-422, 115200, Odd, 8,1), the host computer bus (VMEbus/PCI/PCI Express) or gigabit Ethernet. The tracker communicates and sends status over all connected interfaces simultaneously. The tracker also provides analog and digital track error outputs. Reference Appendix A and Appendix B.

4.2.2 Reticle Generation

The tracker reticle refers to the crosshair that indicates the 0, 0 location or line-of-sight of the tracker field-of-view. This line-of-sight is also called the boresight. The display of this crosshair reticle may be enabled or disabled. The location of the 0, 0 point can be altered by enabling line-of-sight offset and setting offset values.

4.2.3 Offset Tracker Generation

The offset symbol is displayed during offset aim tracking. It is a 2x2 pixel dot that provides a reference point for the offset track point.

4.2.4 Track Flag Generation

The track flag is a line that is displayed to indicate the calculated track point. The left end of the track flag is positioned on the pixel that is identified using the current track mode selection. The display of this symbology may be enabled or disabled.

4.2.5 Track Data Available

Track data is defined as video pixels that are located inside the track window and meet the video levels specified by threshold levels and the target color selected.

4.2.6 Reference Image Display

The reference image display is used to display a representation of the reference image that is being used for correlation within the search area.

4.2.7 Reference Image Window

The reference image window is indicated by four dots, which denote the area within which correlation data is acquired for the reference image. These four dots are displayed during acquire mode.

4.2.8 Centroid Track

In centroid mode, the track point is positioned and track errors are generated based on the above information using the following equations:

XSUM/NCNT	=	X position
YSUM/NCNT	=	Y position

For example, the X and Y positions for the above examples are as follows:

Figure 4.2.2:

X Position	=	XSUM/NCNT	=	4/1	=	4
Y Position	=	YSUM/NCNT	=	4/1	=	4
Track Flag Position	=	(4, 4)				

Figure 4.2.3:

X Position	=	XSUM/NCNT	=	18/4	=	4.5
Y Position	=	YSUM/NCNT	=	18/4	=	4.5
Track Flag Position	=	(4.5, 4.5)				

For each video field, the above signals XSUM, YSUM and NCNT are calculated in hardware. Track flag position and track errors are then calculated in software.

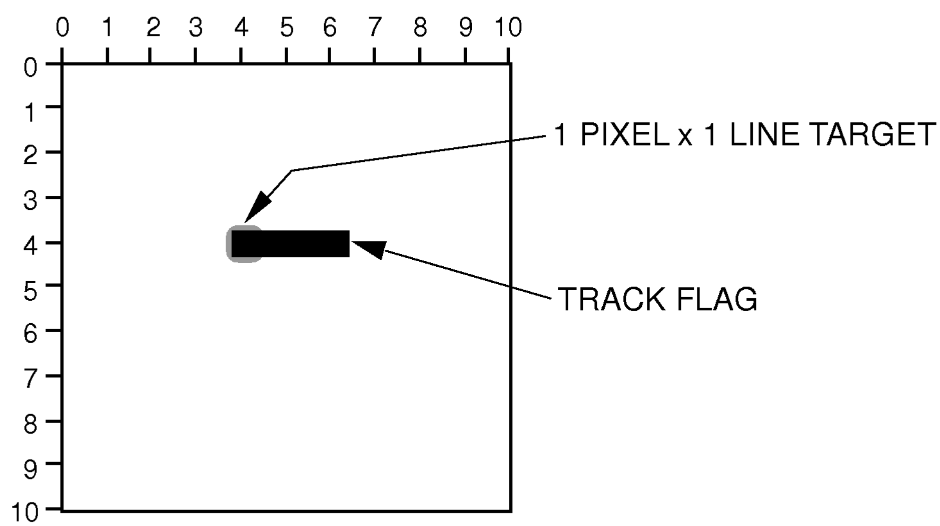


Figure 4.2.2. One (1) Pixel Target

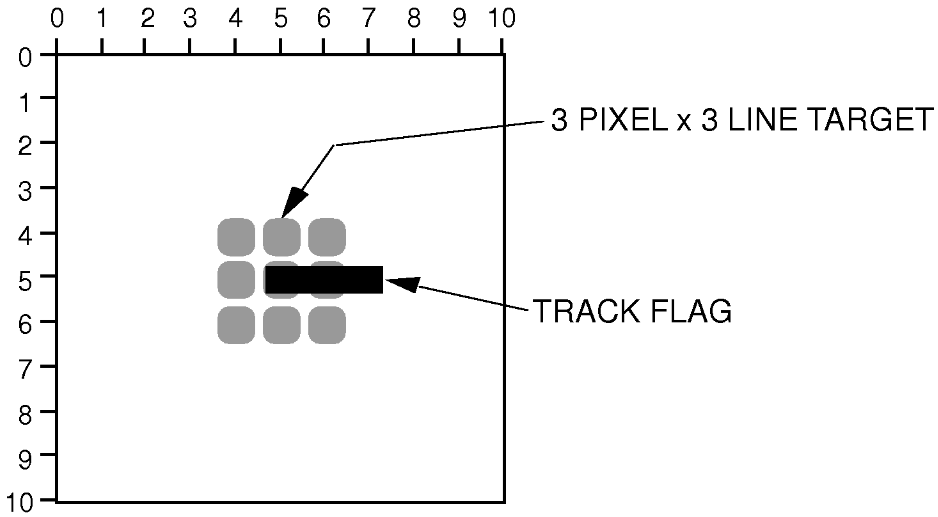


Figure 4.2.3. Nine (9) Pixel Target

4.2.9 Edge Track Mode

Edge tracking is accomplished by finding the data points at the extremes. For example, the coordinates for the diamond target in Figure 4.2.4 are as follows:

Top Edge	=	(5, 3)
Left Edge	=	(3, 5)
Right Edge	=	(7, 5)
Bottom Edge	=	(5, 7)

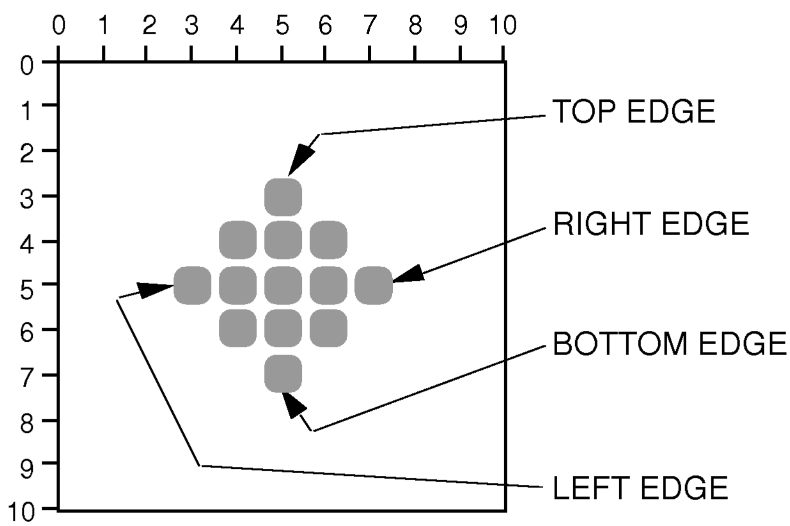


Figure 4.2.4. Edge Tracking

The top edge of the target is found by detecting the first pixel where trackable/thresholded data exists. This is accomplished by a one-time clocking of the XCNT and YCNT of the pixel into registers upon the first valid NCNT. These registers are then read by software and the track flag is positioned and errors are calculated.

The bottom edge of the target is found by detecting the last pixel where valid data exists. This is accomplished by continuously clocking the XCNT and YCNT of pixels into registers whenever data is present. When scanning of the entire track window is complete, the last XCNT and YCNT in the registers is the position of the last trackable pixel. The registers are then read by software and the track flag is positioned and track errors are calculated.

The right edge of the target is found by detecting the pixel where valid data exists, which is farthest right. This is accomplished by a magnitude comparison of the XCNT of each pixel of trackable data with the previous one stored in the register. If the XCNT is of a higher magnitude, it gets clocked through and stored in a register and becomes the present right edge. After the entire track window is scanned, the register is read by software and the track flag is positioned and track errors are calculated.

The left edge of the target is found by detecting the pixel farthest left where valid data exists. This is accomplished by a magnitude comparison of the XCNT of each pixel of trackable/thresholded data with the previous one stored in the register. If the XCNT is of lower magnitude, it gets clocked through and stored in the register and becomes the present left edge. After the entire track window is scanned, the register is read by software and the track flag is positioned and track errors are calculated.

4.2.10 Digital Filter

The digital filter is a 2x2 kernel, which, when enabled, causes the tracker to ignore random thresholded pixels (ie-image noise). To be included as valid target data, thresholded pixels must satisfy the criteria of being at least two pixels by two lines.

4.3 Video

The tracker processes video input from FLIR and CCD sensors using standard and nonstandard formats in determining the target location. Analog video input to the tracker is digitized to a 12-bit signal. These pixel values are then processed to determine the location of pixels inside the active gate area that exceed the current threshold settings.

4.3.1 Video Selection

The video input that is processed by the tracker is determined by the video source that is selected. ***The tracker defaults to analog video source one, VID IN 1.***

4.3.2 Enhancement

The video is modified in the tracker by the enhancement of the data within the track window and the addition of artificial symbology into the video.

4.3.3 Threshold Detection

In the edge and centroid tracking modes, the decision for including a pixel in the target is determined by comparison of the video signal to the threshold levels set by software.

In the automatic threshold mode, the threshold level is determined for each field from the video signal within the tracking gate. The setting is determined by the peak-to-average range and a threshold percentage setting. Increased sensitivity can be obtained by adjusting the level towards the peak level.

In the manual threshold mode, the threshold level is calculated by an operator input that is scaled to the peak-to-average range. For low threshold values, the manual threshold is set close to the video peak. For high threshold values, the threshold is set close to the average.

In correlation mode the threshold settings are not used.

4.3.4 Tracker Video Output(s)

Three analog video outputs are available from the tracker; one (1) unannotated/buffered video output and two (2) video outputs with overlaid symbology.

4.4 Configuration

The tracker powers up in a default configuration. This configuration can be modified by sending the tracker a message containing the desired parameters.

4.5 Area Correlation Processing

The Series 7000 Trackers have two processing units; one provides system control, display functions and clock timing, while the other has the ability to compare a reference image to the image within the track window to determine the best match. After a selectable number of fields, if there is a successful match, the reference image is automatically updated. This allows the tracker to track dynamic targets using area correlation.

The correlation processor provides a 64 pixel by 64 line memory area for the active video, search area and up to a 32 pixel by 32 line memory area for the reference image. The active video is sampled and compared against an 8, 16, 24 or 32 pixel by 8, 16, 24 or 32 line (axis independent, providing 16 reference sizes) reference area.

The correlation processor sums the number of pixels that match for each of the possible locations where the reference image can completely overlay the active search area. The processor then compares each sum against a minimum acceptable value and compares all sums that pass the value criteria to find the best comparison, called the peak correlation value. During the selection process, each sum is identified with its location within the track window. The location and correlation values are sent to the control processor for error processing.

The correlation processor stores the reference image and sends it to the control processor for display in the top left corner of the video field-of-view.

4.5.1 Absolute Counters

The absolute counters identify the location within the track window where the comparisons are being made. Figure 4.5.1 shows the location of the first and last search locations of square reference areas. Since the location of the reference area is defined as the center of the reference area rectangle, the first and last locations are a function of reference area size.

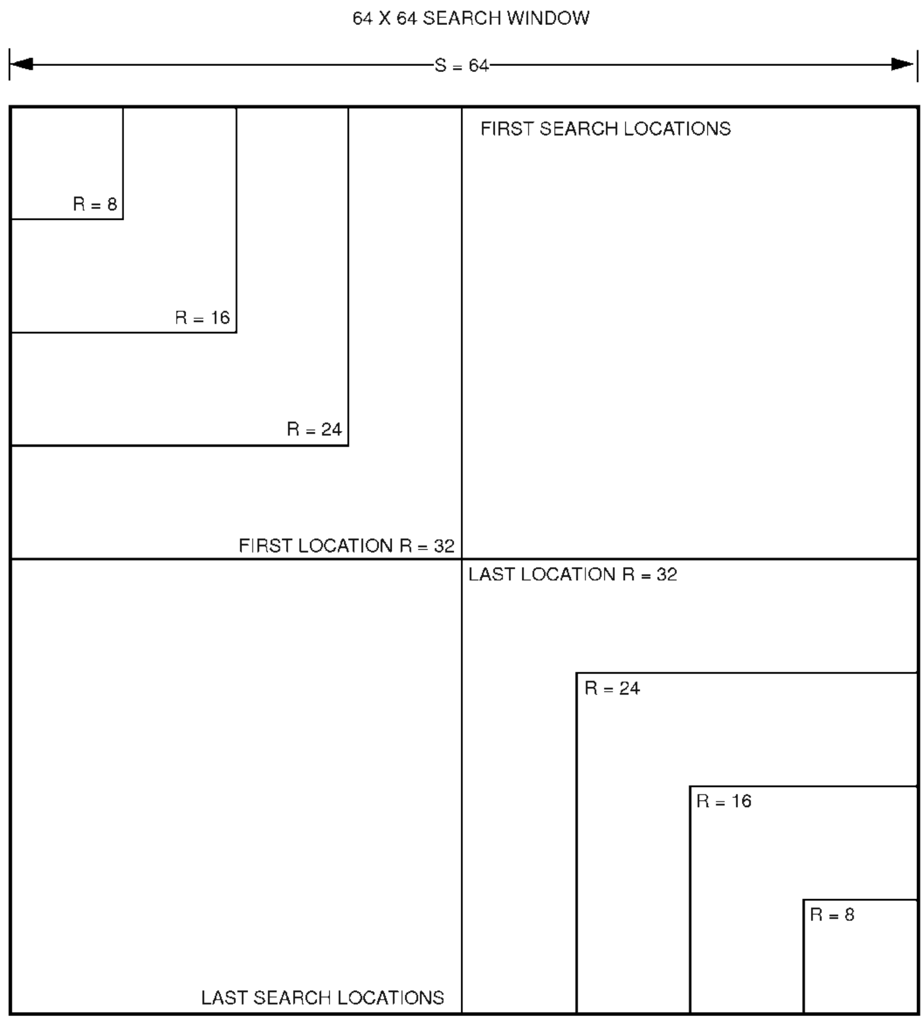


Figure 4.5.1. First and Last Search Locations

4.5.2 Reference Image Update

The correlation processor generates the reference image update. The update only occurs on the same field (odd or even) in which the acquisition occurred. The correlation processor stores the reference image for display in the top left corner of the video field-of-view and controls the updating of the reference image.

4.6 Track Quality Evaluation

This section provides an overview of the track quality evaluation.

4.6.1 General

The quality of the computed track error is determined from the available target characteristics data from which track error is derived. Specifically, the track error quality is determined based on the consistency (from field-to-field) of the target characteristic information. A history, or running average, of the characteristic data is maintained for use in the comparison of the new field data. When the comparison yields a difference greater than a preset allowable rate of change for the particular parameter, a "Pending Breaklock" status is generated, provided a track history has been established, otherwise, a Breaklock is declared. Characteristic data derived from a video field that yields a "Pending Breaklock" is not included into the history. After a configurable number of consecutive fields with the Pending Breaklock status is asserted, a Breaklock status is generated.

As shown in Figure 4.6.1, the single common feature of all track mode related quality computations is the maintenance of the history of the target characteristics. The characteristic data is maintained on a per-video-field basis. The depth (number of fields) of the history is a configurable parameter based on the type of target being tracked and the mount response characteristics. The allowable rate of change parameters utilized in the track quality determination are also configurable to reflect target and system responses.

Several conditions and situations exist that cause the history data to be reinitialized. Basically, all these conditions/situations include the following:

- Loss of target data or breaklock condition before a history is established
- Changing of track mode (including from non-track to "TRACK")
- System initialization or reset

In general, no track quality assessment is made until the history is fully initialized. Pending Breaklock status is not asserted during the history initialization process, i.e., only the Lock or Breaklock status is generated without a fully initialized history.

Breaklock status is also generated when no target data is available or the tracker is not in "TRACK" mode.

Target characteristics available to all modes of tracker processing include the following:

- Target edges (left, right, top and bottom)
- Target density (NCOUNT)
- Target position

The significance of these parameters is dependent upon the action mode of target track. In order to determine the proper evaluations of these parameters for track quality assessment, each track mode and its primary tracking application is considered prior to specifying the track quality determination algorithm. The tracker utilizes the active track mode in the Lock, Breaklock and Pending Breaklock status determination, as explained in the following paragraphs.

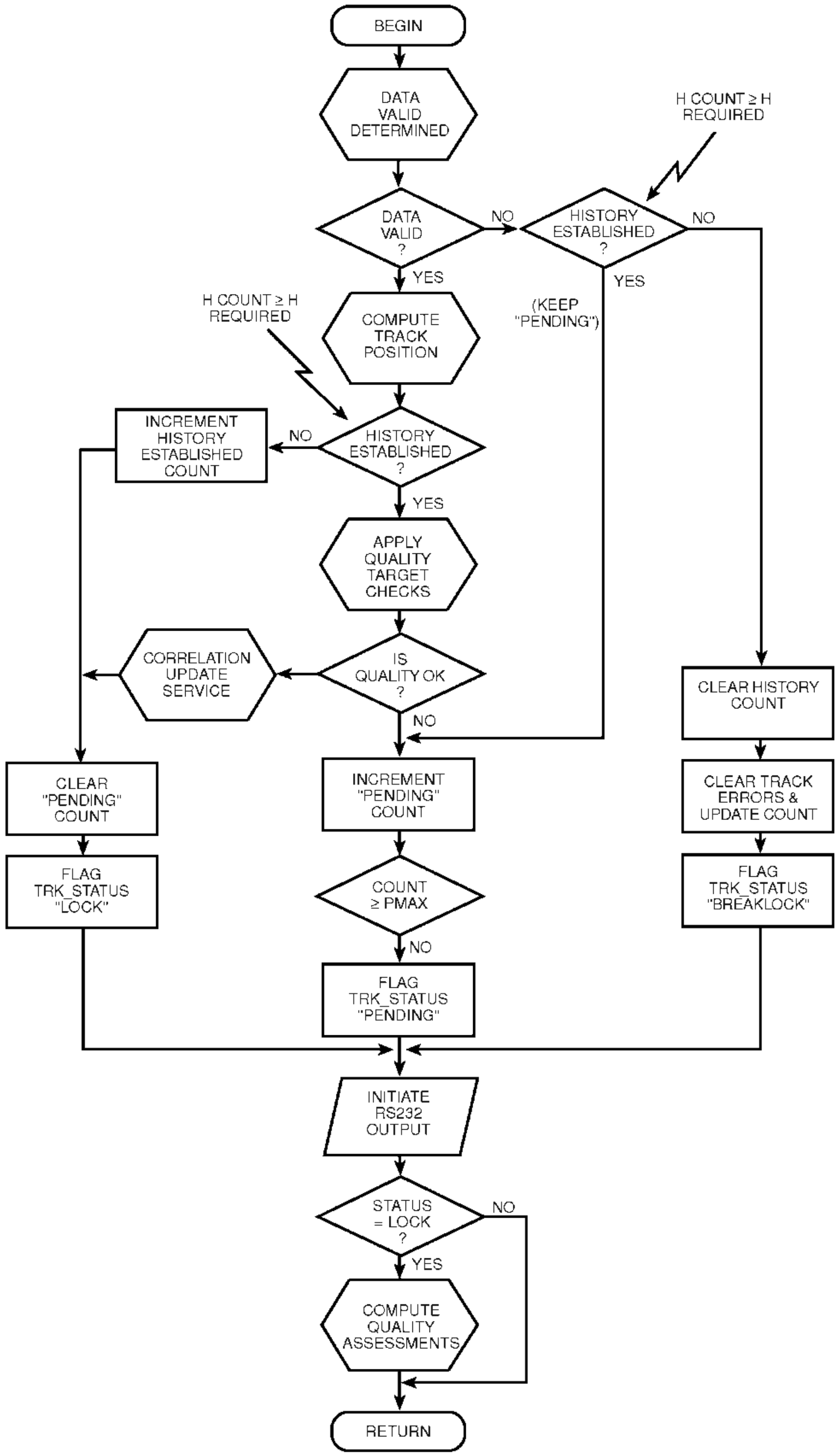


Figure 4.6.1. Track Quality Evaluation Process

4.6.1.1 Edge Tracking

The edge track mode is provided to track a particular point on the edge of the target. This mode is particularly useful when the threshold target data exceeds the size of the track window. This situation would arise while tracking a large (relative to the FOV) missile or a ship at sea silhouetted against the horizon. During edge mode tracking, the digital filter should be enabled to reduce the effects of video noise or minute intrusions within the track window. Still, the edge mode of tracking is the most susceptible to noise or intrusions.

The position rate of change (ROC) is the most important characteristic to be considered for track quality determination during target edge tracking. Any data interference inside the window edge of the selected edge may result in erroneous track error values being computed. The position allowable ROC will immediately detect an intrusion on the selected edge side of the window. Although this test will detect most real intrusions, full target obscuration (by an object or merely contrast) is not easily detected by the allowable position ROC check. For this reason, a target density check is also performed. This check verifies that the count of pixels declared as target has not exceeded configurable field-to-field growth rate. Exceeding the growth rate is a strong indication of intrusions into the track window. These quality check algorithms are described in Paragraph 4.6.3.

4.6.1.2 Centroid Tracking

The centroid track mode is the most effective mode for small targets under low contrast conditions. The centroid process determines the center of the enhanced data encountered within the track window. The noise-to-target ratio is proportional to the true target mass. Noise or minute intrusions of insignificant mass relative to the true target mass does not affect the track error computations. Intrusions, however, greatly increase the apparent target size.

Centroid track processing utilizes three track quality validity checks: target size growth rates in vertical and horizontal axes, target density growth rate, and target position rate of change. Target density and position checks serve the same purpose as explained in Section 4.6.1.1. Size growth rate checks are unique to centroid track. It provides intrusion detection on a per axis basis. Centroid track quality validation check algorithms are described in Section 4.6.3.

4.6.1.3 Correlation Tracking

The correlation track mode is basically an image matching process. The target data being matched is the entire contents of the reference window including the background information. The video field data being analyzed is derived from a different thresholding technique than is used for the density and size parameter computations of the edge and centroid tracking algorithms. Because of these reasons, the size and target density parameters are not applicable to the correlation mode track quality assessment.

The correlation mode track quality is determined from the correlation match value and the allowable position rate of change. The allowable position rate of change is determined the same as for centroid and edge tracking. However, its main function here is the rejection of false correlation peaks within the search area.

The correlation match value is a direct measure of target recognition. The closer the measured correlation value in the current field is to the ideal correlation value, the higher the probability that the correct target has been recognized.

The minimum acceptable correlation value is computed based on reference window size and a minimum acceptable percentage of correlation match for target recognition. The minimum acceptable percentage, which is an externally controlled variable, effectively defines the correlation value noise floor threshold, below which current correlation measurements are rejected.

4.6.2 Data Valid Determination

During edge and centroid modes, track data validity is determined by the number and position of thresholded pixels within the track window. Target validation checks on this pixel data to determine target validity.

During correlation mode, the track point indicator returned from the correlation processor is utilized to determine track data validity. The track point indicator is set and the correlation value is valid if any match count above the specified minimum acceptable value is detected within the search window.

4.6.3 Track Quality Checks

The track quality checks are applied to each field of track data information, once a history has been established. Failure of any of the mode dependent quality checks causes a Pending Breaklock declaration. The parameters applied to the track data information are computed during the previous field. The current track data is utilized by a quality assessment routine to compute quality parameters for application to the next field's track data. The quality checks performed are track mode dependent.

4.6.4 Basic Tracker Algorithm

The tracker software is driven by external events. These events each initiate a service task executive. The events are priority structured such that an event of a higher priority may interrupt a lower priority service executive. The events and associated priorities are as follows:

Power-Up and Reset	Priority	=	2
Serial Data Service	Priority	=	1
Gate Data Available	Priority	=	0

Figure 4.6.2 illustrates the events and associated services of the tracker software.

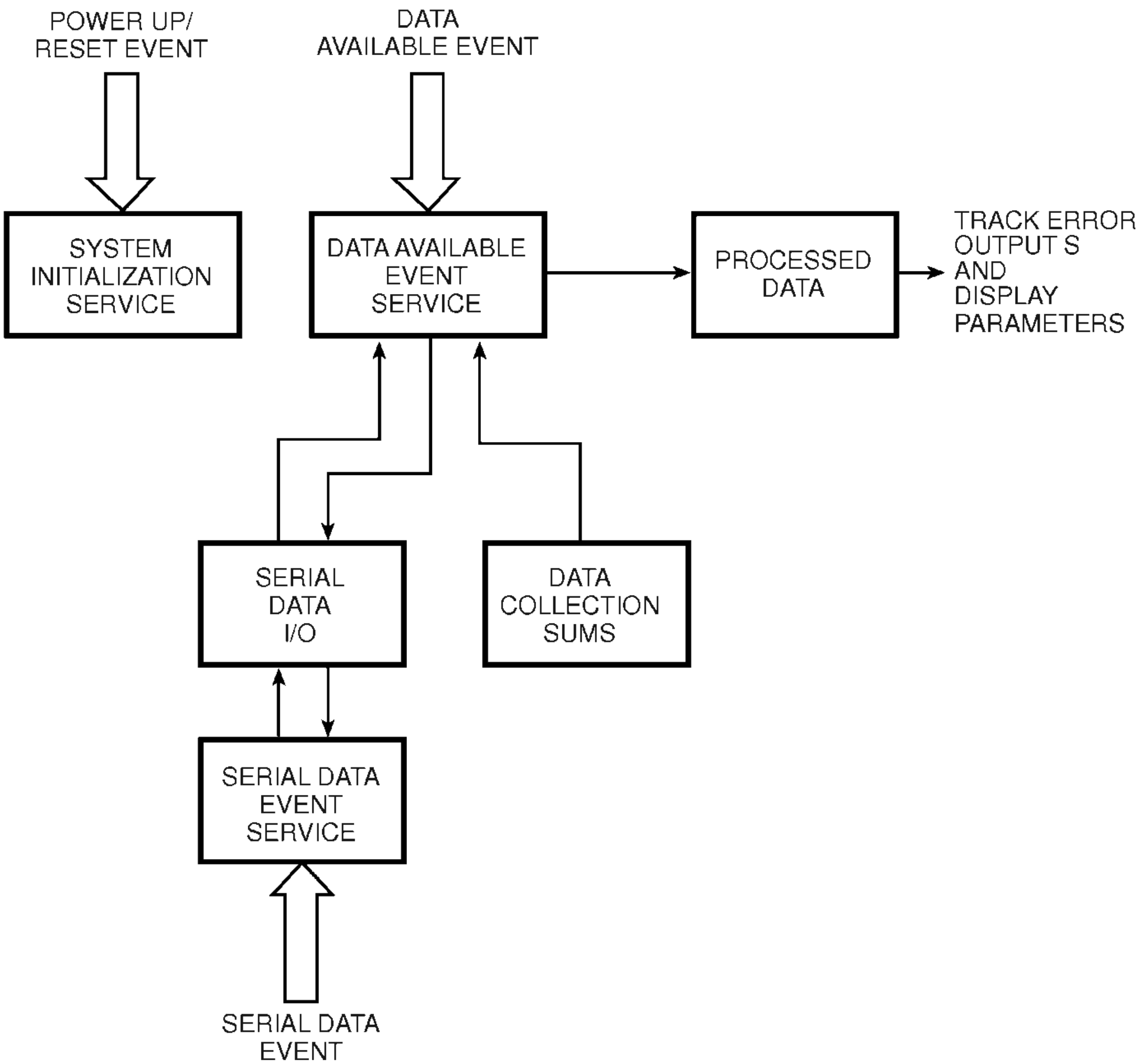


Figure 4.6.2. Tracker Software Block Diagram

4.6.4.1 Power-Up and Reset

The Power-Up and Reset service is entered upon power-up or hardware reset or commanded reset conditions. This process is also executed upon an off-line reset message sequence receipt. Memory is initialized and all tracker devices are reset. The service, upon completion of all initialization functions, transitions to operation mode.

4.6.4.2 Serial Data Service

The Serial Data Service executive monitors the character data transmission and receipt activity of the serial data link.

4.7 Servo Compensation Filter

4.7.1 PID Filter Design

The tracker provides a combination of filtering of the analog error signals. At the core is a classical Proportion Integral Derivative (PID) filter. Figure 4.7.1 illustrates the control system.

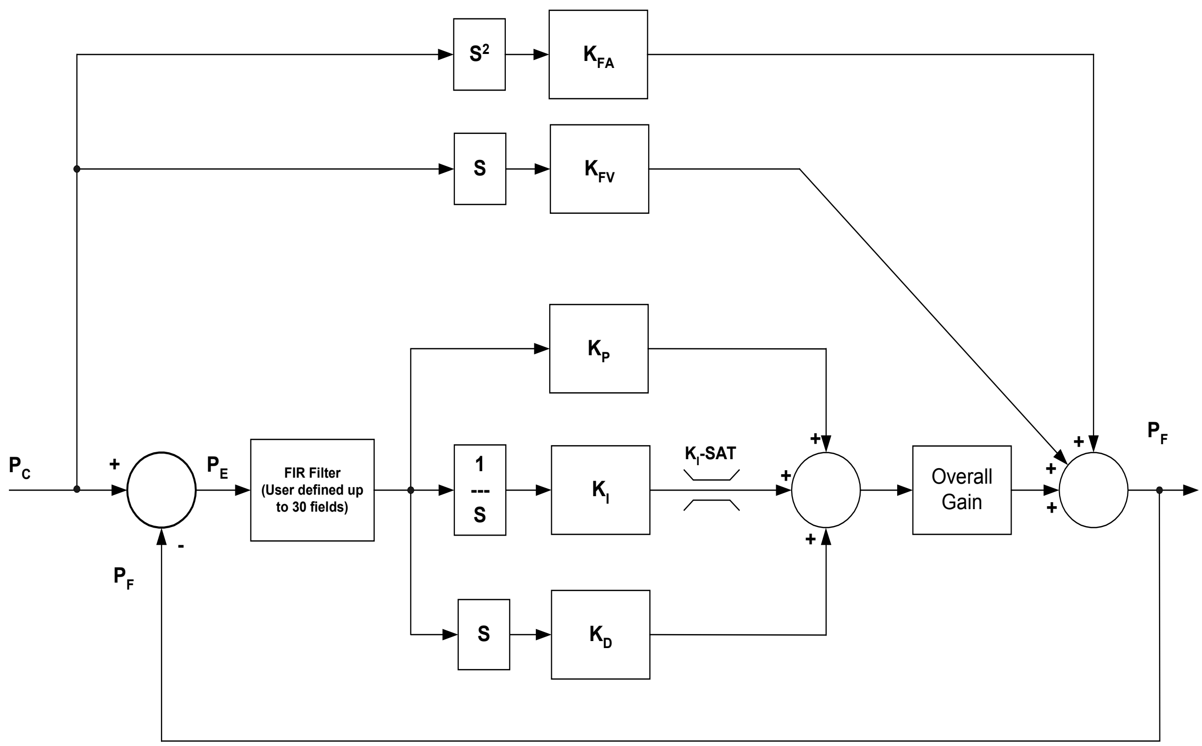


Figure 4.7.1. PID Controller with Feed-Forward and FIR Filtering

The transfer function of the PID filter with feed forward terms in the s domain is:

$$G_c(s) = K_p + \frac{K_i}{s} + K_d s + K_{FA} s^2 + K_{FV} s$$

4.7.2 PID Filter Controls

There are seven primary controls that affect the ability of the tracker system to function in a closed loop environment. Each component performs different but interrelated tasks and each have separate fields for both the X and Y axis.

These components are:

Overall Gain
Proportion
Integral (with clipping)
Derivative
Mount Velocity Feed-Forward
Mount Acceleration Feed-Forward
FIR Filter

4.7.2.1 Overall Gain

Overall gain is simply a multiplier applied to the output of the PID filter. Overall Gain may range from –32.768 to 32.767 and has unique values for both X and Y axis. Default value is 1.0.

4.7.2.2 Proportion

Proportion is a multiplier applied directly to the X and Y track errors. Increasing values of proportion will increase "stiffness" of the mount and decrease the response time of the mount. Values that are too large will cause overshoot and result in oscillation. Setting proportion to 1 results in unity gain of the track errors. Proportion may range from –32.768 to 32.767 and has unique values for both X and Y axis. Default value is 1.0.

4.7.2.3 Integral

The integral term is determined by summing all track errors over the duration of the track period. The integral term is also clipped, or limited in value, to prevent saturation. The integral term may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X and Y axis. The integral clipping term may range from 0.0 to 65.535 in increments of 0.001. Note that clipping is applied to the absolute value of the integral term and does not affect the sign of the integral term. Default value is 0.0.

4.7.2.4 Derivative

The derivative term is simply the difference between the current track and the previous field's track error ($\Delta error / \Delta t$ with Δt equal to one field time). The derivative term may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X and Y axis. Default value is 0.0.

4.7.2.5 Mount Velocity Feed-Forward

The mount position is acquired by the tracker at the end of every field. The velocity is then determined and can be added to the output of the PID filter. Typical values are small, since the mount angle delta can be relatively large compared to the track error in pixels. The mount velocity feed-forward term may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X and Y axis. Default value is 0.0.

4.7.2.6 Mount Acceleration Feed-Forward

The mount position is acquired by the tracker at the end of every field. The acceleration is then determined and can be added to the output of the PID filter. Typical values are small since the mount angle delta can be relatively large compared to the track error in pixels. The mount acceleration feed-forward term may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X and Y axis. Default value is 0.0.

4.7.2.7 FIR Filter

The tracker provides a Finite Impulse Response (FIR) filter prior to the track errors being input to the PID filter. This is effectively a moving average of some number of fields defined by the user. The FIR filter can be up to 255 fields in depth and has unique values for both X and Y axis. Values much greater than a few fields can and probably will lead to instability during track. Default value is 1.

4.7.3 Tuning the PID Filter

There are several books available on PID filter basics, which typically include how to tune a PID filter. The basis for the tracker PID filter design came from Control System Design Guide, second edition, by George Ellis (see his website at http://www.qxdesign.com). It is important to note that tuning a PID filter for a tracking application will depend heavily on the mount performance and its payload. There are multiple ways to tune a PID filter and the method described is simply one of many.

4.7.3.1 PID Tuning - Step 1

Select a high contrast object and position the mount so the target is centered in the video. Make the track box large and set the zoom so that the target occupies about 10-20 percent of the track box.

4.7.3.2 PID Tuning - Step 2

Set the I and D terms for each axis to zero. Set velocity and acceleration terms to zero and disable the FIR filter.

Note: Perform the next two steps one axis at a time for each axis.

4.7.3.3 PID Tuning - Step 3

Offset the object so that the target is close to either side of the track box. Press the track button to get the tracker in track mode. Observe the mount response. Press the track button again to get the tracker in acquire mode.

4.7.3.4 PID Tuning - Step 4

Slowly increase the gain term for the axis under test until an overshoot occurs (when track is selected) with some oscillation. Repeat Step 3 and Step 4 as necessary. Multiply the final gain by 0.75 – this is your final gain value.

4.7.3.5 PID Tuning - Step 5

Slowly increase the differential term for the axis under test until the observed overshoot dissipates to an acceptable level. Repeat Step 3 and Step 5 as necessary.

4.7.3.6 PID Tuning - Step 6

Set the integral clip terms to 0 (unlimited). Slowly increase the integral term for the axis under test until the observed overshoot dissipates to an acceptable level. Repeat Step 3 and Step 6 as necessary. Note that it has been observed that a negative value may be required for some systems.

4.7.3.7 Feed Forward Tuning

Setting the feed-forward terms for velocity and acceleration is a bit more obscure. These terms provide an additional force proportional to the mount's velocity and acceleration. The process is similar to tuning the PID filter but requires a moving target and can be tedious. Feed-forward terms only function for mounts which are controlled serially by the tracker.

4.7.3.8 Feed Forward Tuning - Step 1

Tune the PID filter as described above. Zero the acceleration terms.

4.7.3.9 Feed Forward Tuning - Step 2

Track a moving object with approximately the same velocity and acceleration profile of the subject target. This can be accomplished using a laser mounted on a separate pedestal with a programmable velocity and acceleration profile. Creativity is required on the user's part.

4.7.3.10 Feed Forward Tuning - Step 3

Track the object and slowly increase the velocity term on each subsequent track for each axis until instability is observed, then slightly decrease the term.

4.7.3.11 Feed Forward Tuning - Step 4

Repeat the process for acceleration terms. This process will require some trial and error to obtain the desired values.

4.7.4 Error Signal Polarity

The filter also provides the ability for the user to independently invert the azimuth and elevation error signals.

Appendix A

Interface Definition for the Series 7000 Video Target Tracker

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A1 Tracker I/O

Tracker I/O consists of the following items:

- Power
- Analog Video Inputs (4)
- Analog Video Outputs (3)
- Digital Video I/O (Camera Link, SDI or DVI-D)
- Serial RS-232 / RS-422 Interfaces (4 or 8)
- Analog Errors (2)
- Digital Status (3)
- Digital Errors **or** User Digital I/O (16)
- Analog Inputs (8)
- Gigabit Ethernet Interface
- Bus (VMEbus, PCI or PCI Express) Interface

A1.1 Power

A1.1.1 Model 7005/7006 and 7015/7016 Power

The Model 7005/7006/7015/7016 VME Video Tracker derives its required power, +12/-12/+5 Vdc, from the VMEbus interface connector P1. There is also an external power connector for operation outside of a VMEbus chassis.

A1.1.2 Model 7007/7008 Power

The Model 7007/7008 PCI Video Tracker derives its required power, +12/-12/+5 Vdc, from the PCI interface connector. There is also an external power connector for operation outside of a computer/PCI bus.

A1.1.3 Model 7010/7011 Power

The Model 7010/7011 PCI Express Video Tracker derives its required power, +12 Vdc, from the PCI Express interface connector. There is also an external power connector for operation outside of a computer/PCI Express bus.

A1.1.4 Model 7410/7411/7412 Power

The Model 7410/7411/7412 PCI Express Video Tracker derives its required power, +12 Vdc, from the PCI Express interface connector. There is also an external power connector for operation outside of a computer/PCI Express bus.

A1.2 Analog Video Inputs (4)

Note: Not available on the Model 7410/7411/7412 PCI Express Trackers.

Inputs for up to four (4) analog video sources are provided. Each input video source is switch selectable for single-ended or differential input. Only one analog source can be processed by the tracker at a time. The active source is selected through the serial, bus and/or Ethernet communications link. ***If only one source is to be used, it should be supplied at the VID1 IN connector.*** See Appendix F for video connector pin assignments.

The analog video inputs are RS-170/RS-170A, NTSC, CCIR or PAL standard format; 1.0V peak-to-peak (nominal) and 1.2V peak-to-peak (maximum).

A1.3 Analog Video Outputs (3)

Note: Not available on the Model 7410/7411/7412 PCI Express Trackers.

The video outputs provided are RS-170/RS-170A, NTSC, CCIR or PAL standard format matching the currently selected input video source. The analog outputs are 75 ohm terminated. The video output 3 (VID OUT3) provides an unmodified version of the input video signal. The video outputs 1 (VID OUT1) and 2 (VID OUT2) supply tracker video symbology mixed with the input source video. See Appendix F for pin assignments.

A1.4 Digital Video (Camera Link, SDI or DVI-D)

The Model 7005-CL and 7006-CL VME Trackers have one Camera Link full input and one Camera Link full output. The Model 7005-HD and 7006-HD VME Trackers have two (2) HD-SDI inputs (selectable) and two (2) HD-SDI outputs (one annotated and one un-annotated).

The Model 7410/7411/7412 PCI Express Trackers have one (1) DVI-D input and one (1) DVI-D output.

The Model 7007/7008 PCI, 7010/7011 PCI Express Trackers have optional digital video daughter cards to enable digital video I/O. The Camera Link (CL) daughter card supports one (1) Camera Link full input and one (1) Camera Link full output. The SDI daughter card supports two (2) 3G SDI inputs (selectable) and two (2) 3G SDI outputs (one annotated and one un-annotated). The DVI-D daughter card supports one (1) DVI-D input and one (1) DVI-D output. The CLVS daughter card supports one (1) Camera Link base input and one (1) Camera Link base output.

Reference Appendix F for video connector pin assignments.

A1.5 Serial RS-232 / RS-422 Interfaces (4 or 8)

The Model 7005-CL/7006-CL, 7005-HD/7006-HD, 7007/7008 PCI, and 7010/7011 PCI Express Trackers provide eight (8) serial ports. The first three serial ports are reserved for the GUI (UART0), hand controller (UART1) and mount/servo control (UART2) while the remaining five ports are software selectable for external device control (e.g. camera/lens/LRF/etc). The GUI serial port (UART0) provides user control of the tracker and is jumper or switch selectable between RS-232 and RS-422. The remaining serial ports are ***software*** selectable between RS-232 and RS-422.

The Model 7410/7411/7412 Tracker provides four (4) serial ports. The first three serial ports are reserved for the GUI (UART0), hand controller (UART1) and mount/servo control (UART2) while the remaining port is software selectable for external device control (e.g. camera/lens/LRF/etc). The four (4) serial ports (UART0 – UART3) are switch selectable between RS-232 and RS-422.

Reference Appendix B for serial data interface definitions and Appendix F for serial data pin assignments.

A1.6 Analog Errors (2)

Note: Not available on the Model 7410/7411/7412 PCI Express Trackers.

The computed azimuth and elevation track errors are output as analog voltages. The analog errors are supplied to support the integration of the tracker into a closed loop servo control system. The azimuth and elevation error voltages are switch selectable with ranges of ±5 volts or ±10 volts in standard Cartesian coordinate orientation. The resolution of the analog error output is 16 bits with 1 sign bit and 15 bits of data. The weighting of the LSB is equal to 10V (error voltage range) divided by 2^{15} (-32768 to 32767) which equals 0.15 mV and 0.30 mV for the ±5 volt and ±10 volt ranges respectively. See Appendix F for pin assignments.

A1.7 Digital Status (3)

Note: Not available on the Model 7410/7411/7412 PCI Express Trackers.

The discrete digital signals Coast, Track/Acquire and On-Target are supplied by the tracker. These signals are positive true logic at 3.3 volt TTL voltage levels. See Appendix F for pin assignments.

A1.8 Digital Errors or User Digital I/O (16)

Note: Not available on the Model 7410/7411/7412 PCI Express Trackers.

The computed azimuth and elevation track error values are provided at the digital I/O port. The azimuth error is output first followed by the elevation error. Reference Figure A1.8.1 and Figure A1.8.2. See Appendix F for pin assignments.

The sixteen (16) digital error bits can alternatively be configured for user digital I/O. In this case, there are two 8-bit banks which can be setup as 16-bits of input, 16-bits of output or 8-bits of input and 8-bits of output. User digital input bits can also be mapped to control common tracker functions.

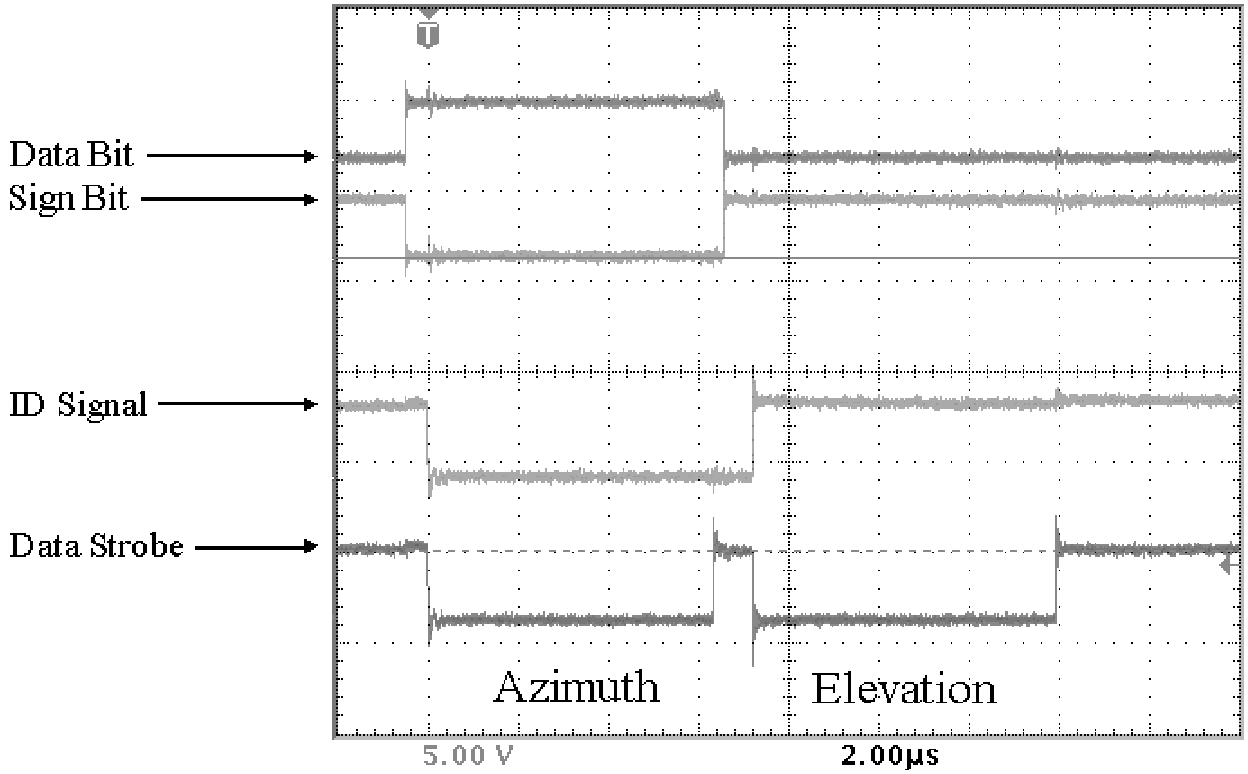

Figure A1.8.1. Digital Error Data Strobe

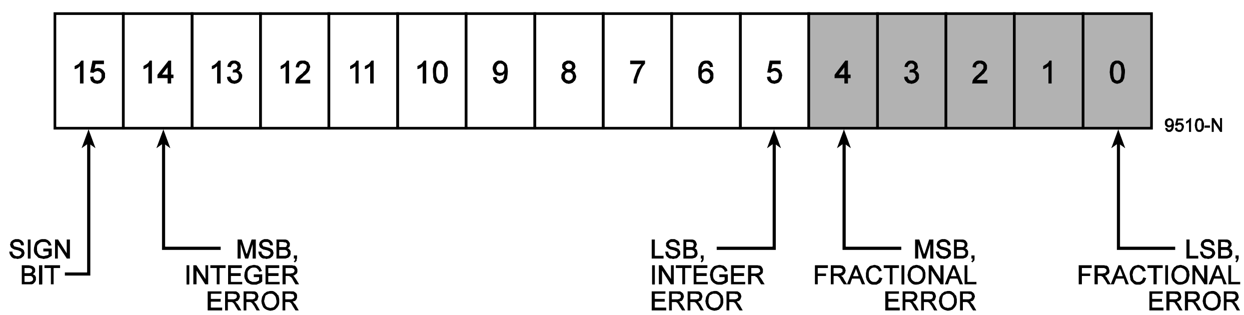

Figure A1.8.2. AZ/EL Position Error Bits (Digital Format)

Note: The digital error signal is composed of integer and fractional bits, along with a sign bit. This allows values to be output in the range -1024.00000 to +1023.96875. If your mount positions adequately using only the integer portion of the error signal, it is not necessary to use the fractional bits. If more precision is desired, including the fractional bits will reduce granularity in the output error signal. The fractional bits are only used in centroid modes.

A1.9 Analog Inputs (8)

Note: Not available on the Model 7410/7411/7412 PCI Express Trackers.

The tracker provides eight analog inputs with a range of ±10 volts. These inputs can also be mapped for joystick or lens input.

A1.10 Gigabit Ethernet

User control of the tracker is provided over a gigabit Ethernet interface via TCP/IP. Reference Appendix B. The tracker may also use this interface for control of external devices such as mounts/gimbals.

A1.11 Bus (VMEbus, PCI or PCI Express) Interface

User control of the tracker is provided over the bus level interface. Reference Appendix B.

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B1 Software Development Kit (SDK)

To access the software development kit (SDK) for the tracker, run the installation program (setup.exe) on the CD-ROM included with the tracker. This will install the Tracker Control GUI, user manual and SDK to your computer. By default, the SDK will be installed to one of the following locations:

C:\Program Files\EO Imaging\<model> Tracker\Tracker SDK

C:\Program Files (x86)\EO Imaging\<model> Tracker\Tracker SDK

Where <model> is the model number of your particular video tracker board or series according to the table below.

Directory	Tracker Models
7005 Tracker	All Series 7000 VMEbus boards
7007 Tracker	7007 / 7008 PCI and 7010 / 7011 PCIe boards
7400 Tracker	7410 / 7411 / 7412 PCIe boards
8000 Tracker	All Series 8000 standalone boards

Under the Tracker SDK directory, the various models are listed similar to above for each type of tracker board. There is a README.TXT file under each which documents changes between releases. Included are helper C++ classes along with C and C++ sample code. The C++ classes provided are the same code used in the Tracker Control GUI. All source code provided is targeted for Windows. However, the MSG_FMT.H header file which defines the tracker message structures is usable for any operating system. When using other programming languages, these files may still be useful as reference material.

B2 Communications Interfaces

B2.1 Serial Communication Protocol

The video tracker supports serial communication with status reported at the video field/frame rate (typically 50 or 60 Hz). The tracker transmission is initiated at the end of the track window processing. After the transmission has been initiated, the processing of the control data received (if any present) will commence. If no control data is present, the tracker state remains unaltered.

The serial interface configuration is as follows:

- 115,200 bps
- Eight data bits
- One start bit
- One parity bit (Odd parity)
- One stop bit

The character data format is depicted in Figure B2.1.

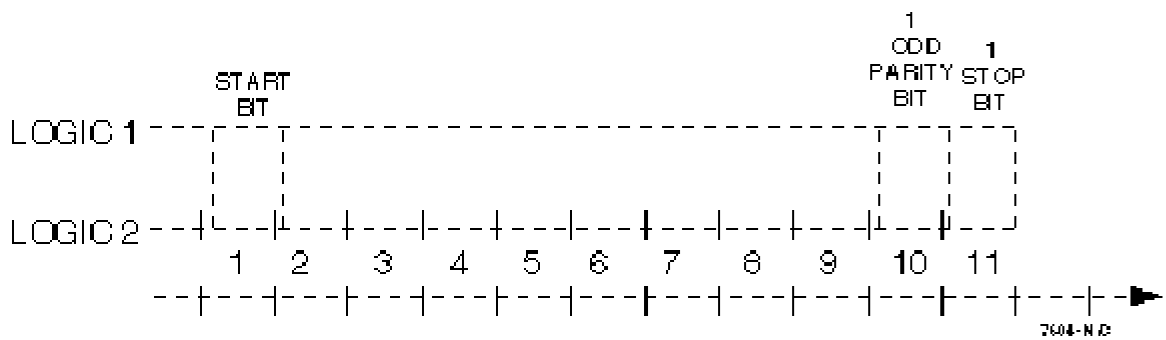

Figure B2.1. Character Data Format

Signal Transmission Frame: The signal transmission frame time for the transmission of 1 byte signal is composed of 11 bit time intervals.

Bit Time Interval: Nominal: 8.68 µs (115.2 kbps)

The message formats, as described in the following paragraphs, are depicted as 16-bit words. The first byte transmitted for each 16-bit word is the most significant byte (Bits 15-8). Each block message consists of a 16-bit sync word, a defined number of data words, and terminated by a 16-bit checksum. The 16-bit sync word is 0xA5A5 (hexadecimal) or 42405 (decimal) for the first track gate. Additional track gates have different sync words. The checksum is the 2's complement of the sum of the message bytes (see example below).

Checksum Calculation Example:

Add message bytes:	0xA5
	+ 0xA5
	+ 0x05
	+ 0xFC
	+ 0x00
	+ 0x00
	0x024B
Calculate 2s compliment	
1. Compliment (negate) the value:	0xFFFFFDB4
2. Increment the value (+1):	0xFFFFFDB5
3. Keep the low order 16 bits for your checksum:	0xFDB5

Figure B2.2. Checksum Calculation Example

B2.2 Bus Communication Protocol

Message structure and content is the same for all interfaces. Tracker transmission over the VMEbus, PCI/PCI Express bus and Ethernet also use the same format as the serial transmissions.

B2.2.1 VME Tracker Control

The VME interface is through a shared dual port RAM providing 4k x 16 bits of data space. The tracker operates as a slave device and may be accessed in supervisory or non-privileged mode.

The VME Base Address of the tracker board is set using switches on the board. The tracker will accept the standard address modifiers: 0x3D supervisory or 0x39 non-privileged. The board is addressed as A24/D16.

The VME Host sends control command messages to the tracker by writing a message block to the base address. All messages—sent and received—are stored in a dual-port memory on the tracker board. There are three control addresses in the tracker's dual-port memory, the command mailbox at base + 0x0FFE, the status mailbox at base + 0x0FFF and the query response mailbox at base + 0x0841 (all addresses referenced here are written as 16-bit addresses and must be doubled if 8-bit addresses are being used).

The following sequences describe the processes that are to be used to communicate with the tracker.

Command Messages to the VME Tracker

Base address + 0x0FFE is the location of the tracker command mailbox. This is the address to which the host writes a non-zero value to interrupt the tracker with a command. The procedure for sending a command to the tracker is:

1. Check the command mailbox for a zero value. If the value in the mailbox is zero, it indicates that the tracker is ready to receive a new command; non-zero indicates that the tracker has not yet processed the last command sent by the host.

2. When the command mailbox contains zero, the host may write the new command into the dual-port memory at address base + 0x0000. The desired message block is written to the memory with the Most Significant Byte (MSB) first, also known as Big Endian.

3. The host then writes a non-zero value into the command mailbox (base + 0x0FFE) to interrupt the tracker and cause the new command to be processed.

4. When the tracker has processed the command, the tracker will write zero into the command mailbox telling the host that a new command may be sent.

Status Messages from the VME Tracker

Base address + 0x0FFF is the location of the tracker status mailbox. This is the address to which the tracker writes a non-zero value to flag the host of the existence of a new tracker status message. Except for addresses, the tracker follows the same procedure as the host did when sending a command message. For the host processor to read the tracker status output message:

1. The host checks the status mailbox (base + 0x0FFF) for a non-zero value. If a zero is found, read the status mailbox periodically (25 microseconds to 1 second) until a non-zero value is read.

2. The tracker writes a status message into the dual-port memory at base address + 0x0800. Then the tracker writes a non-zero value into the status mailbox (base + 0x0FFF) to flag the host that a new status message is available.

3. When the host reads a non-zero value in the status mailbox (base + 0x0FFF), the host reads the status message out of dual-port memory at base address + 0x0800.

4. When the host has finished reading the status message, it must write a zero to the status mailbox (base + 0x0FFF) to indicate to the tracker that the host has completed the read. The tracker will not send any further status messages until the host indicates an "all clear" by writing zero to the status mailbox to prevent the contents of the current message from being modified by the tracker prior to the read being complete.

Query Response Messages from the VME Tracker

Base address + 0x0841 is the location of the tracker query response mailbox. This is the address to which the tracker writes a non-zero value to flag the host of the existence of a new tracker response message. Except for addresses, the tracker follows the same procedure as for status messages. For the host processor to read the tracker query response output message:

1. The host checks the response mailbox (base + 0x0840) for a non-zero value. If a zero is found, read the status mailbox periodically (25 microseconds to 1 second) until a non-zero value is read.

2. The tracker writes a response message into the dual-port memory at base address + 0x0841. Then the tracker writes a non-zero value into the response mailbox (base + 0x0840) to flag the host that a new query response message is available.

3. When the host reads a non-zero value in the response mailbox (base + 0x0840), the host reads the query response message out of dual-port memory at base address + 0x0841.

4. When the host has finished reading the response message, it must write a zero to the response mailbox (base + 0x0840) to indicate to the tracker that the host has completed the read. The tracker will not send any further response messages until the host indicates an "all clear" by writing zero to the response mailbox to prevent the contents of the current message from being modified by the tracker prior to the read being complete.

The host should allow at least 25 microseconds delay between reads of a tracker status or query response mailbox. Longer delays (up to 1 second or so) will not adversely affect the tracker, but shorter ones add unnecessary traffic on the VME bus. When initializing the system, the first thing the host should do is to write a 0x0000 to the status and query response mailboxes. When the tracker initializes its VME interface, it writes a 0x0000 to the command mailbox allowing the host to begin communications.

Address	Size in Bytes	Data
Base Address + 0x0000	128	Command Message to Tracker
Base + 0x0100 (16-bit) Base + 0x0200 (8-bit)	44	Fast User String 1
Base + 0x0116 (16-bit) Base + 0x022C (8-bit)	44	Fast User String 2
Base + 0x012C (16-bit) Base + 0x0258 (8-bit)	44	Fast User String 3
Base + 0x0142 (16-bit) Base + 0x0284 (8-bit)	44	Fast User String 4
Base + 0x0800 (16-bit) Base + 0x1000 (8-bit)	128	Status Message to Host
Base + 0x0840 (16-bit) Base + 0x1080 (8-bit)	2	Query Response Mailbox
Base + 0x0841 (16-bit) Base + 0x1082 (8-bit)	128	Query Response Message to Host
Base + 0x0881 (16-bit) Base + 0x1102 (8-bit)	2	Mount Performance Mailbox
Base + 0x0882 (16-bit) Base + 0x1104 (8-bit)	128	Mount Performance Data
Base + 0x0FFE (16-bit) Base + 0x1FFC (8-bit)	2	Command Mailbox
Base + 0x0FFF (16-bit) Base + 0x1FFE (8-bit)	2	Status Mailbox

Figure B2.3. VME Interface Dual-Port Memory Map

B2.2.2 Tracker Board VMEbus Address Setting

The base address for the tracker board is set (Figure B2.4 and Figure B2.5) using the switches at location S6 indicated in Figure B2.6.

The VMEbus address is 24-bits. The value set on the Address Switch represents the top 8 bits of the 24-bit address. The board address can be set to any value from 0x00 to 0xFF. This provides a base address range from 0x00 0000 to 0xFF 0000.

This switch setting provides an address range of 0xAA0000 through 0xAAFFFF.

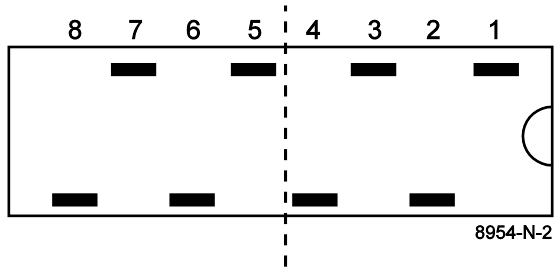

Figure B2.4. S6 Switch Settings

This switch setting provides an address range of 0x550000 through 0x55FFFF.

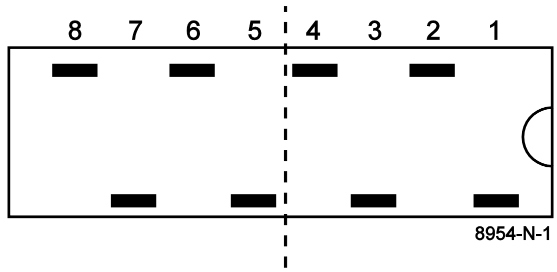

Figure B2.5. Alternate Address S6 Switch Settings

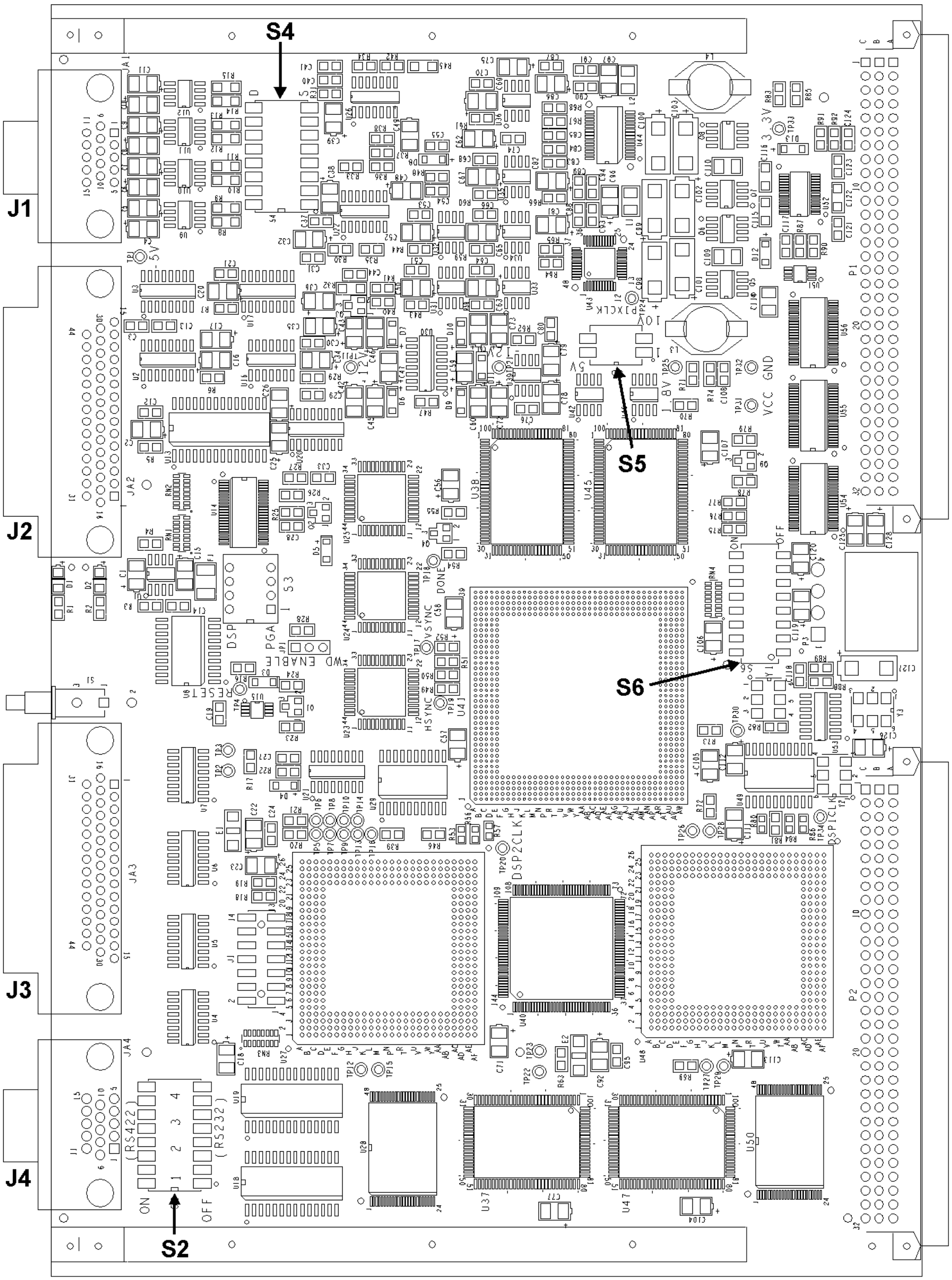

Figure B2.6. Typical Tracker Board Layout

B2.2.3 PCI Tracker Control

The PCI interface is through a shared dual port memory space. The tracker operates as a PCI slave device using the PLX PCI 9054 chipset or a compatible emulation.

The PCI Host sends control command messages to the tracker by writing a message block to the base address. All messages—sent and received—are stored in a dual-port memory on the tracker board. There are three control addresses in the tracker's dual-port memory, the command mailbox at base + 0x03FE, the status mailbox at base + 0x07FE and the query response mailbox at base + 0x07FC (all addresses referenced here are written as standard 8-bit addresses and must be halved if 16-bit addresses are being used).

The following sequences describe the processes that are to be used to communicate with the tracker.

Command Messages to the PCI Tracker

Base address + 0x03FE is the location of the tracker command mailbox. This is the address to which the host writes a non-zero value to interrupt the tracker with a command. The procedure for sending a command to the tracker is:

1. Check the command mailbox for a zero value. If the value in the mailbox is zero, it indicates that the tracker is ready to receive a new command; non-zero indicates that the tracker has not yet processed the last command sent by the host.

2. When the command mailbox contains zero, the host may write the new command into the dual-port memory at address base + 0x0000.

3. The host then writes a non-zero value into the command mailbox (base + 0x03FE) to interrupt the tracker and cause the new command to be processed.

4. When the tracker has processed the command, the tracker will write zero into the command mailbox telling the host that a new command may be sent.

Status Messages from the PCI Tracker

Base address + 0x07FE is the location of the tracker status mailbox. This is the address to which the tracker writes a non-zero value to flag the host of the existence of a new tracker status message. The tracker writing to the status mailbox will also trigger a PCI interrupt. ***(NOTE: The host must clear both the status mailbox and the query response mailbox to clear the PCI interrupt.)*** Except for addresses, the tracker follows the same procedure as the host did when sending a command message. For the host processor to read the tracker status output message:

1. After the host receives an interrupt or if polling, the host checks the status mailbox (base + 0x07FE) for a non-zero value. If a zero is found, read the status mailbox periodically (25 microseconds to 1 second) until a non-zero value is read (only if polling).

2. The tracker writes a status message into the dual-port memory at base address + 0x0400. Then the tracker writes a non-zero value into the status mailbox (base + 0x07FE) to flag the host that a new status message is available.

3. When the host reads a non-zero value in the status mailbox (base + 0x07FE), the host reads the status message out of dual-port memory at base address + 0x0400.

4. When the host has finished reading the status message, it must write a zero to the status mailbox (base + 0x07FE) to indicate to the tracker that the host has completed the read. The tracker will not send any further status messages until the host indicates an "all clear" by writing zero to the status mailbox to prevent the contents of the current message from being modified by the tracker prior to the read being complete. ***(NOTE: The host must clear both the status mailbox and the query response mailbox to clear the PCI interrupt.)***

Query Response Messages from the PCI Tracker

Base address + 0x07FC is the location of the tracker query response mailbox. This is the address to which the tracker writes a non-zero value to flag the host of the existence of a new tracker response message. The tracker writing to the query response mailbox will also trigger a PCI interrupt. *(NOTE: The host must clear both the status mailbox and the query response mailbox to clear the PCI interrupt.)* Except for addresses, the tracker follows the same procedure as for status messages. For the host processor to read the tracker query response output message:

1. After the host receives an interrupt or if polling, the host checks the query response mailbox (base + 0x07FC) for a non-zero value. If a zero is found, read the query response mailbox periodically (25 microseconds to 1 second) until a non-zero value is read (only if polling).

2. The tracker writes a response message into the dual-port memory at base address + 0x0480. Then the tracker writes a non-zero value into the response mailbox (base + 0x07FC) to flag the host that a new query response message is available.

3. When the host reads a non-zero value in the response mailbox (base + 0x07FC), the host reads the query response message out of dual-port memory at base address + 0x0480.

4. When the host has finished reading the response message, it must write a zero to the response mailbox (base + 0x07FC) to indicate to the tracker that the host has completed the read. The tracker will not send any further response messages until the host indicates an "all clear" by writing zero to the response mailbox to prevent the contents of the current message from being modified by the tracker prior to the read being complete. *(NOTE: The host must clear both the status mailbox and the query response mailbox to clear the PCI interrupt.)*

If polling, the host should allow at least 25 microseconds delay between reads of a tracker status or query response mailbox. Longer delays (up to 1 second or so) will not adversely affect the tracker, but shorter ones add unnecessary traffic on the PCI bus. When initializing the system, the first thing the host should do is to write a 0x0000 to the status and query response mailboxes. When the tracker initializes its PCI interface, it writes a 0x0000 to the command mailbox allowing the host to begin communications.

Address	Size in Bytes	Data
Base Address + 0x0000	128	Command Message to Tracker
Base + 0x0200 (8-bit) Base + 0x0100 (16-bit)	44	Fast User String 1
Base + 0x022C (8-bit) Base + 0x0116 (16-bit)	44	Fast User String 2
Base + 0x0258 (8-bit) Base + 0x012C (16-bit)	44	Fast User String 3
Base + 0x0284 (8-bit) Base + 0x0142 (16-bit)	44	Fast User String 4
Base + 0x03FE (8-bit) Base + 0x01FF (16-bit)	2	Command Mailbox
Base + 0x0400 (8-bit) Base + 0x0200 (16-bit)	128	Status Message to Host
Base + 0x0480 (8-bit) Base + 0x0240 (16-bit)	128	Query Response Message to Host
Base + 0x0500 (8-bit) Base + 0x0280 (16-bit)	128	Mount Performance Data
Base + 0x07FA (8-bit) Base + 0x03FD (16-bit)	2	Mount Performance Mailbox
Base + 0x07FC (8-bit) Base + 0x03FE (16-bit)	2	Query Response Mailbox
Base + 0x07FE (8-bit) Base + 0x03FF (16-bit)	2	Status Mailbox

Figure B2.7. PCI Interface Memory Map

B2.2.4 PCI Express Tracker Control

The PCI Express interface and messaging structures are identical to that of the PCI interface (Reference Section B2.2.3).

B2.3 Ethernet Communication Protocol

Message structure and content is the same for all interfaces. The Ethernet interface to the tracker is TCP/IP on port 30000.

B3 Tracker Status and Error Output

The tracker message format for the all the interfaces shall contain the same information, in the same format, as the serial message format.

B3.1 Tracker Status Message

In response to a ping message (message type 0) or at the end of track gate processing (if enabled), the status message will be updated on the VME/PCI interface and/or sent via the serial and/or Ethernet interfaces.

The message block transmitted by the tracker contains the current state of the tracker and the track error status and data. The status message block format is depicted in Figure B3.1. The parameters are defined in the following paragraphs.

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 255</td><td colspan="3">SE</td><td>If</td><td colspan="4">Gate Number</td></tr>
<tr><td>Word 3</td><td colspan="16">Raw Track Error X</td></tr>
<tr><td>Word 4</td><td colspan="16">Raw Track Error Y</td></tr>
<tr><td>Word 5</td><td>ca</td><td>Lf</td><td>scn</td><td>cb</td><td>log</td><td>aaq</td><td colspan="3">Track Mode</td><td>trk</td><td colspan="3">Track State</td><td colspan="3">Target Polarity</td></tr>
<tr><td>Word 6</td><td colspan="16">Status</td></tr>
<tr><td>Word 7</td><td colspan="16">Target Size X</td></tr>
<tr><td>Word 8</td><td colspan="16">Target Size Y</td></tr>
<tr><td>Word 9</td><td colspan="16">Target Left</td></tr>
<tr><td>Word 10</td><td colspan="16">Target Top</td></tr>
<tr><td>Word 11</td><td colspan="16">Target Pixel Count / Correlation Percent</td></tr>
<tr><td>Word 12</td><td colspan="16">Azimuth (least significant word)</td></tr>
<tr><td>Word 13</td><td colspan="16">Azimuth (most significant word)</td></tr>
<tr><td>Word 14</td><td colspan="16">Elevation (least significant word)</td></tr>
<tr><td>Word 15</td><td colspan="16">Elevation (most significant word)</td></tr>
<tr><td>Word 16</td><td colspan="16">Filtered Track Error X</td></tr>
<tr><td>Word 17</td><td colspan="16">Filtered Track Error Y</td></tr>
<tr><td>Word 18</td><td colspan="16">Checksum</td></tr>
</table>

Figure B3.1. Status Message

Sync Word:	0xA5A5
Message Type:	255 (0xFF)
Gate Number:	Gate number generating this status report
If:	Interlace field indicator 0 – Even Field 1 – Odd Field or Progressive
SE:	Spare extended status bit(s) The interlace field indicator (If) and other future extended status bits are only output when enabled (Reference B4.3 System Control Message). If not enabled, these bits will all be zero.
Raw Track Error X:	The X (pixel/azimuth) track error of the target with respect to the boresight position with no filters or scaling applied. Data Format: 16-bits two's complement Scaling: LSB = 1/32 pixel (divide by 32) Range: up to ±1023.96875 pixels ±511.03125 pixels for RS-170/NTSC
Raw Track Error Y:	The Y (line/elevation) track error of the target with respect to the boresight position with no filters or scaling applied. Data Format: 16-bits two's complement Scaling: LSB = 1/32 line (divide by 32) Range: up to ±1023.96875 lines ±511.03125 lines for RS-170/NTSC
Target Polarity:	A coded data field commanding the color of the target to be tracked. ***Reference Appendix C, Section C2.5 Target Polarity*** Color: 000 - Gray 001 - White 010 - Black 011 - Mix 100 - Auto

Track State: The current track state. Information is displayed in real-time output video, if enabled.

000 - Initialization
001 - Acquire
010 - Pending Track
011 - On Track
100 - Coast
101 - Off Track
110 - Auto Acquire

trk: The current desired tracking state. ***Reference Appendix C, Section C2.9 Track Control***

0 - Acquire
1 - Track

Track Mode: The current tracking mode. ***Reference Appendix C, Section C2.8 Track Mode***

Modes:
000 - Top edge
001 - Bottom edge
010 - Left edge
011 - Right edge
100 - Centroid
101 - Intensity
110 - Vector
111 - Correlation

aaq: The Auto-Acquire enabled flag. ***Reference Appendix C, Section C2.9 Track Control, and Section C3.3 Track / Acquire Button***

0 - Disabled
1 – Enabled

log: Log message to scan file flag. See the scan message (Type 16) for a more detailed description.

0 - No action
1 - Log to file

cb: Control box status flag. If the control box is enabled, run-time control messages (Type 1) sent to the tracker will be ignored.

0 - Enabled
1 - Disabled

scn:	Mount scan mode flag. See the scan message (***B4.17***) for a more detailed description. 0 - Enabled/Active 1 - Disabled
Lf:	Log to file flag. See the scan message ***(B4.17***) for a more detailed description. 0 - Enabled/Active (log this message) 1 - Disabled
ca:	Command Acknowledge bit. 0 - Unsolicited 1 – Response to a ping message (0)
Status:	This current target status and validation results. ***Reference Appendix C, Section C2.10 Real Time Data***

BASIC TARGET CRITERIA

BIT 1 SET	-	TOO FEW TARGET PIXELS
BIT 2 SET	-	TOO MANY TARGET PIXELS

TARGET VALIDATION

BIT 3 SET	-	X POSITION FAIL
BIT 4 SET	-	Y POSITION FAIL
BIT 5 SET	-	NCOUNT TOO LARGE
BIT 6 SET	-	NCOUNT TOO SMALL
BIT 7 SET	-	X SIZE FAIL
BIT 8 SET	-	Y SIZE FAIL

CORRELATION

BIT 12 SET	-	CORR MATCH FAIL

Target Size X:	The size in X (pixels) of the smallest rectangle that fully encloses the target.	
	Data Format:	16-bit binary
	Range:	0 to 1023 pixels
Target Size Y:	The size in Y (lines) of the smallest rectangle that fully encloses the target.	
	Data Format:	16-bit binary
	Range:	0 to 1023 lines
Target Left:	The left (X/pixel) position of the bounding rectangle of the target.	
	Data Format:	16-bit binary
	Range:	0 to 2047 pixels where 0,0 is the upper-left of the field/frame
Target Top:	The top (Y/line) position of the bounding rectangle of the target.	
	Data Format:	16-bit binary
	Range:	0 to 2047 lines where 0,0 is the upper-left of the field/frame
Target Pixel Count:	The pixel count (mass size) of the target when in contrast modes or the correlation quality/match percentage when in correlation mode.	
Azimuth:	Least and most significant word of current 32-bit mount azimuth position.	
	Data Format:	32-bits two's complement
	Scaling:	LSB = 0.0001 degree (divide by 10,000)
	Range:	±360.0000 degrees
Elevation:	Least and most significant word of current 32-bit mount elevation position.	
	Data Format:	32-bits two's complement
	Scaling:	LSB = 0.0001 degree (divide by 10,000)
	Range:	±360.0000 degrees
Filtered Track Error X:	The X (pixel/azimuth) track error of the target with respect to the boresight position with scaling and all enabled filters applied.	
	Data Format:	16-bits two's complement
	Scaling:	LSB = 1/32 pixel (divide by 32)
	Range:	up to ±1023.96875 pixels

±511.03125 pixels for RS-170/NTSC

Filtered Track Error Y:	The Y (line/elevation) track error of the target with respect to the boresight position with scaling and all enabled filters applied.

Data Format:	16-bits two's complement
Scaling:	LSB = 1/32 line (divide by 32)
Range:	up to ±1023.96875 lines ±511.03125 lines for RS-170/NTSC

Checksum:	This field is the two's complement of the 16-bit sum of the 8-bit bytes of the message buffer, including the sync word, up to but not including the checksum. This will be a sign extended value. The 16-bit summation of the first n bytes of this buffer, and this field, should equal zero. An example of the checksum calculation is shown in Figure B2.2.

B4 Tracker Command Messages

This section describes the command messages that can be sent to the tracker. Of special notice are the ping message (Type 0), run time control message (Type 1), system control message (Type 2) and the query configuration message (Type 20). Many systems can be implemented using only these four command messages along with standard status message handling.

All command messages include a checksum. This field is the two's complement of the 16-bit sum of the 8-bit bytes of the message buffer, including the sync word, up to but not including the checksum. This will be a sign extended value. The 16-bit summation of the first n bytes of this buffer, and this field, should equal zero. An example of the checksum calculation is shown in Figure B2.2.

Note: In all commands, all spare and unused bits must be cleared to zero (0).

B4.1 Ping Message

The tracker responds to this message by transmitting a status message (if possible). No other functions or messages are affected. This is an easy way to poll the tracker for status when video field/frame rate status updates are disabled. This message has no effect when video field/frame rate status updates are enabled (see the system control message for details).

Reference Appendix C, Section C4.2.2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 0								Spare							
Word 3	Checksum															

Figure B4.1. Ping Message

Sync Word: 0xA5A5

Message Type: 0

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B4.2 Run Time Control Message

The message blocks received by the tracker allow remote control of all tracker states and parameters (Figure B4.2). The tracker accepts configuration messages, as well as control messages. The field parameters are defined in the following paragraphs.

Reference Sections C1 and C2 for a description of the functions and messages.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 1								Rst	AQ	Spare					
Word 3	TA	Track Mode			Target Polarity			AT	AS	AP	Ath	RM		Frc	Spare	
Word 4	Gate Position X															
Word 5	Gate Position Y															
Word 6	Gate Size X															
Word 7	Gate Size Y															
Word 8	Spare					Black Threshold										
Word 9	Spare					White Threshold										
Word 10	Spare															
Word 11	Checksum															

Figure B4.2. Run Time Control Message Format

Sync Word: 0xA5A5

Message Type: 1

AQ: Active or quiet state bit.

1 - Tracker is active; all commands are processed
0 - Tracker is quiet; all commands are ignored until a 1 is received. Tracker is sent to its quiet state upon receipt of first zero.

Rst: Tracker reset bit. Three consecutive fields of a 1 in this bit position will command the tracker to perform a full reset.

Frc: Force an update to the track/acquire status. (See TA bit below)

0 – Normal Operation <DEFAULT>
1 – Force Update

RM:	Right mouse button. 0 – Idle 1 – Down / pressed 2 – Up / released
Ath:	This field controls the threshold mode of the tracker. When Auto is selected, the black and white threshold parameters are interpreted as auto threshold percent values. ***Reference Appendix C, Section C2.2 Threshold Control*** 0 - Manual Threshold <DEFAULT> 1 - Auto Threshold
AP:	This field controls the gate (window) positioning mode of the tracker. ***Reference Appendix C, Section C2.3 Gate Position*** 0 - Manual Gate Position <DEFAULT> 1 - Auto Gate Position
AS:	This field controls the window sizing mode of the tracker. ***Reference Appendix C, Section C2.4 Gate Size*** 0 - Manual Window Size <DEFAULT> 1 - Auto Window Size
AT:	This field commands auto track mode. Enabling will cause the system to transition to track state for any valid targets. 0 - Disabled 1 - Auto Track Enabled
Target Polarity:	A coded data field commanding the color of the target to be tracked. ***Reference Appendix C, Section C2.5 Target Polarity*** 000 - Gray 001 - White <DEFAULT> 010 - Black 011 - Mix 100 - Auto

Track Mode: A coded data field commanding the tracking mode of the tracker. ***Reference Appendix C, Section C2.8 Track Mode***

000 - Top edge
001 - Bottom edge
010 - Left edge
011 - Right edge
100 - Mass Centroid <DEFAULT>
101 - Intensity Centroid
110 - Vector
111 - Correlation

TA: The track/acquire bit. This field commands the tracking state of the tracker. ***Reference Appendix C, SectionC2.9 Track Control***

0 - Acquire <DEFAULT>
1 - Track

Gate Position X & Y: These fields define the track window position, in Manual Window Position mode, relative to the center of the field of view. ***Reference Appendix C, Section C2.3 Gate Position***

Data Format:	16-bit two's complement
Scaling:	LSB = 2 pixels / 2 lines
Range:	X: ±511, Y: ±120 (Y range is video format dependent)
Default Position:	(0, 0)

Gate Size X & Y: These fields define the track window size in Manual Window Size mode. ***Reference Appendix C, Section C.2.4 Gate Size***

Data Format:	16-bit binary
Scaling:	LSB = 4 pixels / 1 line
Range:	X: 1 to 1024, Y: 0 to 255
Default Size:	200 pixels x 50 lines

Black & White Threshold:
This field defines white and black the threshold levels for Manual Threshold mode when the Ath bit is zero, and threshold percent values when the Ath bit is one. ***Reference Appendix C, Section C2.2 Threshold Control***

Data Format:	10-bit binary
Range:	0 to 1023 (manual) / 0 to 100% (auto)
Default:	511 (manual) / 50% (auto)

B4.3 System Control Message

Reference Appendix C, Sections C1 and C2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 2								Rt Dest		DG	Out	Video Source			
Word 3	Auto Size Ratio															
Word 4	Vector Transition Time								Acquire Validation Time							
Word 5	Spare							XS	TG	SL	EA	AK	CE	SE	SA	PA
Word 6	Checksum															

Figure B4.3. System Control Message

Sync Word: 0xA5A5

Message Type: 2

Video Source: This field defines the analog video source selection that will be used when the AD bit is cleared for analog. Note: A video source is required on Video Input 1 for Power Up and Reset in the Analog mode. ***Reference Appendix C, Section C3.1.1 Video Source***

0 – Analog Video Source 1 <DEFAULT>
1 – Analog Video Source 2
2 – Analog Video Source 3
3 – Analog Video Source 4
4 – Digital Video Source 1
5 – Digital Video Source 2 (Only on models with HD-SDI)

Out: This field determines how to handle the Status Message output over the serial and bus interfaces. ***Reference Appendix C, Section C3.1.7 Status Message Output***

0 – Output in response to a Ping Message only
1 – Output at field/frame rate (usually 50 Hz or 60 Hz) <DEFAULT>

DG: This field defines whether the tracker will enable the second track gate. The second gate is only available on the Model 7006, 7008, 7011, 7016, 7411, and 7412 Video Trackers.

0 – Single Gate Only <DEFAULT>
1 – Use Dual Gates

Rt Dest: Destination for field/frame rate status messages.

0 – Both bus and serial <DEFAULT>
1 – Bus (VME/PCI) only
2 – Serial (UART0) only

Auto Size Ratio: This field defines the gate to target ratio when auto size is enabled.

Data Format:	16-bit binary
Scaling:	LSB = 0.01 (divide by 100)
Range:	1.00 to 655.35
Default Value:	1.50 (raw value: 150)

Acquire Validation Time: The required number of fields that a target must be valid in order to enter track mode.

Vector Transition Time: When in vector track mode, the aim point transition time in fields when changing edges.

PA: This bit defines whether or not to allow auto gate (window) position when the tracker is in acquire mode. Reference bit AP in Section B4.2.

0 – Auto Gate Position Disabled when in Acquire Mode <DEFAULT>
1 – Enable

SA: This bit defines whether or not to allow auto gate (window) size when the tracker is in acquire mode. *Reference bit AS in Section B4.2.*

0 – Auto Gate Size Disabled when in Acquire Mode <DEFAULT>
1 – Enable

SE: This bit defines whether or not to allow auto gate (window) size when the tracker is in edge mode. *Reference bit AS in Section B4.2.*

0 – Auto Gate Size Disabled when in Edge Mode <DEFAULT>
1 – Enable

CE: Use the Centroid projected in edge mode.

0 – Disable
1 – Enable

AK: Enable sending of message acknowledgements.

0 – Disable
1 – Enable

EA:	Allow target error output when in acquire mode. 0 – Disable 1 – Enable
SL:	Slave all configured lens FOVs to the currently selected camera/lens. 0 – Disable 1 – Enable
TG:	Enable third gate (***only available on Model 7412***). 0 – Disable 1 – Enable
XS:	Enable extended status (Reference B3.1 Tracker Status Message). 0 – Disable 1 – Enable

B4.4 Line-of-Sight Offset Control Message (DEPRECATED)

Reference Appendix C, Section C3.1.3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 3								Spare							
Word 3	Spare							LOS Position X								
Word 4	Spare							LOS Position Y								
Word 5	Checksum															

Figure B4.4. Line-of-Sight Offset Control Message

NOTE: This message is deprecated in favor of the Line-of-Sight Offset Control 2 message (type 64).

Sync Word: 0xA5A5

Message Type: 3

LOS Position X & Y: These fields define the line-of-sight position relative to the center of the field of view.

Data Format:	9-bit two's complement
Scaling:	LSB = 1 pixel (x) / line (y)
Range:	X: -511 to 511, Y: -120 to 120 (Range is video format dependent)
Default Position:	X: 0, Y: 0

B4.5 Offset Aim Control Message (DEPRECATED)

Reference Appendix C, Section C3.1.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 4								En	Spare						
Word 3	Spare							Offset Aim X								
Word 4	Spare							Offset Aim Y								
Word 5	LOS Transition Time															
Word 6	Checksum															

Figure B4.5. Offset Aim Control Message

NOTE: This message is deprecated in favor of the Offset Aim Control 2 message (type 65).

Sync Word: 0xA5A5

Message Type: 4

En: This field enables/disables the Offset Aim mode of the tracker.

0 – Disabled <DEFAULT>
1 – Offset Aim Enabled

Offset Aim X & Y: These fields define the Offset Cursor Position relative to the center of the field of view when offset aim is enabled.

Data Format: 9-bit two's complement
Scaling: LSB = 1 pixel (x) / line (y)
Range: X: -511 to 511, Y: -120 to 120
(Range is video format dependent)
Default Position: X: 0, Y: 0

LOS Transition Time: The number of video fields it takes to transition from the current offset aim point to the line-of-sight when the offset aim is disabled during tracking. This is used to slow down or smooth the response of a mount when making this transition.

B4.6 Symbology Control Message

Reference Appendix C, Section C3.2.1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 5								Off	Los	GE	Flag	Sym	Enh	Spare	
Word 3	Symbology Color															
Word 4	Checksum															

Figure B4.6. Symbology Control Message

Sync Word: 0xA5A5

Message Type: 5

Enh: This field enables/disables the display of target enhancement symbology.

0 – Disable
1 – Enable <DEFAULT>

Sym: This field defines the symbology color.

0 – Black
1 – White <DEFAULT>

Flag: This field enables/disables the display of the track flag symbology.

0 – Disable
1 – Enable <DEFAULT>

GE: This field enables/disables the display of the track gate (or window) symbology.

0 – Disable
1 – Enable <DEFAULT>

Los: This field enables/disables the display of the Line-of-Sight crosshair symbology.

0 – Disable <DEFAULT>
1 – Enable
0 – Use the standard symbology polarity (Sym) <DEFAULT>
Range: 1 to 1023 to specify color

Off:	This field enables/disables the Offset Aim (or Offset Track) Cursor symbology.. 0 – Disable <DEFAULT> 1 – Enable
Symbology Color:	Custom symbology color (grayscale value).

B4.7 Correlation Control Message

Reference Appendix C, Section C3.3.8

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 6								Spare							
Word 3	Spare										RD	RU	RR	RL	Ref Img	Ref Win
Word 4	Ref Size Y								Ref Size X							
Word 5	Update Rate								Match Percent							
Word 6	Checksum															

Figure B4.7. Correlation Control Message

Sync Word: 0xA5A5

Message Type: 6

Ref Win: This field enables/disables the display of the correlation reference window symbology.

0 – Disable
1 - Enable <DEFAULT>

Ref Img: This field enables/disables the correlation reference image symbology.

0 – Disable
1 - Enable <DEFAULT>

RL: Move reference image left (re-center target)

RR: Move reference image right (re-center target)

RU: Move reference image up (re-center target)

RD: Move reference image down (re-center target)

Ref Size X & Y: These fields determine the reference image size. Reference image size should be set to minimize background information.

Range: 4 to 32 (in multiples of 4)
Valid Values: 4, 8, 12, 16, 20, 24, 28, 32
Default: 32

Match Percent:	This field defines the minimum acceptable correlation percentage allowed for the tracker to establish a track state. ***Reference Appendix C, Section C3.3.8.4 Match Percent***	
	Range:	0 to 100 (0=Automatic)
	Default:	0 (Automatic)
Update Rate:	This field defines the update rate of the reference image in **video frames**. The tracker must remain in the TRACK state for the defined number of consecutive frames in order to update the reference image. ***Reference Appendix C, Section C3.3.8.3 Update Rate***	
	Range:	0 to 255 (0=No Updates)
	Default:	1

B4.8 Reserved Message

Reference Section

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 7								Spare							
Word 3	Spare															
Word 4	Checksum															

Figure B4.8. Reserved Message

Sync Word: 0xA5A5

Message Type: 7

B4.9 Filter Control Message

Reference Appendix C, Section C3.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 8								Sp	Ad	Mt	Fir	Inv AZ	Inv EL	Dig Filt	Pid
Word 3	Gain X															
Word 4	Proportion X															
Word 5	Integral X															
Word 6	Derivative X															
Word 7	Integral Clip X															
Word 8	Vff X															
Word 9	Aff X															
Word 10	Gain Y															
Word 11	Proportion Y															
Word 12	Integral Y															
Word 13	Derivative Y															
Word 14	Integral Clip Y															
Word 15	Vff Y															
Word 16	Aff Y															
Word 17	FIR Depth Y								FIR Depth X							
Word 18	Step Initial Percent								Spare							Stp En
Word 19	Step Ramp Time															
Word 20	Checksum															

Figure B4.9. Filter Control Message

Sync Word: 0xA5A5

Message Type: 8

Pid: Enable the PID compensation filter.

0 – Disabled <DEFAULT>
1 - Enabled

Dig Filt: Enable the 2x2 digital image noise filter. When enabled, this filter will remove isolated single thresholded pixels. Generally, this filter should be enabled when tracking targets larger than four pixels and disabled when tracking smaller targets.

0 - Disabled <DEFAULT>
1 - Enabled

Inv EL: Invert the elevation error signal output.

0 - Normal <DEFAULT>
1 - Inverted

Inv AZ: Invert the azimuth error signal output.

0 - Normal <DEFAULT>
1 - Inverted

Fir: Enable the FIR filter.

0 - Disabled <DEFAULT>
1 - Enabled

Mt: Enable the mount's analog compensation filter (if supported by connected mount).

0 - Disabled <DEFAULT>
1 - Enabled

Ad: Enable advanced PID features like integrator preloading and integrator dump on direction change (only support with serial mounts)

0 - Disabled <DEFAULT>
1 - Enabled

Sp: Spare bit. Set to zero.

Gain X & Y:

Data Format:	16-bit two's complement
Scaling:	LSB = 0.001 (divide by 1000)
Range:	±32.767
Default Value:	1 (raw value: 1000 or 0x03E8)

Proportion X & Y:

Data Format:	16-bit two's complement
Scaling:	LSB = 0.001 (divide by 1000)
Range:	±32.767
Default Value:	1 (raw value: 1000 or 0x03E8)

Integral X & Y:

Data Format:	16-bit two's complement
Scaling:	LSB = 0.001 (divide by 1000)
Range:	±32.767
Default Value:	0

Derivative X & Y:

Data Format:	16-bit two's complement
Scaling:	LSB = 0.001 (divide by 1000)
Range:	±32.767
Default Value:	0

Integral Clip X & Y:

Data Format:	16-bit binary
Scaling:	LSB = 0.1 (divide by 10)
Range:	0 to 6553.5
Default Value:	0 (disable integrator)

V_{FF} X & Y:

Data Format:	16-bit two's complement
Scaling:	LSB = 0.001 (divide by 1000)
Range:	±32.767
Default Value:	0

A_{FF} X & Y:

Data Format:	16-bit two's complement
Scaling:	LSB = 0.001 (divide by 1000)
Range:	±32.767
Default Value:	0

FIR Depth X & Y: The depth of the FIR filter in fields.

Range:	0 to 255
Default Value:	0

Stp En: Enable step response filter. If enabled, this filter shapes the error signal when the tracker's state changes from acquire to track in order to prevent target video smearing and overshoot.

0 - Disabled <DEFAULT>
1 - Enabled

Step Initial Percent: Percentage of initial error signal to use for step.

Range:	0 to 100
Default:	0

Step Ramp Time: Ramp time in fields from initial step to full error output.

Range:	0 to 65535
Default:	0

B4.10 Coast Control Message

Reference Appendix C, Section C3.3.5

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 9								Sp	Gc	Lp	En	Mode		Rate	
Word 3	Coast Duration															
Word 4	Spare												Search Mode			
Word 5	Search Duration															
Word 6	Checksum															

Figure B4.10. Coast Control Message

Sync Word: 0xA5A5

Message Type: 9

Rate: Gate growth rate. ***Reference Appendix C, Section C3.3.5.3 Coast Parameters***

0 - No growth <DEFAULT>
1 - 1 Pixel/Line per Field
2 - 2 Pixels/Lines per Field
3 - 4 Pixels/Lines per Field

Mode: Coast mode. ***Reference Appendix C, Section C3.3.5.3 Coast Parameters***

0 - Zero-Output Coast <DEFAULT>
1 - Hold-Last Coast
2 - Predicted Coast
3 - Invalid/Not Used

En: Enable coast.

0 - Disabled <DEFAULT>
1 - Enabled

Lp: Control loop mode.

0 - Closed <DEFAULT>
1 - Open

Gc:	Allow user gate position control during coast. 0 - Disable 1 - Enable
Sp:	Spare bit. Set to zero.
Coast Duration:	Coast duration in fields (range: 1-3600 fields). ***Reference Appendix C, Section C3.3.5.3 Coast Parameters*** Default: 30 fields
Search Mode:	Search mode. ***Reference Appendix C, Section C3.3.5.4 Search Parameters*** 1 - Return to Boresight <DEFAULT> 2 - Hold-Last Position 3 - Raster Scan 4 - Spiral Scan
Search Duration:	Search duration in fields (range: 0-65535 fields) Default: 0 fields (search until target found)

B4.11 Single Target Validation Control Message

Reference Appendix C, Section C3.3.6

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 10								Spare			Gt	Cnt	Pos	Size	En
Word 3	Size Tolerance X															
Word 4	Size Tolerance Y															
Word 5	Position Tolerance X															
Word 6	Position Tolerance Y															
Word 7	Pixel Count Tolerance															
Word 8	Checksum															

Figure B4.11. Single Target Validation Control Message

Sync Word: 0xA5A5

Message Type: 10

En: Enable target validation (track quality) processing.

0 – Disabled <DEFAULT>
1 – Enabled

Size: Enable target size testing (when target validation is enabled).
Reference Appendix C, Section C3.3.6.1 Size Test

0 – Disabled <DEFAULT>
1 – Enabled

Pos: Enable target position testing (when target validation is enabled).
Reference Appendix C, Section C3.3.6.2 Position Test

0 – Disabled <DEFAULT>
1 – Enabled

Cnt: Enable target pixel count testing (when target validation is enabled).
Reference Appendix C, Section C3.3.6.3 Count Test

0 – Disabled <DEFAULT>
1 – Enabled

Gt: Enable target fully enclosed in gate testing.

0 – Disabled <DEFAULT>
1 – Enabled

Size Tolerance X&Y: The allowable target size tolerance in percent.

Data Format:	16-bit binary
Scaling:	LSB = 0.1 percent (divide by 10)
Range:	0 to 6553.5%

Position Tolerance X&Y:

The allowable target position tolerance in pixels/lines.

Data Format:	16-bit binary
Scaling:	LSB = 0.1 pixels/lines (divide by 10)
Range:	0 to 6553.5 pixels/lines

Pixel Count Tolerance: The allowable target pixel count tolerance in percent.

Data Format:	16-bit binary
Scaling:	LSB = 0.1 percent (divide by 10)
Range:	0 to 6553.5%

B4.12 Auto Acquire Parameter Message (DEPRECATED)

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 11</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="5">Spare</td><td colspan="11">Gate Size X</td></tr>
<tr><td>Word 4</td><td colspan="5">Spare</td><td colspan="11">Gate Size Y</td></tr>
<tr><td>Word 5</td><td colspan="4">Spare</td><td>En</td><td colspan="11">Gate Position X</td></tr>
<tr><td>Word 6</td><td colspan="5">Spare</td><td colspan="11">Gate Position Y</td></tr>
<tr><td>Word 7</td><td colspan="3">Polarity</td><td colspan="2">Spare</td><td>Ath</td><td colspan="10">Black Threshold</td></tr>
<tr><td>Word 8</td><td colspan="6">Spare</td><td colspan="10">White Threshold</td></tr>
<tr><td>Word 9</td><td colspan="16">Spare</td></tr>
<tr><td>Word 10</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.12. Auto Acquire Parameter Message

<u>This functionality is deprecated. Please use Multi-Target functions instead.</u>

Sync Word: 0xA5A5

Message Type: 11

Gate Size X & Y: The gate size to be used in Acquire mode (if Auto Acquire is enabled).

Data Format:	11-bit binary
Scaling:	LSB = 1 pixel / line
Range:	16 to 1020 pixels (X), 8 to 256 lines (Y)
Default Size:	200 pixels, 50 lines

En: Enable Auto Acquire Mode.

0 – Disabled <DEFAULT>
1 – Enabled

The data provided to the tracker in messages of Type 11, 12 and 13 will not be utilized until Auto Acquire is enabled with this bit.

Gate Position X & Y: The gate position that will be used in Acquire mode (if Auto Acquire is enabled).

Data Format:	11-bit two's complement
Scaling:	LSB = 1 pixel / line
Range:	±512 pixels / lines
Default Position:	0, 0

Polarity: The target polarity selection that is to be used in Acquire mode (if Auto Acquire is enabled).

000 – Gray
001 – White <DEFAULT>
010 – Black
011 – Mix
100 – Auto

Ath: This field controls the threshold mode to be used in Acquire mode (if Auto Acquire is enabled). When Auto is selected, the black and white threshold parameters are interpreted as auto threshold percent values.

0 – Manual Threshold <DEFAULT>
1 – Auto Threshold

Black & White Threshold:
This field defines white and black threshold levels for Manual Threshold mode when the Ath bit is zero and threshold percent values when the Ath bit is one. This sets the threshold values to be used during Acquire mode (if Auto Acquire is enabled).

Data Format:	10-bit binary
Range:	0 to 1023 (manual) / 0 to 100% (auto)
Default:	511 (manual) / 50% (auto)

B4.13 AAQ Track Parameter Message (DEPRECATED)

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 12								Spare							
Word 3	Spare				AS	Gate Size X										
Word 4	Spare				En	Gate Size Y										
Word 5	Spare				AP	Gate Position X										
Word 6	Spare					Gate Position Y										
Word 7	Polarity			Spare		Ath	Black Threshold									
Word 8	Spare						White Threshold									
Word 9	Spare															
Word 10	Checksum															

Figure B4.13. AAQ Track Parameter Message

<u>This functionality is deprecated. Please use Multi-Target functions instead.</u>

Sync Word: 0xA5A5

Message Type: 12

The data provided to the tracker in this message is only used if Auto Acquire mode is enabled with message 11, and the En bit is set in this message.

Gate Size X & Y: The gate size that will be used in the Track state (if Auto Acquire is enabled).

Data Format: 11-bit binary
Scaling: LSB = 1 pixel / line
Range: 16 to 1020 pixels (X), 8 to 256 lines (Y)
Default Size: 200 pixels, 50 lines

En: Enable AAQ Track Mode. This bit determines whether to use this messages parameters or the run time control message parameters when in Auto Acqure mode and in the Track state.

0 – Disabled (use run time control parameters) <DEFAULT>
1 – Enabled (use this message’s parameters when on track)

AS: The gate sizing mode to use in the Track state (if Auto Acquire is enabled).

0 - Manual Gate Size <DEFAULT>
1 - Auto Gate Size

AP: The gate positioning mode to use in the Track state (if Auto Acquire is enabled).

0 - Manual Gate Position <DEFAULT>
1 - Auto Gate Position

Gate Position X & Y: The gate position that will be used in the Track state (if Auto Acquire is enabled). If auto position is enabled, the tracker will not reposition the gate to this location when it transitions to track mode.

Data Format:	11-bit two's complement
Scaling:	LSB = 1 pixel / line
Range:	±512 pixels / lines
Default Position:	0, 0

Polarity: The target polarity selection that is to be used in the Track state (if Auto Acquire is enabled).

000 – Gray
001 – White <DEFAULT>
010 – Black
011 – Mix
100 – Auto

Ath: The threshold mode to use in the Track state (if Auto Acquire is enabled). When Auto is selected, the black and white threshold parameters are interpreted as auto threshold percent values.

0 – Manual Threshold <DEFAULT>
1 – Auto Threshold

Black & White Threshold:
The white and black threshold levels for Manual Threshold mode when the Ath bit is zero and threshold percent values when the Ath bit is one. This sets the threshold values to be used during the Track state (if Auto Acquire is enabled).

Data Format:	10-bit binary
Range:	0 to 1023 (manual) / 0 to 100% (auto)
Default:	511 (manual) / 50% (auto)

B4.14 Target Select Control Message (DEPRECATED)

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 13</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td>BS</td><td>Spd</td><td>Dir</td><td>Asp</td><td>Sze</td><td>En</td><td colspan="10">Size X</td></tr>
<tr><td>Word 4</td><td colspan="6">Spare</td><td colspan="10">Size Y</td></tr>
<tr><td>Word 5</td><td>Sp</td><td colspan="7">Size Tolerance</td><td colspan="3">End Direction</td><td colspan="3">Start Direction</td><td colspan="2">Asp Ratio</td></tr>
<tr><td>Word 6</td><td colspan="7">Spare</td><td colspan="9">Speed</td></tr>
<tr><td>Word 7</td><td colspan="16">Spare</td></tr>
<tr><td>Word 8</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.14. Target Select Control Message

<u>This functionality is deprecated. Please use Multi-Target functions instead.</u>

Sync Word: 0xA5A5

Message Type: 13 (DEPRECATED)

The data provided to the tracker in this message is only used if Auto Acquire is enabled with message 11. Note: When using Target Selection Discrimination, it is recommended that Unique Track Parameters (message 12), with Auto Size enabled, also be used.

En: Enable target selection. Target selection must be enabled for the other settings in this message to be utilized.

0 – Disabled <DEFAULT>
1 – Enabled

Sze: Enable size target selection.

0 – Disabled <DEFAULT>
1 – Enabled

Asp: Enable aspect ratio target selection.

0 – Disabled <DEFAULT>
1 – Enabled

Dir:	Enable direction target selection. Target is acquired only if it enters the gate from the designated direction. ***The Tracker Gate will continue to display the direction of Acquisition during the Track Mode.*** 0 – Disabled <DEFAULT> 1 – Enabled
Spd:	Enable speed target selection. Target is acquired only if it is moving at a certain minimum speed. 0 – Disabled <DEFAULT> 1 – Enabled
BS:	Enable boresight target selection. Target is acquired based upon its delta to boresight. The target nearest to the 0,0 point is selected over targets further from the boresight. Selects the closest target to the boresight. 0 – Disabled <DEFAULT> 1 – Enabled
Size X & Y:	Target selection size X (desired target width in pixels) and Y (desired target height in lines). Range: 0 to 1023
Asp Ratio:	Aspect ratio selection code (desired target aspect ratio of width to height). 0 - aspect ratio < 1.0 (width less than height -- tall) 1 - aspect ratio = 1.0 (width same as height -- square) <DEFAULT> 2 - aspect ratio > 1.0 (width greater than height -- wide) 3 - invalid / not used
Start Direction:	Target selection direction start angle. 0 – Top center 1 – Top right 2 – Middle right 3 – Bottom right 4 – Bottom center 5 – Bottom left 6 – Middle left 7 – Top left

End Direction:	Target selection direction end angle.	
	Set equal to **StartDirection**	
Size Tolerance:	Target size tolerance as a percentage.	
	Range:	0 to 100
	Example:	A value of 10 would represent a ±10% tolerance.
Speed:	The target select speed is entered in pixels per field. The thresholded target must be moving at least this many pixels per field to be acquired as a target.	
	Range:	0 to 511
	Default:	5

B4.15 Annotation Control Message

Reference Appendix C, Section C3.2.2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 14								Spare						Col	En
Word 3	Spare		Fov	Rng	VEl	VAz	MEl	MAz	Val	El	Az	Auto	St	State	Pol	Mod
Word 4	Background Color								Foreground Color							
Word 5	Checksum															

Figure B4.15. Annotation Control Message

Sync Word: 0xA5A5

Message Type: 14

En: This bit enables or disables the display of all annotation text. When this bit is enabled, the remaining fields of the message determine the content of the display. The annotation fields all default to enabled. ***Reference Figure B4.16.***

0 – Disabled
1 – Enabled <DEFAULT>

Col: Annotation color (used if background and foreground color are zero)

0 – Black chars on gray background
1 – White chars on gray background <DEFAULT>

Mod: Track Mode Display Enable

0 - Disabled
1 - Enabled

Pol: Target Polarity Display Enable

0 - Disabled
1 - Enabled

State: Track State Display Enable

0 - Disabled
1 - Enabled

St:	Target Status Display Enable 0 - Disabled 1 - Enabled
Auto:	Auto Controls Display Enable 0 - Disabled 1 - Enabled
Az:	Azimuth Error Signal Display Enable 0 - Disabled 1 - Enabled
El:	Elevation Error Signal Display Enable 0 - Disabled 1 - Enabled
Val:	Target Validation Display Enable 0 - Disabled 1 - Enabled
MAz:	Mount Azimuth Display Enable 0 - Disabled 1 - Enabled
MEl:	Mount Elevation Display Enable 0 - Disabled 1 - Enabled
VAz:	Mount Velocity in Azimuth Enable 0 - Disabled 1 - Enabled
VEl:	Mount Velocity in Elevation Enable 0 - Disabled 1 - Enabled

Rng:	Range to Target Display Enable 0 - Disabled 1 - Enabled
Fov:	Lens Field-of-View Enable 0 - Disabled 1 - Enabled
Background Color:	Annotation background color (set to zero for legacy behavior). 0 – Transparent <DEFAULT> Range: 1 to 255
Foreground Color:	Annotation foreground color (set to zero for legacy behavior). 0 – Transparent <DEFAULT> Range: 1 to 255

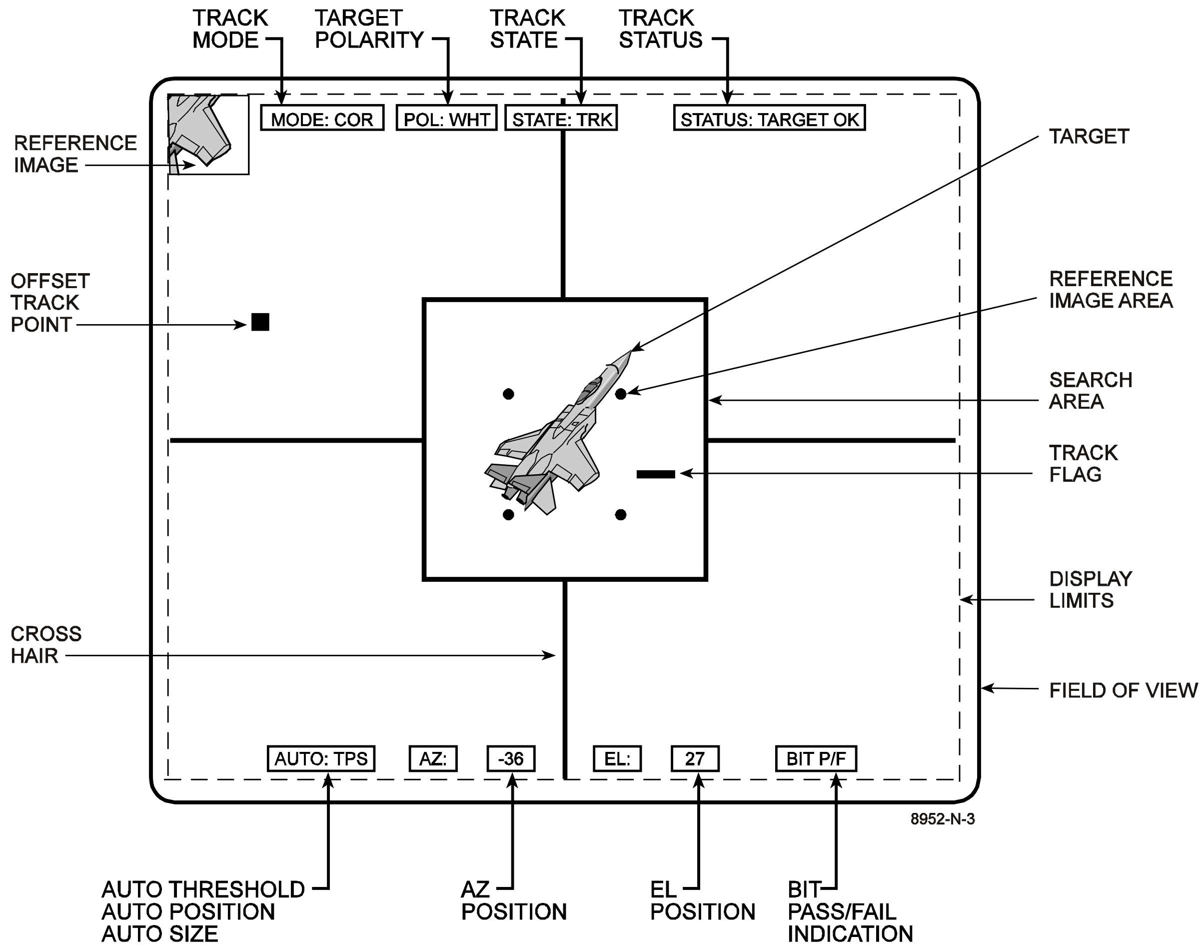

Figure B4.16. Video Annotation Locations

B4.16 User String Message (DEPRECATED)

Reference Appendix C, Section C3.2.3

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 15</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="5">Spare</td><td colspan="5">Start Row</td><td colspan="6">Start Column</td></tr>
<tr><td>Word 4</td><td colspan="8">Char 1</td><td colspan="8">Char 0</td></tr>
<tr><td>Word 5</td><td colspan="8">Char 3</td><td colspan="8">Char 2</td></tr>
<tr><td>…</td><td colspan="16">…</td></tr>
<tr><td>Word 22</td><td colspan="8">NULL (0x00h)</td><td colspan="8">Char 36</td></tr>
<tr><td>Word 23</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.17. User String Message

NOTE: This message is deprecated in favor of the User String 2 message (type 56).

Sync Word: 0xA5A5

Message Type: 15

This message is a fixed 23 words long. All bytes after the NULL terminated string must be zero filled through word 22. Annotation strings can be processed at up to 10 Hz updates.

Start Column: Start column defines the character column where the beginning of the string is to be displayed.

Range: 0 to 63

NOTE: The actual number of visible rows/columns depends on the input video type and the monitor used to display the tracker output. Therefore, the actual useable rows/columns will be less than the theoretical maximum ranges given above.

Start Row: Start row defines the character row where the string is to be displayed

Range: 0 to 31

Char 0 to 36: User string of 37 characters in length plus a NULL termination. The string is packed two characters per word. Char 0 is the first character of the string, Char 1 is the second character, etc. Clear the display by writing spaces to the same location.

B4.17 Scan Message

Reference Appendix C, Section C3.6

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 16</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="8">Type</td><td colspan="4">Spare</td><td>Joy</td><td>Acq</td><td>Rst</td><td>En</td></tr>
<tr><td>Word 4</td><td colspan="16">Step Azimuth</td></tr>
<tr><td>Word 5</td><td colspan="16">Step Elevation</td></tr>
<tr><td>Word 6</td><td colspan="16">Dwell Time</td></tr>
<tr><td>Word 7</td><td colspan="16">Start Azimuth LSW</td></tr>
<tr><td>Word 8</td><td colspan="16">Start Azimuth MSW</td></tr>
<tr><td>Word 9</td><td colspan="16">Start Elevation LSW</td></tr>
<tr><td>Word 10</td><td colspan="16">Start Elevation MSW</td></tr>
<tr><td>Word 11</td><td colspan="16">Stop Azimuth LSW</td></tr>
<tr><td>Word 12</td><td colspan="16">Stop Azimuth MSW</td></tr>
<tr><td>Word 13</td><td colspan="16">Stop Elevation LSW</td></tr>
<tr><td>Word 14</td><td colspan="16">Stop Elevation MSW</td></tr>
<tr><td>Word 15</td><td colspan="16">Spare</td></tr>
<tr><td>Word 16</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.18. Scan Message

Sync Word: 0xA5A5

Message Type: 16

En: Enable mount scan mode.

0 – Disabled / Stop Scan <DEFAULT>
1 – Enabled / Start Scan

Rst: Reset scan mode. When this bit is set, the mount moves to the start position and all scan parameters are reset.

0 – No Action/Continue Scan
1 – Reset

Acq: Enable target acquisition during scan. If enabled, the tracker will stop scanning and enter TRACK mode when a valid target is acquired.

0 – Disabled <DEFAULT>
1 – Enabled

Joy: Enable the joystick during scan. If enabled, any joystick movement will stop and override scan mode.

0 – Disabled <DEFAULT>
1 – Enabled

Type: The type of scan (or scan pattern to follow)

0 – Line
1 – Horizontal Raster
2 – Vertical Raster
3 – Horizontal Zig-Zag
4 – Vertical Zig-Zag
5 – Step Spiral
6 – Continuous Spiral

Step Azimuth: The number of steps to take between the start and stop azimuth point or the number of steps per 360º for spiral type scans.

Step Elevation: The number of steps to take between the start and stop elevation point or the growth factor for spiral type scans. For spiral type scans, the growth factor is a number from 0 to 65.535 (a scale factor of 1000).

Dwell Time: The time in fields to remain stationary after a mount step has occurred before the next step is taken.

Start Azimuth MSW & LSW:
The start azimuth (X) location of the mount in degrees; most significant word (MSW) and least significant word (LSW).

Data Format:	32-bit two's complement
Scaling:	LSB = 0.0001 degree (divide by 10,000)
Range:	±180.0000 degrees

Stop Elevation MSW & LSW:
The stop elevation (Y) location of the mount in degrees; most significant word (MSW) and least significant word (LSW).

Data Format:	32-bit two's complement
Scaling:	LSB = 0.0001 degree (divide by 10,000)

Range: ±180.0000 degrees

B4.18 Mount Rate Drive Message

Reference Appendix C, Sections C2.7 Mount and C3.5.10 Mount Tab

This message can be used to drive a supported mount which is connected to UART2 of the tracker. The tracker will support message update rates up to the field rate of the input video (typically 50Hz or 60Hz). This message can be used for remote joystick control, radar slaving, initial target trajectory profiling, etc…

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 17								Spare							dac
Word 3	Velocity Azimuth LSW															
Word 4	Velocity Azimuth MSW															
Word 5	Velocity Elevation LSW															
Word 6	Velocity Elevation MSW															
Word 7	Checksum															

Figure B4.19. Mount Rate Drive Message

Sync Word: 0xA5A5

Message Type: 17

dac: Velocity represented in digital to analog converter (DAC) counts or in degrees per second.

0 – Velocity in degrees per second (if supported by mount)
1 – Velocity in DAC counts

Velocity Azimuth MSW & LSW:
The mount azimuth velocity most significant word (MSW) and least significant word (LSW).

Data Format:	32-bit two's complement
Scaling:	LSB = 0.001 degree/second (divide by 1,000)
	LSB = 1 DAC count
Range:	±10,000.000 degrees/second
	±2,147,483,647 DAC counts

Velocity Elevation MSW & LSW:

The mount elevation velocity most significant word (MSW) and least significant word (LSW).

Data Format:	32-bit two's complement
Scaling:	LSB = 0.001 degree/second (divide by 1,000)
	LSB = 1 DAC count
Range:	±10,000.000 degrees/second
	±2,147,483,647 DAC counts

B4.19 Mount Control Message

Reference Sections C2.9 Mount and C3.5.10 Mount Tab

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 18</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="4">Spare</td><td>lim</td><td>tk</td><td>lp</td><td>dac</td><td colspan="8">Command</td></tr>
<tr><td>Word 4</td><td colspan="16">Azimuth LSW</td></tr>
<tr><td>Word 5</td><td colspan="16">Azimuth MSW</td></tr>
<tr><td>Word 6</td><td colspan="16">Elevation LSW</td></tr>
<tr><td>Word 7</td><td colspan="16">Elevation MSW</td></tr>
<tr><td>Word 8</td><td colspan="16">Velocity Azimuth LSW</td></tr>
<tr><td>Word 9</td><td colspan="16">Velocity Azimuth MSW</td></tr>
<tr><td>Word 10</td><td colspan="16">Velocity Elevation LSW</td></tr>
<tr><td>Word 11</td><td colspan="16">Velocity Elevation MSW</td></tr>
<tr><td>Word 12</td><td colspan="16">Duration</td></tr>
<tr><td>Word 13</td><td colspan="8">Ramp Decelerate</td><td colspan="8">Ramp Accelerate</td></tr>
<tr><td>Word 14</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.20. Mount Control Message

Sync Word: 0xA5A5

Message Type: 18

Command: Mount command.

0 – No Action
1 – Set azimuth and elevation offsets so the current position is zero
2 – Clear azimuth and elevation offset
3 – Drive to the zero position (0,0)
4 – Rate drive Az/El (Rate Mode) <ONLY FOR DIAGNOSTICS>
5 – Move to Az/El position (Position Mode)
6 – Standby (turn off power to motors)
7 – Active (turn on power to motors)
8 – Set azimuth offset (North offset)
9 – Set elevation offset
10 – Set offset for both azimuth and elevation (also used in query)

11 – Set azimuth and elevation velocity limits (also used in query)
12 – Move to primary stow position Az/El and power off
13 – Move to secondary stow position Az/El and power off

dac: Velocity represented in digital to analog converter (DAC) counts or in degrees per second.

0 – Velocity in degrees per second (if supported by mount)
1 – Velocity in DAC counts

lp: Loop the movement command (moving back and forth)

0 – Disable <DEFAULT>
1 – Loop Movement

tk: Enable the position mode tracking filter in the mount controller (if supported by mount)

0 – Disable <DEFAULT>
1 – Enable Filter

lim: Enable velocity limiting.

0 – Disable <DEFAULT>
1 – Enable

Azimuth MSW & LSW: The desired mount azimuth (X) location for the move; most significant word (MSW) and least significant word (LSW). For commands 0 through 4 this field is not used and should be zero.

Data Format:	32-bit two's complement
Scaling:	LSB = 0.0001 degree (divide by 10,000)
Range:	±360.0000 degrees

Elevation MSW & LSW: The desired mount elevation (Y) location for the move; most significant word (MSW) and least significant word (LSW). For commands 0 through 4 this field is not used and should be zero.

Data Format:	32-bit two's complement
Scaling:	LSB = 0.0001 degree (divide by 10,000)
Range:	±360.0000 degrees

Velocity Azimuth MSW & LSW:

The target azimuth velocity of the mount during the move; most significant word (MSW) and least significant word (LSW).
0 = Maximum Velocity

Data Format:	32-bit two's complement
Scaling:	LSB = 0.001 degree/second (divide by 1,000) LSB = 1 DAC count
Range:	±10,000.000 degrees/second ±2,147,483,647 DAC counts

Velocity Elevation MSW & LSW:

The target elevation velocity of the mount during the move; most significant word (MSW) and least significant word (LSW).
0 = Maximum Velocity

Data Format:	32-bit two's complement
Scaling:	LSB = 0.001 degree/second (divide by 1,000) LSB = 1 DAC count
Range:	±10,000.000 degrees/second ±2,147,483,647 DAC counts

Duration: The duration of the mount drive in video fields. This parameter is only used for command 4. All other commands should set this field to zero.

Ramp Accelerate: The number of video fields over which to ramp the velocity from zero to the target velocity.

0 = No Ramp (step function)

Ramp Decelerate: The number of video fields to ramp down the velocity to zero before reaching the target position.

0 = No Ramp (hard stop)

B4.20 Control Box Message

Reference Appendix C, Section C2.6

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 19								Spare							
Word 3	Spare															En
Word 4	Checksum															

Figure B4.21. Control Box Message

Sync Word: 0xA5A5

Message Type: 19

En: Enable control box. When the control box is enabled, the tracker will ignore all Run Time Control messages (Type 1).

0 – Disabled <DEFAULT>
1 – Enabled

B4.21 Query Configuration Message

Reference Appendix C, Sections C1 and C2 for a list and functional description of the various messages

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 20								Spare							
Word 3	Query Message ID								Query Message Type							
Word 4	Checksum															

Figure B4.22. Query Configuration Message

Sync Word: 0xA5A5

Message Type: 20

Query Message Type: The message type to query. For example, if this parameter is set to 1, then the tracker will respond with a Run Time Control message (containing the current settings of the tracker).

Query Message ID: Message type specific data to identify a unique message (only necessary for some messages).

B4.22 Preset Configuration Message

Reference Appendix C, Section C3.5.5

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 21								Spare							
Word 3	Command															
Word 4	Preset Number															
Word 5	Spare															
Word 6	Checksum															

Figure B4.23. Preset Configuration Message

Sync Word: 0xA5A5

Message Type: 21

Command: The present configuration command.

0 – No Action
1 – Save Current Settings to Preset
2 – Load Preset Settings
3 – Clear Preset Settings

Preset Number: The preset configuration number from 0 to 9 to use. The tracker has ten (10) memory banks to store presets.

B4.23 Lens Configuration Message

Reference Appendix C, Section C3.8

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 22								Spare							
Word 3	Lens Analog 1															
Word 4	Lens Analog 2															
Word 5	Lens Analog 3															
Word 6	Lens Analog 4															
Word 7	Lens Digital 1															
Word 8	Lens Digital 2															
Word 9	Spare															
Word 10	Checksum															

Figure B4.24. Lens Configuration Message

Sync Word: 0xA5A5

Message Type: 22

Lens analog 1: Lens type connected to analog video source 1

Lens analog 2: Lens type connected to analog video source 2

Lens analog 3: Lens type connected to analog video source 3

Lens analog 4: Lens type connected to analog video source 4

Lens digital 1: Lens type connected to digital video source 1

Lens digital 2: Lens type connected to digital video source 2 (Only available on models with HD-SDI)

Valid values for lens types above:

0 – None <DEFAULT>
1 – Graflex (**DEPRECATED**, Message Type 23)
2 – Optimum Optical System Tri-FOV (Message Type 24)
3 – Sophie Thermal Binoculars (Message Type 24)
4 – Generic Lens (Message Type 26)
5 – Western Video / ITS 6125 DF (Message Type 27)

6 – DiOP/Senspex FieldPro 5X (Message Type 28)
7 – Graflex Serial / Model 901 (Message Type 27)
8 – Graflex Vinten (Message Type 27)
9 – Generic Analog Zoom (Message Type 29)
10 – Cohu MPC Protocol (Message Type 27)
11 – Janos Asio Dual-FOV (Message Type 25)
12 – Janos Alba Tri-FOV (Message Type 24)
13 – Optimum Optical System Telescope (Message Type 32)
14 – FLIR MilCAM Dual-FOV (**UNSUPPORTED,** Message Type 33)
15 – Fujinon D60 / Model 902 (Message Type 27)
16 - Graflex 35X (Message Type 27)
17 - FLIR Ranger HRC (Message Type 28)
18 - Fujinon C22x23R2D-ZP1 (Message Type 27)
19 – Graflex Fixed FOV (Message Type 32)
20 – FLIR RS6700 Dual-FOV (Message Type 33)
21 – Optec Focuser (Message Type 32)

B4.24 Graflex Lens Message (DEPRECATED)

Reference Appendix C, Section C3.8

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 23</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="5">Spare</td><td>Cl</td><td>At</td><td colspan="3">Iris</td><td colspan="3">Focus</td><td colspan="3">Zoom</td></tr>
<tr><td>Word 4</td><td colspan="16">Zoom Position</td></tr>
<tr><td>Word 5</td><td colspan="16">Zoom Gain Min</td></tr>
<tr><td>Word 6</td><td colspan="16">Zoom Gain Max</td></tr>
<tr><td>Word 7</td><td colspan="16">Spare</td></tr>
<tr><td>Word 8</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.25. Graflex Lens Message

<u>This functionality is deprecated (See B4.28).</u>

Note: Lens type: 1 – Graflex (OBSOLETE, use type: 8 – Graflex Vinten instead)

Sync Word: 0xA5A5

Message Type: 23

Zoom: Zoom command

0 – None <DEFAULT>
1 – Narrow
2 – Wide
3 – Go To Position

Focus: Focus command

0 – None <DEFAULT>
1 – Near
2 – Far

Iris: Iris command

0 – None <DEFAULT>
1 – Close
2 – Open

At:	Automatic iris enable 0 – Disabled <DEFAULT> 1 – Enabled
Cl:	Perform zoom scale calibration 0 – Disabled <DEFAULT> 1 – Perform calibration
Zoom Position:	Current zoom position
Zoom Gain Min:	Minimum zoom gain limit (0 to 0.99999)
Zoom Gain Max:	Maximum zoom gain limit (0 to 0.99999)

B4.25 Serial Lens Triple FOV Message

Reference Appendix C, Sections by lens type as shown below

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 24</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="2">Spare</td><td>AI</td><td colspan="2">Iris</td><td colspan="2">Focus</td><td colspan="2">FOV</td><td colspan="3">Serial Port</td><td colspan="4">Video Source</td></tr>
<tr><td>Word 4</td><td colspan="16">FOV Wide</td></tr>
<tr><td>Word 5</td><td colspan="16">FOV Medium</td></tr>
<tr><td>Word 6</td><td colspan="16">FOV Narrow</td></tr>
<tr><td>Word 7</td><td colspan="16">LOS Wide Azimuth</td></tr>
<tr><td>Word 8</td><td colspan="16">LOS Wide Elevation</td></tr>
<tr><td>Word 9</td><td colspan="16">LOS Medium Azimuth</td></tr>
<tr><td>Word 10</td><td colspan="16">LOS Medium Elevation</td></tr>
<tr><td>Word 11</td><td colspan="16">LOS Narrow Azimuth</td></tr>
<tr><td>Word 12</td><td colspan="16">LOS Narrow Elevation</td></tr>
<tr><td>Word 13</td><td colspan="16">Focus Wide</td></tr>
<tr><td>Word 14</td><td colspan="16">Focus Medium</td></tr>
<tr><td>Word 15</td><td colspan="16">Focus Narrow</td></tr>
<tr><td>Word 16</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.26. Serial Lens Triple FOV Message

Note: This message supports the following lens types (reference section also shown):

2 – ***C3.8.1*** Optimum Optical System Tri-FOV
3 – ***C3.8.2*** Sophie Thermal Binoculars
12 – ***C3.8.11*** Janos Alba Tri-FOV

Sync Word: 0xA5A5

Message Type: 24

Video Source:	Video source lens is connected to
	0 – Analog 1 <DEFAULT> 1 – Analog 2 2 – Analog 3 3 – Analog 4 4 – Digital 1 5 – Digital 2 (Only on models with HD-SDI)
Serial Port:	Tracker serial port lens is connected to (3-7, 0-2 are reserved)
FOV:	Field of View command
	0 – None <DEFAULT> 1 – Wide 2 – Medium 3 – Narrow
Focus:	Focus command
	0 – None <DEFAULT> 1 – Near 2 – Far
Iris:	Iris command
	0 – None <DEFAULT> 1 – Close 2 – Open
AI:	Automatic iris enable
	0 – Disabled <DEFAULT> 1 – Enabled
FOV Wide:	Wide field-of-view of the lens in degrees
	Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
FOV Medium:	Medium field-of-view of the lens in degrees
	Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees

FOV Narrow:	Narrow field-of-view of the lens in degrees Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
LOS Wide Azimuth:	Line of Sight (boresight) offset for wide field of view
LOS Wide Elevation:	Line of Sight (boresight) offset for wide field of view
LOS Medium Azimuth:	Line of Sight (boresight) offset for medium field of view
LOS Medium Elevation:	Line of Sight (boresight) offset for medium field of view
LOS Narrow Azimuth:	Line of Sight (boresight) offset for narrow field of view
LOS Narrow Elevation:	Line of Sight (boresight) offset for narrow field of view
Focus Wide:	Focus setting for wide field of view
Focus Medium:	Focus setting for medium field of view
Focus Narrow:	Focus setting for narrow field of view

B4.26 Serial Lens Dual FOV Message

Reference Appendix C, Sections by lens type as shown below

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 25								Spare							
Word 3	Spare		AI	Iris		Focus		FOV		Serial Port			Video Source			
Word 4	FOV Wide															
Word 5	FOV Narrow															
Word 6	LOS Wide Azimuth															
Word 7	LOS Wide Elevation															
Word 8	LOS Narrow Azimuth															
Word 9	LOS Narrow Elevation															
Word 10	Focus Wide															
Word 11	Focus Narrow															
Word 12	Checksum															

Figure B4.27. Serial Lens Dual FOV Message

Note: This message supports the following lens types (reference section also shown):

11 – ***C3.8.10*** Janos Asio Dual-FOV

Sync Word: 0xA5A5

Message Type: 25

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2
2 – Analog 3
3 – Analog 4
4 – Digital 1
5 – Digital 2 (Only on models with HD-SDI)

Serial Port: Tracker serial port lens is connected to (3-7, 0-2 are reserved)

FOV:	Field of View command 0 – None <DEFAULT> 1 – Wide 2 – Narrow
Focus:	Focus command 0 – None <DEFAULT> 1 – Near 2 – Far
Iris:	Iris command 0 – None <DEFAULT> 1 – Close 2 – Open
AI:	Automatic iris enable 0 – Disabled <DEFAULT> 1 – Enabled
FOV Wide:	Wide field-of-view of the lens in degrees Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
FOV Narrow:	Narrow field-of-view of the lens in degrees Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
LOS Wide Azimuth:	Line of Sight (boresight) offset for wide field of view
LOS Wide Elevation:	Line of Sight (boresight) offset for wide field of view
LOS Narrow Azimuth:	Line of Sight (boresight) offset for narrow field of view
LOS Narrow Elevation:	Line of Sight (boresight) offset for narrow field of view
Focus Wide:	Focus setting for wide field of view
Focus Narrow:	Focus setting for narrow field of view

B4.27 Generic Lens Message

Reference Appendix C, Sections by lens type as shown below

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 26								Spare							
Word 3	Spare											Uf	Video Source			
Word 4	Mount Gain															
Word 5	Lens FOV															
Word 6	Checksum															

Figure B4.28. Generic Lens Message

Note: This message supports the following lens types (reference section also shown):

4 – ***C3.8.3*** Generic Lens

Sync Word: 0xA5A5

Message Type: 26

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2
2 – Analog 3
3 – Analog 4
4 – Digital 1
5 – Digital 2 (Only on models with HD-SDI)

Uf: Use the lens' FOV parameter instead of raw mount gain

0 – Use raw mount gain <DEFAULT>
1 – Use lens' FOV parameter

Mount Gain: Mount gain, should be set only if Uf is set to 0

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.00048828125 (divide by 2048)
Range: 0 to 31.999

Lens FOV: Lens' FOV in degrees, should be set only if Uf is set to 1

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 degree (divide by 100)

Range: 0 to 360.00 degrees

B4.28 Serial Lens Zoom Message

Reference Appendix C, Sections by lens type as shown below

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 27								Lens ID							
Word 3	Lens Type															
Word 4	AI	Iris		Focus			Zoom			Serial Port			Video Source			
Word 5	Spare													2X	Op	Cl
Word 6	Zoom FOV															
Word 7	FOV Min															
Word 8	FOV Max															
Word 9	FOV Gain Min															
Word 10	FOV Gain Max															
Word 11	Focus Position															
Word 12	Checksum															

Figure B4.29. Serial Lens Zoom Message

Sync Word: 0xA5A5

Message Type: 27

Lens ID: Lens protocols that support multiple lenses require a lens ID:

C3.8.9 Cohu MPC Protocol

Lens Type: Lens type (valid types and ***reference section*** are listed below)

5 – ***C3.8.4*** Western Video / ITS 6125 DF
7 – ***C3.8.6*** Graflex 27X (Serial) / Model 901
8 – ***C3.8.7*** Graflex 27X (Vinten)
10 – ***C3.8.9*** Cohu MPC Protocol
15 – ***C3.8.14*** Fujinon D60 / Model 902
16 – ***C3.8.15*** Graflex 35X
18 – ***C3.8.17*** Fujinon C22x23R2D-ZP1

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2

	2 – Analog 3 3 – Analog 4 4 – Digital 1 5 – Digital 2 (Only on models with HD-SDI)
Serial Port:	Tracker serial port lens is connected to (3-7, 0-2 are reserved)
Zoom:	Zoom command 0 – None <DEFAULT> 1 – Narrow 2 – Wide 3 – Go To Position
Focus:	Focus command 0 – None <DEFAULT> 1 – Near 2 – Far 3 – Go To Position
Iris:	Iris command 0 – None <DEFAULT> 1 – Close 2 – Open
AI:	Automatic iris enable 0 – Disabled <DEFAULT> 1 – Enabled
Cl:	Perform zoom scale calibration 0 – Disabled <DEFAULT> 1 – Perform calibration
Op:	Use older lens communication protocol (only valid for lens type 10) 0 – Use latest protocol <DEFAULT> 1 – Use old protocol
2X:	Enable 2X extender (Fujinon D60)
Zoom FOV:	Current zoom field of view in degrees Data Format: 16-bit unsigned integer

	Scaling:	LSB = 0.01 degree (divide by 100)
	Range:	0 to 360.00 degrees

FOV Min: Minimum field of view of the lens in degrees

Data Format:	16-bit unsigned integer
Scaling:	LSB = 0.01 degree (divide by 100)
Range:	0 to 360.00 degrees

FOV Max: Maximum field of view of the lens in degrees

Data Format:	16-bit unsigned integer
Scaling:	LSB = 0.01 degree (divide by 100)
Range:	0 to 360.00 degrees

FOV Gain Min: Minimum mount gain for lens' minimum FOV (range of 0 to .99999)
This field is deprecated and is no longer used.

FOV Gain Max: Maximum mount gain for lens' maximum FOV (range of 0 to .99999)
This field is deprecated and is no longer used.

Focus Position: Current focus position

B4.29 Serial IR Lens Zoom Message

Reference Appendix C, Sections by lens type as shown below

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 28</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="16">Lens Type</td></tr>
<tr><td>Word 4</td><td>GC</td><td>Po</td><td colspan="3">Focus</td><td>Cl</td><td colspan="3">Zoom</td><td colspan="3">Serial Port</td><td colspan="4">Video Source</td></tr>
<tr><td>Word 5</td><td colspan="8">Spare</td><td colspan="4">On-Screen Menu</td><td>LC</td><td>AC</td><td>HS</td><td>DM</td></tr>
<tr><td>Word 6</td><td colspan="16">Manual Gain</td></tr>
<tr><td>Word 7</td><td colspan="16">Manual Offset</td></tr>
<tr><td>Word 8</td><td colspan="16">Correction Table</td></tr>
<tr><td>Word 9</td><td colspan="16">Zoom FOV</td></tr>
<tr><td>Word 10</td><td colspan="16">FOV Min</td></tr>
<tr><td>Word 11</td><td colspan="16">FOV Max</td></tr>
<tr><td>Word 12</td><td colspan="16">Spare</td></tr>
<tr><td>Word 13</td><td colspan="16">Spare</td></tr>
<tr><td>Word 14</td><td colspan="16">Focus Position</td></tr>
<tr><td>Word 15</td><td colspan="16">Spare</td></tr>
<tr><td>Word 16</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.30. Serial IR Lens Zoom Message

Sync Word: 0xA5A5

Message Type: 28

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2
2 – Analog 3
3 – Analog 4
4 – Digital 1
5 – Digital 2 (Only on models with HD-SDI)

Serial Port: Tracker serial port lens is connected to (3-7, 0-2 are reserved)

Lens Type: Lens type (valid types and ***reference section*** are listed below)

6 – ***C3.8.5*** DiOP/Senspex FieldPro 5X
17 – ***C3.8.16*** FLIR Ranger HRC

Zoom: Zoom command

0 – None <DEFAULT>
1 – Narrow
2 – Wide
3 – Go To Position

Cl: Perform zoom scale calibration

0 – Disabled <DEFAULT>
1 – Perform calibration

Focus: Focus command

0 – None <DEFAULT>
1 – Near
2 – Far
3 – Go To Position

Po: Image polarity

0 – Normal/White Hot <DEFAULT>
1 – Inverted/Black Hot

GC: Automatic Gain Control (AGC)

0 – Disabled <DEFAULT>
1 – Enabled

DM: Day Mode Enable

0 – Disabled/Night <DEFAULT>
1 – Enabled/Day

HS: High Sensitivity Enable

0 – Disabled/Normal <DEFAULT>
1 – Enabled/High

AC:	Automatic Calibration Enable 0 – Disabled <DEFAULT> 1 – Enabled
LC:	Lens Cover Control (FLIR Ranger HRC) 0 – Close lens cover <DEFAULT> 1 – Open lens cover
On-Screen Menu:	Button press command to on-screen menu (FLIR Ranger HRC) 0 – No Operation 1 – Menu ENTER 2 – Menu CANCEL 3 – Menu LEFT 4 – Menu RIGHT 5 – Menu UP 6 – Menu DOWN 7 – Menu TAB
Manual Gain:	Sensor Gain, used when GC=0
Manual Offset:	Sensor Offset, used when GC=0
Correction Table:	Sensor Non-Uniformity Correction Table
Zoom FOV:	Current zoom field of view in degrees (valid on query) Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
FOV Min:	Minimum field of view of the lens in degrees Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
FOV Max:	Maximum field of view of the lens in degrees Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
Focus Position:	Current focus position

B4.30 Analog Zoom Lens Message

Reference Appendix C, Sections by lens type as shown below

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 29</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="8">Zoom Feedback</td><td colspan="4">Spare</td><td colspan="4">Video Source</td></tr>
<tr><td>Word 4</td><td colspan="16">Gain</td></tr>
<tr><td>Word 5</td><td colspan="16">Bias</td></tr>
<tr><td>Word 6</td><td colspan="16">Coeff 1</td></tr>
<tr><td>Word 7</td><td colspan="16">Coeff 2</td></tr>
<tr><td>Word 8</td><td colspan="16">Coeff 3</td></tr>
<tr><td>Word 9</td><td colspan="16">Spare</td></tr>
<tr><td>Word 10</td><td colspan="16">Zoom Voltage</td></tr>
<tr><td>Word 11</td><td colspan="16">Zoom FOV</td></tr>
<tr><td>Word 12</td><td colspan="16">FOV Min</td></tr>
<tr><td>Word 13</td><td colspan="16">FOV Max</td></tr>
<tr><td>Word 14</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.31. Analog Zoom Lens Message

Note: This message supports the following lens types (reference section also shown):

9 – ***C3.8.8*** Generic Analog Zoom

Sync Word: 0xA5A5

Message Type: 29

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2
2 – Analog 3
3 – Analog 4
4 – Digital 1
5 – Digital 2 (Only on models with HD-SDI)

Zoom Feedback:	Analog input channel for zoom position feedback 0 – Disabled <DEFAULT> 1-8 – Tracker (analog input channel) 9 – Model 702 Controller Lens Input 1 10 – Model 702 Controller Lens Input 2
Gain:	Input voltage gain Data Format: 16-bit two's complement Scaling: LSB = 0.01 (divide by 100)
Bias:	Input voltage bias Data Format: 16-bit two's complement Scaling: LSB = 0.01 (divide by 100)
Coeff 0 to 2:	Polynomial coefficients 0 to 2 Data Format: 16-bit two's complement Scaling: LSB = 0.0001 (divide by 10,000) The voltage presented to the tracker, x, is: x = Gain * (input voltage + Bias) FOV = (Coeff2 * x^2) + (Coeff1 * x) + Coeff0
Zoom Voltage:	Current zoom feedback voltage before adjustment, as seen by tracker. Data Format: 16-bit two's complement Scaling: LSB = 0.001 (divide by 1,000) Range: Tracker range: ±10.000V Controller range: 0.000 to 10.000V
Zoom FOV:	Current zoom Field of View in degrees Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
FOV Min:	Minimum field of view of the lens in degrees Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 degree (divide by 100) Range: 0 to 360.00 degrees
FOV Max:	Maximum field of view of the lens in degrees

Data Format:	16-bit unsigned integer
Scaling:	LSB = 0.01 degree (divide by 100)
Range:	0 to 360.00 degrees

Valid values for lens types above:

B4.31 Camera Configuration Message (DEPRECATED)

Reference Appendix C, Section C3.9

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 30								Spare							
Word 3	Analog 1															
Word 4	Analog 2															
Word 5	Analog 3															
Word 6	Analog 4															
Word 7	Digital 1															
Word 8	Digital 2															
Word 9	Spare															
Word 10	Checksum															

Figure B4.32. Camera configuration Message

Sync Word:	0xA5A5
Message Type:	30
Analog 1 to 4:	Camera type connected to analog video source 1 to 4
Digital 1 to 2:	Camera type connected to digital video source 1 to 2
	Valid values for camera types above:
	1 – Indigo Merlin (Message Type 31)

B4.32 Generic Camera Configuration Message (DEPRECATED)

Reference Appendix C, Section C3.9

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 31								Spare							
Word 3	Spare								GC	Serial Port			Video Source			
Word 4	Manual Gain															
Word 5	Correction Table															
Word 6	Spare															
Word 7	Spare															
Word 8	Spare															
Word 9	Spare															
Word 10	Checksum															

Figure B4.33. Generic Camera Configuration Message

Sync Word: 0xA5A5

Message Type: 31

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2
2 – Analog 3
3 – Analog 4
4 – Digital 1
5 – Digital 2 (Only on models with HD-SDI)

Serial Port: Tracker serial port lens is connected to (3-7, 0-2 are reserved)

GC: Automatic Gain Control (AGC)

0 – Disabled <DEFAULT>
1 – Enabled

Manual Gain: Sensor Gain, used when GC=0

Correction Table: Sensor Non-Uniformity Correction Table

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B4.33 Serial Fixed Field of View Lens Message

Reference Appendix C, Sections by lens type as shown below

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 32								Lens ID							
Word 3	Lens Type															
Word 4	Spare		FR	At	AI	Iris		Focus		Serial Port			Video Source			
Word 5	Lens FOV															
Word 6	Focus Position															
Word 7	Spare															
Word 8	Checksum															

Figure B4.34. Serial Fixed Field of View Lens Message

Sync Word: 0xA5A5

Message Type: 32

Lens ID: Lens protocols that support multiple lenses require a lens ID:

C3.8.12 Optimum Optical System (OOS) Multiband Telescope
C3.8.18 Graflex Fixed FOV Lens
C3.8.20 Optec Focuser

Lens Type: Lens type (valid types and ***reference section*** are listed below)

13 – ***C3.8.12*** Optimum Optical System (OOS) Multiband Telescope
19 – ***C3.8.18*** Graflex Fixed FOV Lens
21 – ***C3.8.20*** Optec Focuser

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2
2 – Analog 3
3 – Analog 4
4 – Digital 1
5 – Digital 2 (Only on models with HD-SDI)

Serial Port: Tracker serial port lens is connected to (3-7, 0-2 are reserved)

Focus: Focus command

0 – None <DEFAULT>
1 – Near
2 – Far
3 – Go to position

Iris: Iris command

0 – None <DEFAULT>
1 – Close
2 – Open

AI: Automatic iris enable

0 – Disabled <DEFAULT>
1 – Enabled

At: Athermalization (focus temperature correction) enable

0 – Disabled <DEFAULT>
1 – Enabled

FR: Focus to range enable

0 – Disabled <DEFAULT>
1 – Enabled

Lens FOV: The field of view of the lens in degrees

Data Format:	16-bit unsigned integer
Scaling:	LSB = 0.01 degree (divide by 100)
Range:	0 to 360.00 degrees

Focus Position: Current focus position

B4.34 Serial IR Dual Field of View Lens Message

Reference Appendix C, Sections by lens type as shown below

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 33</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="16">Lens Type</td></tr>
<tr><td>Word 4</td><td>Sp</td><td>AG</td><td>AO</td><td>PO</td><td colspan="3">Focus</td><td colspan="2">FOV</td><td colspan="3">Serial Port</td><td colspan="4">Video Source</td></tr>
<tr><td>Word 5</td><td colspan="8">NUC Table</td><td colspan="6">Spare</td><td>RF</td><td>RP</td></tr>
<tr><td>Word 6</td><td colspan="16">Manual Offset</td></tr>
<tr><td>Word 7</td><td colspan="16">Manual Gain</td></tr>
<tr><td>Word 8</td><td colspan="16">FOV Wide</td></tr>
<tr><td>Word 9</td><td colspan="16">FOV Narrow</td></tr>
<tr><td>Word 10</td><td colspan="16">LOS Wide X</td></tr>
<tr><td>Word 11</td><td colspan="16">LOS Wide Y</td></tr>
<tr><td>Word 12</td><td colspan="16">LOS Narrow X</td></tr>
<tr><td>Word 13</td><td colspan="16">LOS Narrow Y</td></tr>
<tr><td>Word 14</td><td colspan="16">Focus Wide</td></tr>
<tr><td>Word 15</td><td colspan="16">Focus Narrow</td></tr>
<tr><td>Word 16</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.35. Serial IR Dual Field of View Lens Message

Sync Word: 0xA5A5

Message Type: 33

Lens Type: Lens type (valid types and ***reference section*** are listed below)

14 – ***C3.8.13*** FLIR MilCAM Dual-FOV (**UNSUPPORTED**)
20 – ***C3.8.19*** FLIR RS6700 Dual-FOV Lens

Video Source:	Video source lens is connected to 0 – Analog 1 1 – Analog 2 2 – Analog 3 3 – Analog 4 4 – Digital 1 5 – Digital 2 (Only on models with HD-SDI)
Serial Port:	Tracker serial port lens is connected to (3-7, 0-2 are reserved)
FOV:	Field of view command 0 – None 1 – Wide 2 – Narrow
Focus:	Focus command 0 – None 1 – Near 2 – Far 3 – Go To Position 4 - Auto
PO:	Image polarity 0 – Normal / White Hot 1 – Inverted / Black Hot
AO:	Automatic offset / level / bias control 0 – Disabled 1 – Enabled / Automatic
AG:	Automatic gain control 0 – Disabled 1 – Enabled / Automatic
Sp:	Spare bit. Set to zero.
RP:	Run partial / quick non-uniformity correction command 0 – Do not run now 1 – Run Now

RF:	Run full non-uniformity correction command	
	0 – Do not run now 1 – Run Now	
NUC Table:	Non-uniformity correction (equalization) table	
	Data Format:	8-bit unsigned integer
Manual Offset:	Sensor offset / level / bias setting	
	Data Format:	16-bit unsigned integer
Manual Gain:	Sensor gain setting	
	Data Format:	16-bit unsigned integer
FOV Wide:	Wide field-of-view of the lens in degrees	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 degree (divide by 100)
	Range:	0 to 360.00 degrees
FOV Narrow:	Narrow field-of-view of the lens in degrees	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 degree (divide by 100)
	Range:	0 to 360.00 degrees
LOS Wide X:	Line of sight (boresight) offset for the wide field of view	
	Data Format:	16-bit two's complement
LOS Wide Y:	Line of sight (boresight) offset for the wide field of view	
	Data Format:	16-bit two's complement
LOS Narrow X:	Line of sight (boresight) offset for the narrow field of view	
	Data Format:	16-bit two's complement
LOS Narrow Y:	Line of sight (boresight) offset for the narrow field of view	
	Data Format:	15-bit two's complement
Focus Wide:	Focus setting for the wide field of view	
	Data Format:	16-bit unsigned integer

Focus Narrow:	Focus setting for the narrow field of view	
	Data Format:	16-bit unsigned integer

B4.35 Analog Inputs Message

Reference Appendix C, Section C4.3.6

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 40								Spare							
Word 3	Analog 0															
Word 4	Analog 1															
Word 5	Analog 2															
Word 6	Analog 3															
Word 7	Analog 4															
Word 8	Analog 5															
Word 9	Analog 6															
Word 10	Analog 7															
Word 11	Spare															
Word 12	Checksum															

Figure B4.36. Analog Inputs Message

NOTE: This message is feedback from a query only and not a command message.

Sync Word: 0xA5A5

Message Type: 40

Analog 0 through 7: The analog to digital converter (ADC) value for each analog input to the tracker. To scale the error signals to ±10 volts, use the following equation; volts = analog * 10/32768.

Data Format: 16-bit two’s complement

B4.36 Tracker Capabilities Message

Reference Appendix C, Section C4.3.1

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 41</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="16">Type</td></tr>
<tr><td>Word 4</td><td colspan="10">Spare</td><td>T3</td><td>DV</td><td>CL</td><td>DH</td><td>DT</td><td>CO</td></tr>
<tr><td>Word 5</td><td colspan="16">DSP1 Version</td></tr>
<tr><td>Word 6</td><td colspan="16">DSP1 Revision</td></tr>
<tr><td>Word 7</td><td colspan="16">DSP2 Version</td></tr>
<tr><td>Word 8</td><td colspan="16">DSP2 Revision</td></tr>
<tr><td>Word 9</td><td colspan="8">FPGA Revision</td><td colspan="4">FPGA Type</td><td colspan="4">FPGA Version</td></tr>
<tr><td>Word 10 to Word 16</td><td colspan="16">DSP Build Date</td></tr>
<tr><td>Word 17 to Word 21</td><td colspan="16">DSP Build Time</td></tr>
<tr><td>Word 22 to Word 25</td><td colspan="16">Serial Number</td></tr>
<tr><td>Word 26</td><td colspan="8">DSP1 BL Revision</td><td colspan="8">DSP1 BL Version</td></tr>
<tr><td>Word 27</td><td colspan="8">DSP2 BL Revision</td><td colspan="8">DSP2 BL Version</td></tr>
<tr><td>Word 28</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.37. Tracker Capabilities Message

NOTE: This message is feedback from a query only and not a command message.

Sync Word: 0xA5A5

Message Type: 41

Type: Type/Model of tracker

6005 – VME tracker, Single target
6006 – VME tracker, Dual target
6007 – PCI tracker, Single target
6008 – PCI tracker, Dual target
6010 – Compact PCI tracker, Single target

6011 – Compact PCI tracker, Dual target
7005 – VME tracker, Single target
7006 – VME tracker, Dual target
7007 – PCI tracker, Single target
7008 – PCI tracker, Dual target
7010 – PCI Express tracker, Single target
7011 – PCI Express tracker, Dual target
8100 – Standalone tracker, Single target
8101 – Standalone tracker, Dual target
8200 – Standalone tracker, Single target
8201 – Standalone tracker, Dual target

CO:	Correlation available 0 – No Correlation 1 – Correlation Available
DT:	Second gate available 0 – Second gate not available 1 – Second gate available
DH:	Dual HD-SDI digital video inputs present 0 – Dual HD-SDI digital video inputs not present 1 – Dual HD-SDI digital video inputs present
CL:	Camera link digital video input present 0 – Camera link digital video input not present 1 – Camera link digital video input present
DV:	DVI digital video input present 0 - DVI digital video input not present 1 - DVI digital video input present
T3:	Third gate available (***only available on Model 7412***). 0 – Third gate not available 1 – Third gate available
DSP1 Version:	DSP1 software version number
DSP1 Revision:	DSP1 software revision number
DSP2 Version:	DSP2 software version number

DSP2 Revision:	DSP2 software revision number
FPGA Version:	FPGA hardware version number 1 – Model 60XX VME 2 – Model 60XX PCI 3 – Model 60XX Compact PCI 4 – Model 70XX-CL VME 5 – Model 70XX-HD VME 6 – Model 70XX Custom 7 – Model 70XX PCI 8 – Model 81XX 9 – Model 82XX 10 – Model 701X VME 11 – Model 741X PCI Express
FPGA Type:	FPGA hardware type number 1 – Virtex 1600E (XVE1600) 2 – Virtex 2000E (XVE2000) 3 – Virtex 4 LX80 (XC4V-LX80) 4 – Virtex 4 LX160 (XC4V-LX160) 5 – Virtex 5 LX110 (XC5V-LX110)
FPGA Revision:	FPGA firmware revision number
DSP Build Date:	DSP software build date in ASCII text format Example: Oct. 23, 2005
DSP Build Time:	DSP software build time in ASCII text format Example: 14:23:04
Serial Number:	Tracker serial number in ASCII text format Example: 12345678
DSP1 BL Version:	DSP1 software boot loader version number
DSP1 BL Revision:	DSP1 software boot loader revision number
DSP2 BL Version:	DSP2 software boot loader version number
DSP2 BL Revision:	DSP2 software boot loader revision number

B4.37 Mount Status Message

Reference Appendix C, Section C3.5.10

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 43</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="12">Spare</td><td>Fa</td><td>Li</td><td>Ac</td><td>En</td></tr>
<tr><td>Word 4</td><td colspan="8">Status 2</td><td colspan="8">Status 1</td></tr>
<tr><td>Word 5</td><td colspan="8">Status 4</td><td colspan="8">Status 3</td></tr>
<tr><td>Word 6</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.38. Mount Status Message

NOTE: This message is feedback from a query only and not a command message.

Sync Word: 0xA5A5

Message Type: 43

En: Mount support enabled

0 – Mount not enabled/connected/detected (no communication)
1 – Mount communication established and functioning

Ac: Mount active

0 – Motor power is off
1 – Motor power is on

Li: Limit alarm

0 – Mount within limits
1 – Mount has reached a limit

Fa: Fault alarm

0 – No faults detected
1 – Mount fault alarm

Status 1 to 4: Raw status bytes returned by the mount (if supported)

Data Format: 8-bit unsigned integer

B4.38 Laser Rangefinder (LRF) Message

Reference Appendix C, Section C3.5.12

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 44</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="3">Spare</td><td>FT</td><td>HV</td><td colspan="3">Serial Port</td><td colspan="8">Command</td></tr>
<tr><td>Word 4</td><td colspan="16">Type</td></tr>
<tr><td>Word 5</td><td colspan="16">Fire Interval</td></tr>
<tr><td>Word 6</td><td colspan="16">Range Min LSW</td></tr>
<tr><td>Word 7</td><td colspan="16">Range Min MSW</td></tr>
<tr><td>Word 8</td><td colspan="16">Range Max LSW</td></tr>
<tr><td>Word 9</td><td colspan="16">Range Max MSW</td></tr>
<tr><td>Word 10</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.39. Laser Rangefinder (LRF) Message

Sync Word: 0xA5A5

Message Type: 44

Command: Mount support enabled

0 – No action (for configuration)
1 – Fire laser one time
2 – Fire laser continuously
3 – Stop firing laser continuously

Serial Port: Tracker serial port lens is connected to (3-7, 0-2 are reserved)

HV: High voltage enable

0 – Disable high voltage to laser
1 – Enable high voltage to laser

FT: First target inside the range gate

0 – Last target
1 – first target in the range gate

Type:	Laser Rangefinder type 0 – None <DEFAULT> 1 – ALST ELRF-1 2 – ALST ELRF-2 3 – ALST ELRF-3 4 – Newcon Optik LRB 25,000 5 – Newcon Optik MOD25HFLC
Fire Interval:	Periodic fire time in milliseconds Data Format: 16-bit unsigned integer
Range Min LSW, MSW:	Minimum target range in meters Data Format: 32-bit unsigned integer
Range Max LSW, MSW:	Maximum target range in meters Data Format: 32-bit unsigned integer

B4.39 Target Range Message

Reference Appendix C, Section C3.5.12

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 45</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="2">Spare</td><td>RE</td><td>HO</td><td>LF</td><td>V</td><td>MT</td><td>RF</td><td colspan="6">Spare</td><td>Un</td><td>Sc</td></tr>
<tr><td>Word 4</td><td colspan="16">Range LSW</td></tr>
<tr><td>Word 5</td><td colspan="16">Range MSW</td></tr>
<tr><td>Word 6</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.40. Target Range Message

NOTE: This message is feedback from a query only and not a command message.

Sync Word: 0xA5A5

Message Type: 45

Sc: Source of range data

0 – Tracker supplies range data
1 – User supplies range data

Un: Units for range data

0 – Range data in meters
1 – Range data in centimeters

RF: Ready to fire (for LRF only)

0 – Laser not ready to fire
1 – Laser ready to fire

MT: Multiple targets in range gate (for LRF data)

0 – One or no targets in range gate
1 – Multiple targets in range gate

V: Valid range data

0 – Range data is not valid
1 – Range data is valid

LF:	Laser fired (for LRF only)
	0 – Laser has not fired 1 – Laser successfully fired
HO:	Heater on (for some LRFs only)
	0 – Heater off 1 – Heater on
RE:	Range gate error (for LRF only)
	0 – Tracker supplies range data 1 – Range gate error (max ≤ min)
Range LSW:	Range in meters/centimeters
	Data Format: 32-bit unsigned integer

B4.40 Target Generator Message

Reference Appendix C, Section C4.3.8

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 46</td><td colspan="6">Spare</td><td>ME</td><td>En</td></tr>
<tr><td>Word 3</td><td colspan="8">Target Type</td><td colspan="8">Target Select</td></tr>
<tr><td>Word 4</td><td colspan="16">Color</td></tr>
<tr><td>Word 5</td><td colspan="16">Position X</td></tr>
<tr><td>Word 6</td><td colspan="16">Position Y</td></tr>
<tr><td>Word 7</td><td colspan="16">Size X</td></tr>
<tr><td>Word 8</td><td colspan="16">Size Y</td></tr>
<tr><td>Word 9</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.41. Target Generator Message

Sync Word: 0xA5A5

Message Type: 46

En: Global target generator enable

0 – Disabled <DEFAULT>
1 – Enabled

ME: Target motion enable (DEBUG ONLY)

0 – Disabled <DEFAULT>
1 – Enabled

Target Select: Target select

0 – Background
1 – Target #1
2 – Target #2

Target Type:	Target type	
	0 – Disabled <DEFAULT> 1 – Rectangle 1 – Background (only when Target Select = 0) 2 – Diamond 3 – Color Bars (only when Target Select = 1) 4 – Single Pixel (only when Target Select = 2)	
Color:	Target grayscale color (0 to 1023)	
Position X & Y:	Target center position	
	Data Format:	16-bit two's complement
	Scaling:	LSB = 1 pixel / line
	Range:	X: ±511, Y: ±511 (Y range is video format dependent)
Size X & Y:	Target size	
	Data Format:	16-bit binary
	Scaling:	LSB = 1 pixel / line
	Range:	X: 1 to 1023, Y: 1 to 1023 (Y range is video format dependent)

B4.41 Gate Control Message

Reference Appendix C, Section C2.1

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 47</td><td colspan="8">Gate Number</td></tr>
<tr><td>Word 3</td><td colspan="7">Spare</td><td>En</td><td colspan="8">Transition Event</td></tr>
<tr><td>Word 4</td><td colspan="16">Transition Step</td></tr>
<tr><td>Word 5</td><td colspan="16">Transition Time</td></tr>
<tr><td>Word 6</td><td colspan="16">Slave Offset X</td></tr>
<tr><td>Word 7</td><td colspan="16">Slave Offset Y</td></tr>
<tr><td>Word 8</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.42. Gate Control Message

Sync Word: 0xA5A5

Message Type: 47

Gate Number: The tracking gate number currently generating the mount drive

0 – Gate 0 (the first gate) <DEFAULT>
1 – Gate 1 (the second gate)
2 – Gate 2 (the third gate)

Transition Event: Event which will trigger a transition between gates

0 – None <DEFAULT>
1 – Gate 1 entering the track state

En: Second gate (Gate 1) slaved to first gate (Gate 0) enable. This is a one-shot event and this flag will be automatically disabled after a transition.

0 – Disabled <DEFAULT>
1 – Enabled

Transition Step: Percent of gate error to use for the initial transition step. This is a parameter of the ramp filter used to smooth the transition.

Data Range: 0 to 100

Transition Time:	Time in field to transition between gates. This is a parameter of the ramp filter used to smooth the transition.
	Data Format: 16-bit unsigned integer
Slave Offset X & Y:	Second gate (Gate 1) slaved offset from the location of the first gate (Gate 0)
	Data Range: ±511 pixels/lines

B4.42 Mount Feedback Message

Reference Appendix C, Section C3.5.10

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 48								Spare							
Word 3	Azimuth (least significant word)															
Word 4	Azimuth (most significant word)															
Word 5	Elevation (least significant word)															
Word 6	Elevation (most significant word)															
Word 7	Velocity Azimuth (least significant word)															
Word 8	Velocity Azimuth (most significant word)															
Word 9	Velocity Elevation (least significant word)															
Word 10	Velocity Elevation (most significant word)															
Word 11	Spare															
Word 12	Checksum															

Figure B4.43. Mount Feedback Message

Sync Word: 0xA5A5

Message Type: 48

Azimuth : The current azimuth angle of the mount in degrees.

Data Format:	32-bit signed integer
Scaling:	LSB = 0.0001 degrees (divide by 10,000)
Range:	Typically ±180.0000

Elevation: The current elevation angle of the mount in degrees.

Data Format:	32-bit signed integer
Scaling:	LSB = 0.0001 degrees (divide by 10,000)
Range:	Typically ±90.0000

Velocity Az : The current azimuth velocity of the mount in degrees per second.

Data Format:	32-bit signed integer
Scaling:	LSB = 0.001 degrees/sec (divide by 1,000)
Range:	Typically ±100.000

Velocity El:	The current elevation velocity of the mount in degrees per second.	
	Data Format:	32-bit signed integer
	Scaling:	LSB = 0.001 degrees/sec (divide by 1,000)
	Range:	Typically ±100.000

B4.43 Digital I/O Message

Reference Appendix C, Section C3.5.9

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 49								Spare							Ty
Word 3	Digital I/O Bits															
Word 4	Checksum															

Figure B4.44. Digital I/O Message

NOTE: This message is both feedback from a query (read) and a command (write).

Sync Word: 0xA5A5

Message Type: 49

Ty: Type of message

0 – Read (response to a query)
1 – Write (command to write digital I/O bits)

Digital I/O Bits: The tracker's 16-bits of digital input/output

Data Format: 16-bit unsigned integer

B4.44 Gate Statistics Message

Reference Appendix C, Section C4.3.3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 54								Spare							
Word 3	Absolute Maximum															
Word 4	Absolute Minimum															
Word 5	Maximum															
Word 6	Minimum															
Word 7	Mean															
Word 8	Median															
Word 9	Mode															
Word 10	Checksum															

Figure B4.45. Gate Statistics Message

NOTE: This message is feedback from a query only and not a command message.

Sync Word: 0xA5A5 (for Gate 0) or 0xA6A6 (for Gate 1)

Message Type: 54

Absolute Maximum: The absolute maximum intensity value in the gate

Data Format: 16-bit unsigned integer

Absolute Minimum: The absolute minimum intensity value in the gate

Data Format: 16-bit unsigned integer

Maximum: The statistically significant maximum intensity value in the gate

Data Format: 16-bit unsigned integer

Minimum: The statistically significant minimum intensity value in the gate

Data Format: 16-bit unsigned integer

Mean: The average (arithmetic mean) intensity value in the gate

Data Format: 16-bit unsigned integer

Median:	The middle (statistical median) intensity value in the gate	
	Data Format:	16-bit unsigned integer
Mode:	The peak (largest histogram bin) intensity value in the gate	
	Data Format:	16-bit unsigned integer

B4.45 Digital Video Status Message

Reference Appendix C, Section C3.5.3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 55								Spare							
Word 3	Spare															Pr
Word 4	Pixel Count															
Word 5	Line Count															
Word 6	Video Rate															
Word 7	Pixel Clock															
Word 8	Checksum															

Figure B4.46. Digital Video Status Message

NOTE: This message is feedback from a query only and not a command message.

Sync Word: 0xA5A5

Message Type: 55

Pr: Digital video input source present

0 – No digital video detected
1 – Digital video input detected

Pixels Count: The number of pixels per line

Data Format: 16-bit unsigned integer

Line Count: The number of lines for video field/frame

Data Format: 16-bit unsigned integer

Video Rate: The video field/frame rate in microseconds

Data Format: 16-bit unsigned integer

Pixel Clock: The video pixel clock rate in MHz

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 MHz (divide by 100)
Range: 0 to 327.67 MHz

B4.45.1.1.1.1.1 User String 2 Message

Reference Appendix C, Section C3.2.3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 56								Spare							
Word 3	Start Row								Start Column							
Word 4	Char 1								Char 0							
Word 5	Char 3								Char 2							
…	…															
Word 22	NULL (0x00h)								Char 36							
Word 23	Checksum															

Figure B4.47. User String 2 Message

NOTE: This message supersedes the User String message (message type 15) adding expanded row and column fields in order to support higher resolution digital video.

Sync Word: 0xA5A5

Message Type: 56

This message is a fixed 23 words long. All bytes after the NULL terminated string must be zero filled through word 22. Annotation strings can be processed at up to 10 Hz updates.

Start Row: Start row defines the character row where the string is to be displayed.

Range: 0 to 255

Start Column: Start column defines the character column where the beginning of the string is to be displayed.

Range: 0 to 255

NOTE: The actual number of visible rows/columns depends on the input video type and the monitor used to display the tracker output. Therefore, the actual useable rows/columns will be less than the theoretical maximum ranges given above.

Char 0 to 36: User string of 37 characters in length plus a NULL termination. Erase previous annotation by writing spaces to the same location.

B4.46 Target Simulator Message

Reference Appendix C, Section C4.3.9

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 57								Spare							
Word 3	Command								Spare					Rn	Fb	En
Word 4	Time (least significant word)															
Word 5	Time (most significant word)															
Word 6	Azimuth (least significant word)															
Word 7	Azimuth (most significant word)															
Word 8	Elevation (least significant word)															
Word 9	Elevation (most significant word)															
Word 10	Range (least significant word)															
Word 11	Range (most significant word)															
Word 12	Checksum															

Figure B4.48. Target Simulator Message

<u>This message implements a customer specific function and is not generally supported.</u>

Sync Word: 0xA5A5

Message Type: 57

En: Target simulator enable

0 – Disabled <DEFAULT>
1 – Enabled

Fb: Unsolicited video rate feedback (of this message) enable

0 – Disabled <DEFAULT>
1 – Enabled

Rn: Simulation run status

0 – Not running
1 – Simulation currently running

Command:	Simulator command	
	0 – None (query) 1 – Run (start the simulation running) 2 – Stop (stop a currently running simulator)	
Time:	The current simulation time in milliseconds (32-bit unsigned value)	
Azimuth:	The current azimuth position of the mount in degrees	
	Data Format:	32-bits two's complement
	Scaling:	LSB = 0.0001 degree (divide by 10,000)
	Range:	±360.0000 degrees
Elevation:	The current elevation position of the mount in degrees	
	Data Format:	32-bits two's complement
	Scaling:	LSB = 0.0001 degree (divide by 10,000)
	Range:	±360.0000 degrees
Range:	The current range to the target in millimeters	
	Data Format:	32-bit unsigned integer

B4.47 Steered Mirror Filter Control Message (DEPRECATED)

Reference Appendix C, Section C3.4.8

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 59								Spare							
Word 3 to Word 15	Custom Data															
Word 16	Checksum															

Figure B4.49. Steered Mirror Filter Control Message

<u>This message is deprecated.</u>

Sync Word: 0xA5A5

Message Type: 59

Custom Data: This custom message has been deprecated

B4.48 IFF Track Status Message

Reference Appendix C, Section C4.3.14

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 60</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="12">Spare</td><td>R2</td><td>R1</td><td>ET</td><td>AT</td></tr>
<tr><td>Word 4</td><td colspan="16">Azimuth RSS1 Raw</td></tr>
<tr><td>Word 5</td><td colspan="16">Azimuth RSS2 Raw</td></tr>
<tr><td>Word 6</td><td colspan="16">Azimuth Error Raw</td></tr>
<tr><td>Word 7</td><td colspan="16">Azimuth Error (least significant word)</td></tr>
<tr><td>Word 8</td><td colspan="16">Azimuth Error (most significant word)</td></tr>
<tr><td>Word 9</td><td colspan="16">Azimuth Drive (least significant word)</td></tr>
<tr><td>Word 10</td><td colspan="16">Azimuth Drive (most significant word)</td></tr>
<tr><td>Word 11</td><td colspan="16">Elevation Drive (least significant word)</td></tr>
<tr><td>Word 12</td><td colspan="16">Elevation Drive (most significant word)</td></tr>
<tr><td>Word 13</td><td colspan="16">Checksum</td></tr>
</table>

Figure B4.50. IFF Track Status Message

<u>This message implements a customer specific function and is not generally supported.</u>

Sync Word: 0xA5A5

Message Type: 60

AT: Azimuth axis track indicator

0 – Azimuth is not tracking
1 – Azimuth is tracking

ET: Elevation axis track indicator

0 – Elevation is not tracking
1 – Elevation is tracking

R1: Azimuth Received Signal Strength 1 (RSS1) fault indicator

0 – OK
1 – Fault

R2:	Azimuth Received Signal Strength 2 (RSS2) fault indicator 0 – OK 1 – Fault
Azimuth RSS1 Raw:	Raw analog input reading for Azimuth Received Signal Strength 1 Data Format: 16-bit two's compliment
Azimuth RSS2 Raw:	Raw analog input reading for Azimuth Received Signal Strength 2 Data Format: 16-bit two's complement
Azimuth Error Raw:	Raw analog input reading for Azimuth Pointing Error Data Format: 16-bit two's complement
Azimuth Error:	Azimuth Point Error (AzPE) in degrees after lookup table is applied Data Format: 32-bit two's complement Scaling: LSB = 0.0001 degrees (divide by 10,000) Range: -360.0000 to 360.0000
Azimuth Drive:	Current azimuth velocity drive in degrees per second (if tracking) Data Format: 32-bit two's complement Scaling: LSB = 0.001 degree/sec (divide by 1,000) Range: Typically -100.000 to 100.000
Elevation Drive:	Current elevation velocity drive in degrees per second (if tracking) Data Format: 32-bit two's complement Scaling: LSB = 0.001 degree/sec (divide by 1,000) Range: Typically -100.000 to 100.000

B4.49 Steered Mirror Calibration Message (DEPRECATED)

Reference Appendix C, Section C3.4.8

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 61								Spare							
Word 3 to Word 5	Custom Data															
Word 6	Checksum															

Figure B4.51. Steered Mirror Calibration Message

<u>This functionality is deprecated.</u>

Sync Word: 0xA5A5

Message Type: 61

Custom Data: This custom message has been deprecated

B4.50 Overlay Control Message

Reference Appendix C, Section C4.3.7

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 62								Spare							
Word 3	Command								Target							
Word 4	Arg1															
Word 5	Arg2															
Word 6	Arg3															
Word 7	Arg4															
Word 8	Arg5															
Word 9	Arg6															
Word 10 to Word 21	Additional Args															
Word 22	Checksum															

Figure B4.52. Overlay Control Message

Sync Word: 0xA5A5

Message Type: 62

Target: Command destination/target

0 – None
1 – Overlay
2 – Sprite 1
3 – Sprite 2
4 – Sprite 3
5 – Sprite 4

Command: Overlay command (see table below)

Arg1 – Arg6: Command arguments (see table below)

Data Format: 16-bit unsigned integer

Additional Args: Additional pixel arguments (see table below)

Data Format: 16-bit unsigned integer

Commands and Command Dependent Argument Definitions

Command	Command Description	Argument Usage
1	Enable the video overlay/sprite	n/a
2	Disable the video overlay/sprite	n/a
3	Clear the overlay/sprite	n/a
4	Toggle selected overlay buffer	n/a
5	Select overlay buffer #1	n/a
6	Select overlay buffer #2	n/a
7	Set the sprite position	Arg1 = X Arg2 = Y
8	Normal Output Overlay/Sprite	n/a
9	Invert Output Overlay/Sprite	n/a
20	Draw pixel(s)	Arg1 = X Arg2 = Y Arg3 = count Arg4 = pixel value Arg5 = pixel value Arg6 = pixel value Args = up to 12 additional pixel values
21	Draw line	Arg1 = X1 Arg2 = Y1 Arg3 = X2 Arg4 = Y2 Arg5 = pixel value
22	Draw a rectangle	Arg1 = X Arg2 = Y Arg3 = X length Arg4 = Y length Arg5 = pixel value
23	Draw a square	Arg1 = X Arg2 = Y Arg3 = X length Arg4 = pixel value
24	Draw a triangle	Arg1 = X Arg2 = Y Arg3 = X length Arg4 = Y length Arg5 = direction (0=up, 1=right, 2=down, 3=left) Arg6 = pixel value

Command	Command Description	Argument Usage
25	Draw an ellipse	Arg1 = X Arg2 = Y Arg3 = X radius Arg4 = Y radius Arg5 = pixel value
26	Draw a circle	Arg1 = X Arg2 = Y Arg3 = radius Arg4 = pixel value
27	Draw an arc (partial circle)	Arg1 = X Arg2 = Y Arg3 = radius Arg4 = start Arg5 = stop Arg6 = pixel value
28	Draw a diamond	Arg1 = X Arg2 = Y Arg3 = X length Arg4 = Y length Arg5 = segment map (0=all, 1=lower right, 2=lower left, 4=upper right, 8=upper left) Arg6 = pixel value
100	Draw a color bar	Arg1 = X Arg2 = Y Arg3 = X length Arg4 = Y length
101	Draw a graticule	Arg1 = X Arg2 = Y Arg3 = radius Arg4 = pixel value
102	Draw a string	Arg1 = X Arg2 = Y Arg3 = pixel background Arg4 = pixel foreground Arg5 = ASCII text (up to 28 characters, null terminated if less than 28 used)

B4.51 Overlay Status Message

Reference Appendix C, Section C4.3.7

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 63								Spare							
Word 3	Spare				I4	I3	I2	I1	OI	S4	S3	S2	S1	OB	OD	OE
Word 4	Sprite 1 position X															
Word 5	Sprite 1 position Y															
Word 6	Sprite 2 position X															
Word 7	Sprite 2 position Y															
Word 8	Sprite 3 position X															
Word 9	Sprite 3 position Y															
Word 10	Sprite 4 position X															
Word 11	Sprite 4 position Y															
Word 12	Overlay Position X															
Word 13	Overlay Position Y															
Word 14	Checksum															

Figure B4.53. Overlay Status Message

NOTE: This message is feedback from a query only and not a command message.

Sync Word: 0xA5A5

Message Type: 63

OE: Overlay enable

0 – Disabled
1 – Enabled

OD: Overlay displayed

0 – Overlay #1
1 – Overlay #2

OB:	Overlay busy 0 – Ready 1 – Busy	
S1, S2, S3, S4:	Sprite 1 to 4 enable 0 – Disabled 1 – Enabled	
OI:	Overlay invert 0 – Not inverted 1 – Inverted	
I1, I2, I3, I4:	Sprite 1 to 4 invert 0 – Not inverted 1 – Inverted	
Sprite position X & Y:	Left (X), Top (Y) coordinate of sprite (1 to 4)	
	Format:	16-bit two's compliment
	Scaling:	LSB = 1 pixel (x) / line (y)
	Range:	up to ±2047 (Range is video format dependent)
Overlay position X & Y:	Left (X), Top (Y) coordinate of overlay	
	Format:	16-bit two's compliment
	Scaling:	LSB = 1 pixel (x) / line (y)
	Range:	up to ±2047 (Range is video format dependent)

B4.52 Line-of-Sight Offset Control 2 Message

Reference Appendix C, Section C3.1.3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 64								Spare							
Word 3	Position X															
Word 4	Position Y															
Word 5	Checksum															

Figure B4.54. Line-of-Sight Offset Control 2 Message

Note: This message supersedes the Line-of-Sight Offset Control message (message type 3).

Sync Word: 0xA5A5

Message Type: 64

Position X: Line of sight (boresight reticle) position X.

Format: 16-bit two’s compliment
Scaling: LSB = 1 pixel (x) / line (y)
Range: up to ± 2047
(Range is video format dependent)

Position Y: Line of sight (boresight reticle) position Y.

Format: 16-bit two’s compliment
Scaling: LSB = 1 pixel (x) / line (y)
Range: up to ±2047
(Range is video format dependent)

B4.53 Offset Aim Control 2 Message

Reference Appendix C, Sections C4.3.11, C4.3.12 and C4.3.13

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 65								OE	Spare						
Word 3	Position X															
Word 4	Position Y															
Word 5	LOS Transition Time															
Word 6	Checksum															

Figure B4.55. Offset Aim Control 2 Message

Note: This message supersedes the Offset Aim Control message (message type 4).

Sync Word: 0xA5A5

Message Type: 65

OE: Offset Aim Enable

0 – Disabled
1 – Enabled

Position X: Offset Aim position X

Data Format: 16-bit two's compliment
Scaling: LSB = 1 pixel (x) / line (y)
Range: up to ± 2047
(Range is video format dependent)

Position Y: Offset Aim position Y

Data Format: 16-bit two's compliment
Scaling: LSB = 1 pixel (x) / line (y)
Range: up to ± 2047
(Range is video format dependent)

LOS Transition Time: The number of video fields it takes to transition from the current offset aim point to the line-of-sight when the offset aim is disabled during tracking. This is used to slow down or smooth the response of a mount when making this transition.

Data Format: 16-bit unsigned integer

B4.54 Position Tracking Status Message

Reference Appendix C, Section C3.5.11

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 66								Spare							
Word 3	Spare												EE	AE	ET	AT
Word 4	Azimuth Velocity Drive (least significant word)															
Word 5	Azimuth Velocity Drive (most significant word)															
Word 6	Elevation Velocity Drive (least significant word)															
Word 7	Elevation Velocity Drive (most significant word)															
Word 8	Checksum															

Figure B4.56. Position Tracking Status Message

Sync Word: 0xA5A5

Message Type: 66

AT: Azimuth tracking indicator

0 – Azimuth is not tracking
1 – Azimuth is tracking

ET: Elevation tracking indicator

0 – Elevation is not tracking
1 – Elevation is tracking

AE: Azimuth estimation indicator

0 – Tracking
1 – Coasting using Kalman filter estimation

EE: Elevation estimation indicator

0 – Tracking
1 – Coasting using Kalman filter estimation

Azimuth Velocity Drive:

Current azimuth velocity drive in degrees per second (if tracking)

Data Format:	32-bit two's complement
Scaling:	LSB = 0.001 degree per second (divide by 1,000)
Range:	Typically ±100.000

Elevation Velocity Drive:

Current elevation velocity drive in degrees per second (if tracking)

Data Format:	32-bit two's complement
Scaling:	LSB = 0.001 degree per second (divide by 1,000)
Range	Typically ±100.000

B4.55 Control Box Control Message

Reference Appendix C, Section C3.5.8

When acting as a proxy, your application must wrap the message coming from the Model 702 Controller to the video tracker. Reference the Model 702 Controller user manual for details.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 67								Spare							
Word 3	Control Box Sync 0xC3C3															
Word 4	CB Message Type 102								Spare							
Word 5	TA	Track Mode			AT	TM	Polarity		GS	GP	BR	TB	RB	AO	GO	VS
Word 6	L1FOV		1F	1R	1N	1W	L1I		L2FOV		2F	2R	2N	2W	L2I	
Word 7	User Inputs															
Word 8	RC	SM		Spare				VN	User Outputs							
Word 9	Joystick Pan															
Word 10	Joystick Tilt															
Word 11	Gate Size X															
Word 12	Gate Size Y															
Word 13	Black Threshold															
Word 14	White Threshold															
Word 15	Analog Input 1															
Word 16	Analog Input 2															
Word 17	CB Checksum															
Word 18	Checksum															

Figure B4.57. Control Box Control Message

Sync Word: 0xA5A5

Message Type: 67

Control Box Sync Word: 0xC3C3

CB Message Type: Control Box message type (102)

VS:	Video input select
	0 - Video #1 1 - Video #2
GO:	Mount gain override
	0 – Normal 1 – Override
AO:	Aim point offset
	0 – Inactive 1 – Switch Pressed
RB:	Reset aim point to boresight
	0 – Inactive 1 – Pressed
TB	Joystick track button state
	0 – Not Pressed 1 – Pressed
BR:	Box reset indicator
	0 – Manual 1 – Just Booted
GP:	Gate position mode
	0 – Manual 1 – Automatic
GS:	Gate size mode
	0 – Manual 1 – Automatic
Polarity:	Target Polarity
	0 – Automatic 1 – White 2 – Black

TM:	Threshold mode 0 – Manual 1 – Automatic
AT:	Auto track 0 – Manual 1 – Automatic
Track Mode:	Track mode 0 – Top Edge 1 – Bottom Edge 2 – Left Edge 3 – Right Edge 4 – Centroid 5 – Intensity 6 – Leading Edge 7 – Correlation
TA:	Track acquire (OBSOLETE)
L2I:	Lens #2 Iris Mode 0 – Inactive 1 – Open 2 – Close 3 – Auto
2W:	Lens #2 Zoom Wide 0 – Inactive 1 – Zoom Wide
2N:	Lens #2 Zoom Narrow 0 – Inactive 1 – Zoom Narrow
2R:	Lens #2 Focus Near 0 – Inactive 1 – Focus Near

2F:	Lens #2 Focus Far 0 – Inactive 1 – Focus Far
L2FOV:	Lens #2 tri-Field-of-View 0 – Medium 1 – Narrow 2 – Wide
L1I:	Lens #1 Iris Mode 0 – Inactive 1 – Open 2 – Close 3 – Auto
1W:	Lens #1 Zoom Wide 0 – Inactive 1 – Zoom Wide
1N:	Lens #1 Zoom Narrow 0 – Inactive 1 – Zoom Narrow
1R:	Lens #1 Focus Near 0 – Inactive 1 – Focus Near
1F:	Lens #1 Focus Far 0 – Inactive 1 – Focus Far
L1FOV:	Lens #1 tri-Field-of-View 0 – Medium 1 – Narrow 2 – Wide
User Inputs:	Stats of the user digital inputs (16-bits) Data Format: 16-bit unsigned integer

User Outputs: State of the user digital outputs (8-bits)

Data Format: 8-bit unsigned integer

VN: Control box version

0 – Rev. -
1 – Rev A (Default)

SM: Symbology

0 – Obey GUI Symbology
1 – Black
2 – White
3 – Off

RC: Reticle Control

0 – Off
1 – On

Joystick Pan and Tilt: Joystick Pan/Azimuth and Tilt/Elevation Reading

Data Format:	16-bit unsigned integer
Range:	0 – 1023 (10-bit ADC)
	Center position nominally 511

Gate Size X & Y: Gate Size X and Y Reading

Data Format:	16-bit unsigned integer
Range:	0 – 1023 (10-bit ADC)

Black and White Threshold: Threshold reading

Data Format:	16-bit unsigned integer
Range:	0 – 1023 (10-bit ADC)

Analog Inputs 1 and 2: External Analog inputs 1 and 2

Data Format:	16-bit unsigned integer
Range:	0 – 1023 (10-bit ADC)

CB Checksum: Signed arithmetic sum of the embedded Control Box Control Message data bytes (Word 3 to Word 16).

Data Format: 16-bit two's compliment

B4.56 Control Box Status Message

Reference Appendix C, Section C3.5.8

When acting as a proxy, your application must forward the message going to the Model 702 Controller from the video tracker. Reference the Model 702 Controller user manual for details.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 68								Spare							
Word 3	Control Box Sync 0xC3C3															
Word 4	CB Message Type 103								Spare		Z2	Z1	M2	M1	OT	TA
Word 5	Spare															
Word 6	Spare								User Outputs							
Word 7	CB Checksum															
Word 8	Checksum															

Figure B4.58. Control Box Status Message

Sync Word: 0xA5A5

Message Type: 68

Control Box Sync Word: 0xC3C3

TA: Track Acquire LED

0 - Off
1 - On

OT: On Target LED

0 – Off
1 – On

M1: Video source #1, Multi-Field-of-View lens LED

0 - Off
1 - On

M2: Video source #2, Multi-Field-of-View lens LED

0 - Off
1 - On

Z1:	Video source #1, Zoom lens LED 0 - Off 1 - On
Z2:	Video source #2, Zoom lens LED 0 - Off 1 - On
CB Message Type:	Control Box message type (103)
User Outputs:	State of the user digital outputs (8 bits) Data Format: 8-bit unsigned integer
CB Checksum:	Signed arithmetic sum of the embedded Control Box Status Message data bytes (Word 3 to Word 6). Data Format: 16-bit two's compliment

B4.57 Threshold Statistics Message

Reference Appendix C, Section C4.3.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 69								Spare							
Word 3	Target Contrast															
Word 4	Target Average															
Word 5	Target Background															
Word 6	Gate Peak White															
Word 7	Gate Peak Black															
Word 8	Gate Average															
Word 9	Background Average															
Word 10	White Contrast															
Word 11	Black Contrast															
Word 12	Spare															
Word 13	Spare															
Word 14	Checksum															

Figure B4.59. Threshold Statistics Message

Sync Word: 0xA5A5

Message Type: 69

Target Contrast: Contrast of the thresholded target in the gate (as a percentage)

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 percent (divide by 100)
Range: 0 to 100.00

Target Average: Average intensity of the thresholded target pixels in the gate

Data Format: 16-bit unsigned integer

Target Background: Average intensity of the non-thresholded pixels in the gate

Data Format: 16-bit unsigned integer

Gate Peak White:	Maximum pixel intensity in the gate	
	Data Format:	16-bit unsigned integer
Gate Peak Black:	Minimum pixel intensity in the gate	
	Data Format:	16-bit unsigned integer
Gate Average:	Average pixel intensity in the gate	
	Data Format:	16-bit unsigned integer
Background Average:	Average intensity of the background (intrusion area around gate)	
	Data Format:	16-bit unsigned integer
White Contrast:	Contrast of potential target data in the white region (above background average)	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 percent (divide by 100)
	Range:	0 to 100.00
Black Contrast:	Contrast of potential target data in the black region (below background average)	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 percent (divide by 100)
	Range:	0 to 100.00

B4.58 Multi-Target General Setup Message

Reference Appendix C, Section C3.3.2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 80								Spare							
Word 3	Minimum Pixel Count (least significant word)															
Word 4	Minimum Pixel Count (most significant word)															
Word 5	Maximum Percent															
Word 6	Spare															OE
Word 7 to Word 9	Spare															
Word 10	Checksum															

Figure B4.60. Multi-Target General Setup Message

Sync Word: 0xA5A5

Message Type: 80

Minimum Pixel Count: Minimum pixel count required to be considered a target (0=Disabled/No Minimum Filter).

Data Format: 32-bit unsigned integer
Range: typically 1 to 2500

Maximum Percent: Maximum pixel count required to be considered a target, expressed as a percentage of total gate pixel count (0=Disabled/No Maximum Filter).

Data Format: 16-bit unsigned integer
Range: 0 to 100

OE: Enable video rate output of multi-target data. ***Reference Section B4.61***.

0 – Disable
1 - Enable

B4.59 Multi-Target Acquire Setup Message

Reference Appendix C, Section C3.3.1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 81								Spare							
Word 3	Select Method								Spare					SN	US	EN
Word 4	Sp	IG	Motion Y		Motion X		Aspect		Maximum Targets							
Word 5	Minimum Pixel Count (least significant word)															
Word 6	Minimum Pixel Count (most significant word)															
Word 7	Maximum Percent															
Word 8	Minimum Life															
Word 9	Minimum Speed															
Word 10	Maximum Speed															
Word 11	Spare															
Word 12	Checksum															

Figure B4.61. Multi-Target Acquire Setup Message

Sync Word: 0xA5A5

Message Type: 81

EN: Enable multi-target engine when in acquire mode

0 – Disable
1 – Enable

US: Allows user to select target to track, otherwise best-match is selected

0 – Disable (best match selected)
1 – Enable

SN: Selects next-valid target (only when US = 1)

0 – Target selection is unchanged
1 – Select the next valid target

Select Method:	Target selection method 0 – Closest to boresight 1 – Closest to gate center 2 – Largest target 3 – Fastest target 4 – Slowest target 5 – Brightest (target with highest average pixel intensity) 6 – Darkest (target with lowest average pixel intensity)
Maximum Targets:	Maximum number of targets to identify Data Format: 8-bit unsigned integer Range: 1 to 10
Aspect:	Aspect ratio selection filter 0 – Disable 1 – Square 2 – Tall 3 – Long
Motion X:	Azimuth (X) motion selection filter 0 – Disable 1 – Left 2 – Right
Motion Y:	Elevation (Y) motion selection filter 0 – Disable 1 – Up 2 – Down
IG:	Gate filter 0 – Disable 1 – Enable (valid targets must be fully enclosed inside the gate)
Minimum Pixel Count:	Minimum pixel count required to be considered a target (0=Disabled). Data Format: 32-bit unsigned integer Range: Typically 1 to 2500

Maximum Percent:	Maximum pixel count required to be considered a target, expressed as a percentage of total gate pixel count (0=Disabled).		
	Data Format:	16-bit unsigned integer	
	Range:	1 to 100	
Minimum Life:	Minimum target life, in frames/fields to be considered a target (0=Disabled).		
	Data Format:	16-bit unsigned integer	
	Range:	Typically 1 to 60	
Minimum Speed:	Minimum speed to be considered a target as a percentage of the field-of-view traversed by the target in one second (0=Disabled).		
	Data Format:	16-bit unsigned integer	
	Scaling:	LSB = 0.001 percent (divide by 1000)	
	Range:	0.001 to 65.535 % of FOV per second	
Maximum Speed:	Maximum speed to be considered a target as a percentage of the field-of-view traversed by the target in one second (0=Disabled).		
	Data Format:	16-bit unsigned integer	
	Scaling:	LSB = 0.001 percent (divide by 1000)	
	Range:	0.001 to 65.535 % of FOV per second	

B4.60 Multi-Target Track Setup Message

Reference Appendix C, Section C3.3.2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 82								Spare							
Word 3	Spare															En
Word 4	Spare															
Word 5	Spare															
Word 6	Checksum															

Figure B4.62. Multi-Target Track Setup Message

Sync Word: 0xA5A5

Message Type: 82

En: Enable multi-target engine when in track mode

0 – Disabled
1 – Enabled

B4.61 Multi-Target Data Message

Reference Appendix C, Section C4.3.5

The Multi-Target Data message contains a sorted array of up to five (5) targets. Section B4.61.1 defines the individual target data structure and Section B4.61.2 defines the overall message format.

B4.61.1 Individual Target Data Format

	15–0
Word 1	ID
Word 2	Pixel Count (least significant word)
Word 3	Pixel Count (most significant word)
Word 4	Target Width
Word 5	Target Height
Word 6	Target Position X
Word 7	Target Position Y
Word 8	Average Intensity
Word 9	Centroid X
Word 10	Centroid Y
Word 11	Confidence

Figure B4.63. Individual Target Data Sub-Structure

ID:	Target identifier (0 = Invalid / No Target Data)	
Pixel Count:	Target pixel count; most significant word (MSW) and least significant word (LSW).	
	Data Format:	32-bit unsigned integer
Target Width, Height:	Target width (X size) in pixels, height (Y size) in lines	
	Data Format:	16-bit unsigned integer
	Range:	1 to 2048
Target Position X, Y:	The left (X/pixel) and top (Y/line) corner position of the bounding rectangle of the target.	
	Data Format:	16-bit unsigned integer
	Range:	0 to 2047 (top/left of image is 0,0)

Average Intensity:	Average target pixel intensity		
	Data Format:	16-bit unsigned integer	
	Range:	Video dependant (typically 0 to 1023)	
Centroid X, Y:	Target centroid in X (pixels) and Y (lines) from boresight		
	Data Format:	16-bit two's compliment	
	Scaling:	LSB = 0.03125 (divide by 32)	
	Range:	+/- 1023.969	
Confidence:	Target match confidence (as a percentage)		
	Data Format:	16-bit unsigned integer	
	Scaling:	LSB = 0.01 percent (divide by 100)	
	Range:	0.00 to 100.00	

B4.61.2 Message Format

	15–8	7–0
Word 1	Sync Word	
Word 2	Message Type 83	Spare
Word 3	Target Count	
Word 4	Selected ID	
Word 5	Spare	
Word 6	Spare	
Word 7 to Word 61	Target Array	
Word 62	Checksum	

Figure B4.64. Multi-Target Data Message

Sync Word:	0xA5A5
Message Type:	83
Target Count:	Total number of targets detected
Selected ID:	ID of currently selected target
Target Array:	Sorted array of five (5) target data blocks (see Figure B4.63)

B4.62 Multi-Target Validation Message

Reference Appendix C, Section C3.3.3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 84								Spare							
Word 3	Spare													Se	Pe	Fp
Word 4	Position Tolerance															
Word 5	Pixel Count Tolerance															
Word 6	Width Tolerance															
Word 7	Height Tolerance															
Word 8 to Word 11	Spare															
Word 12	Checksum															

Figure B4.65. Multi-Target Validation Message

Sync Word: 0xA5A5

Message Type: 84

Fp: Force position validation

0 – Disabled
1 – Enabled

Pe: Pixel count validation enable

0 – Disabled
1 – Enabled

Se: Size validation enable

0 – Disabled
1 – Enabled

Position Tolerance: Percent of total FOV to use for target position/movement tolerance

Data Format:	16-bit unsigned integer
Scaling:	LSB = 0.01 percent (divide by 100)
Range:	0.00 to 100.00

Pixel Count Tolerance:	Percent of target pixel count to use for mass change tolerance		
	Data Format:	16-bit unsigned integer	
	Scaling:	LSB = 0.01 percent (divide by 100)	
	Range:	0.00 to 100.00	
Width Tolerance:	Percent of target width to use for x-size change tolerance		
	Data Format:	16-bit unsigned integer	
	Scaling:	LSB = 0.01 percent (divide by 100)	
	Range:	0.00 to 100.00	
Height Tolerance:	Percent of target height to use for y-size change tolerance		
	Data Format:	16-bit unsigned integer	
	Scaling:	LSB = 0.01 percent (divide by 100)	
	Range:	0.00 to 100.00	

B5 Configuration Messages

Several messages are provided for configuring the tracker. These configuration parameters may be modified after boot up and the tracker will run with them, or the configuration can be programmed into Flash memory where it will be stored and used as the default configuration upon power-up or reset of the tracker. ***Reference Sections C3.5.2 through C3.5.13.***

A control message is provided (Type 21) which will save to Flash, load from Flash or clear all custom tracker configuration parameters and return to the factory configuration. This provides a quick and painless way for the tracker to return to a known state if the custom configuration has an undesirable result. ***Reference Section B4.21.***

All configuration messages include a checksum. This field is the two's complement of the 16-bit sum of the 8-bit bytes of the message buffer, including the sync word, up to but not including the checksum. This will be a sign extended value. The 16-bit summation of the first n bytes of this buffer, and this field, should equal zero. An example of the checksum calculation is shown in Figure B2.2.

Note: In all commands, all spare and unused bits must be cleared to zero (0).

B5.1 Gate Size Limit Configuration Message

Reference Appendix C, Section C3.5.2.1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message 200								Spare							
Word 3	Spare						Minimum Gate Size X									
Word 4	Spare						Minimum Gate Size Y									
Word 5	Spare						Maximum Gate Size X									
Word 6	Spare						Maximum Gate Size Y									
Word 7	Spare															
Word 8	Checksum															

Figure B5.1. Gate Size Limit Configuration Message

Sync Word: 0xA5A5

Message Type: 200

Minimum Gate Size X & Y:

These fields define the minimum size to which the track or acquire gates may be sized manually or will size in auto size mode.

Caution should be used to insure that these minimum limits are configured to be smaller than the maximum limits.

Data Format: 10-bit unsigned binary
Scaling: LSB = 1 pixel (x) / line (y)
Range: X: 4 to 1000, Y: 1 to 250
Default: X: 32, Y: 8

Maximum Gate Size X & Y:

These fields define the maximum size to which the track or acquire gates may be sized manually or will size in auto size mode.

Caution should be used to insure that these maximum limits are configured to be larger than the minimum limits.

Data Format: 10-bit unsigned binary
Scaling: LSB = 1 pixel (x) / line (y)
Range: X: 4 to 1000, Y: 1 to 250
Default: X: 984, Y: 224

B5.2 Gate Position Limit Configuration Message

Reference Appendix C, Section C3.5.2.2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 201								Spare							
Word 3	Spare						Minimum Gate Position X (left)									
Word 4	Spare						Minimum Gate Position Y (top)									
Word 5	Spare						Maximum Gate Position X (right)									
Word 6	Spare						Maximum Gate Position Y (bottom)									
Word 7	Spare															
Word 8	Checksum															

Figure B5.2. Gate Position Limit Configuration Message

Sync Word: 0xA5A5

Message Type: 201

Minimum Gate Position X & Y:

These fields define the minimum position to which the track or acquire gates may be positioned manually or will position in auto position mode.

Caution should be used to insure that these minimum limits are configured to be Left Of and Above the maximum limits (far enough to create an active area large enough for the maximum gate size).

Data Format:	10-bit signed binary
Scaling:	LSB = 1 pixel (x) / line (y)
Range:	–512 to 0 (left of center)
	128 to 0 (above center)
Default:	X (left) = -511
	Y (top) = 127

Maximum Gate Position X & Y:

These fields define the maximum position to which the track or acquire gates may be positioned manually or will position in auto position mode.

Caution should be used to insure that these maximum limits are configured to be Right Of and Below the minimum limits.

Data Format:	10-bit signed binary
Scaling:	LSB = 1 pixel (x), line (y)
Range:	0 to 512 (right of center)
	0 to –128 (below center)
Default:	X (right) = 511
	Y (bottom) = -127

B5.3 Annotation Configuration Message (DEPRECATED)

Reference Appendix C, Section C3.5.1.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 202								Spare							
Word 3	Spare						Y-Location, String 1					Y-Location, String 2				
Word 4	Spare															
Word 5	Checksum															

Figure B5.3. Annotation Configuration Message

Note: This message is deprecated in favor of the Annotation 2 Configuration message (type 221).

Sync Word: 0xA5A5

Message Type: 202

Y-Location 1 & 2: The character row that will contain the string display. There is a Y-Location field for each of the two (2) display strings.

Scale: Whole Character Positions
Units: Character Rows (8 lines = 1 Character Row)
Range: 0 to 31

String 1 contains MODE, POL, STATE and STATUS displays.
Default: Row 0

String 2 contains AUTO, AZ, EL, and TVAL displays.
Default: Row 26

B5.4 Symbology Configuration Message

Reference Appendix C, Section C3.5.1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 203								Spare							
Word 3	Spare										TH	LR	RS			FE
Word 4	Spare															
Word 5	Checksum															

Figure B5.4. Symbology Configuration Message

Sync Word: 0xA5A5

Message Type: 203

FE: Flash enable (the flash behavior of the track gate symbology when coast mode times out (i.e.-the tracker is off track))

0 – Solid gate symbology
1 – Flashing (or blinking) gate symbology

RS: Reticle Style (the type of reticle that will be displayed when the LOS reticle is enabled)

0 – Closed reticle (solid)
1 – Open reticle (break in center)
2 – Wide open reticle (larger break in center)
3 – Custom reticle (see message type 217)

LR: LOS Reticle. Display the line-of-sight (LOS) reticle (also referred to as the boresight reticle).

0 – Disable
1 – Enable

TH: The thickness of the line-of-sight (LOS) reticle.

0 – Double (two pixels/lines)
1 – Single (one pixel/line)

B5.5 Correlation Reference Image Position Configuration Message

Reference Appendix C, Section C3.5.1.3

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 204</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="6">Spare</td><td colspan="10">Ref Image Position X</td></tr>
<tr><td>Word 4</td><td colspan="6">Spare</td><td colspan="10">Ref Image Position Y</td></tr>
<tr><td>Word 5</td><td colspan="16">Spare</td></tr>
<tr><td>Word 6</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.5. Correlation Reference Image Position Message

Sync Word: 0xA5A5

Message Type: 204

Ref Image Position X & Y:

This field defines the location of the reference image display during correlation mode when the display is enabled. This location is defined by the position the upper left corner of the reference image. The size of the image is determined by the selected reference image size. Reasonable positions are limited by the type of video (number of lines), the type of monitor (with or without underscan capability), and the size of the references image.

Data Format:	10-bit signed binary
Scaling:	LSB = 1 pixel (x) / line (y)
Range:	X = -512 to 512
	Y = -127 to 127
Default Position:	X = -512
	Y = 127

B5.6 System Video Configuration Message

Reference Appendix C, Section C3.5.2.3

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 205</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="13">Spare</td><td colspan="3">Video Type</td></tr>
<tr><td>Word 4</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.6. System Video Configuration Message

Sync Word:	0xA5A5
Message Type:	205
Video Type:	This field defines the type of video that is to be processed by the tracker. The tracker uses this information to set up video specific parameters. 0 – NTSC/RS-170 1 – Digital 7 – PAL/CCIR

B5.7 Preset Configuration Message

Reference Appendix C, Section C3.5.5

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 206								Spare							
Word 3	Preset Number															
Word 4	Checksum															

Figure B5.7. Preset Configuration Message

Sync Word: 0xA5A5

Message Type: 206

Preset Number: The preset configuration number from 0 to 9 to load on tracker power up. The tracker has ten (10) memory banks to store presets. ***Reference Section B4.21.***

B5.8 Auto Size Configuration Message

Reference Appendix C, Section C3.5.6

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 207								Spare							
Word 3	Spare															EN
Word 4	Grow Rate X															
Word 5	Grow Rate Y															
Word 6	Shrink Rate X															
Word 7	Shrink Rate Y															
Word 8	Checksum															

Figure B5.8. Auto Size Configuration Message

Sync Word: 0xA5A5

Message Type: 207

EN: Enable auto size rate controls.

0 – Disabled
1 – Enabled

Grow Rate X & Y: The rate in pixels/lines per field to grow/increase the gate size.

Data Format:	16-bit unsigned binary
Scaling:	LSB = 0.01 (divide by 100)
Range:	0 to 655.35
Default:	X: 400, Y: 400

Shrink Rate X & Y: The rate in pixels/lines per field to shrink/reduce the gate size.

Data Format:	16-bit unsigned binary
Scaling:	LSB = 0.01 (divide by 100)
Range:	0 to 655.35
Default:	X: 400, Y: 400

B5.9 Target Validation Configuration Message

Reference Appendix C, Section C3.5.2.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 208								Spare							
Word 3	Target Pixels Min															
Word 4	Spare								Target Percent Max							
Word 5	Spare								History Depth							
Word 6	Checksum															

Figure B5.9. Target Validation Configuration Message

Sync Word: 0xA5A5

Message Type: 208

Target Pixels Min: Minimum number of target pixels.

Data Format: 16-bit unsigned integer
Range: 1 to 10,000
Default: 1

Target Percent Max: Maximum number of target pixels as a percentage of the max gate pixel count.

Data Format: 8-bit unsigned integer
Range: 1 to 100
Default: 75

History Depth: Depth of target history queue (smoothes target validation statistics). Value must be equal to or greater than acquire validation time. ***Reference Section B4.3***.

Data Format: 8-bit unsigned integer
Range: 1 to 255
Default: 20

B5.10 Joystick Configuration Message

Reference Appendix C, Section C3.5.7

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 209</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="11">Spare</td><td colspan="3">RF</td><td>JR</td><td>ZS</td></tr>
<tr><td>Word 4</td><td colspan="16">Joystick Gain X</td></tr>
<tr><td>Word 5</td><td colspan="16">Joystick Gain Y</td></tr>
<tr><td>Word 6</td><td colspan="16">Joystick Offset X</td></tr>
<tr><td>Word 7</td><td colspan="16">Joystick Offset Y</td></tr>
<tr><td>Word 8</td><td colspan="16">Joystick Dead Band X</td></tr>
<tr><td>Word 9</td><td colspan="16">Joystick Dead Band Y</td></tr>
<tr><td>Word 10</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.10. Joystick Configuration Message

Sync Word: 0xA5A5

Message Type: 209

ZS: Enable zoom scaling.

0 – Disabled
1 – Enabled

JR: Reset joystick parameters to system defaults.

0 – Don't reset
1 – Reset to defaults and calibrate zero point

RF: Joystick response function.

0 – Linear
1 – Non-Linear
2 – Squared
3 – Cubed
4 – Quad

Joystick Gain X & Y: The gain values to apply to the x and y-axis joystick readings. Increasing the gain will make the joystick more responsive/sensitive and will drive the mount faster for a given deflection.

Data Format:	16-bit binary
Scaling:	LSB = 0.01 (divide by 100)
Default:	X: 100, Y: 100 (unity gain)

Joystick Offset X & Y: The joystick value the tracker should use as the zero point. Anything less than this value is left (x) or down (y) movement and anything greater than this value is right (x) or up (y) movement. When a control box is detected during power-up, the offset values are automatically set using the current position of the joystick.

Data Format:	16-bit two's complement
Scaling:	LSB = 1 (count)
Default:	X: 512, Y: 512 (typical)

Joystick Dead Band X & Y:
The dead band defines the window around the zero point of the joystick (defined by the joystick offset) where movement will be ignored.

Data Format:	16-bit binary
Scaling:	LSB = 1 (count)
Default:	X: 25, Y: 25 (typical)

B5.11 Lens Field-of-View Message (OBSOLETE)

Reference Appendix C, Section C3.8

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 210								Spare							
Word 3 to Word 7	Spare															
Word 8	Checksum															

Figure B5.11. Lens Field-of-View Message

<u>This functionality is obsolete.</u>

Sync Word: 0xA5A5

Message Type: 210

B5.12 Mount Configuration Message

Reference Appendix C, Section C3.5.10

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 211</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="16">Mount Type</td></tr>
<tr><td>Word 4</td><td colspan="12">Spare</td><td>AF</td><td>AS</td><td>Md</td><td>AU</td></tr>
<tr><td>Word 5</td><td colspan="16">Azimuth Drift</td></tr>
<tr><td>Word 6</td><td colspan="16">Elevation Drift</td></tr>
<tr><td>Word 7</td><td colspan="16">Minimum Azimuth</td></tr>
<tr><td>Word 8</td><td colspan="16">Maximum Azimuth</td></tr>
<tr><td>Word 9</td><td colspan="16">Minimum Elevation</td></tr>
<tr><td>Word 10</td><td colspan="16">Maximum Elevation</td></tr>
<tr><td>Word 11</td><td colspan="16">Spare</td></tr>
<tr><td>Word 12</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.12. Mount Configuration Message

Sync Word: 0xA5A5

Message Type: 211

Mount Type: The type of mount connected to the tracker. Please note that these options are always expanding as E-O Imaging adds support for additional mounts. Please check with the factory for the latest list of supported mounts.

0 – None
1 – Vinten HS-105P (customized)
2 – Vinten HS-1020ME (customized)
3 – Rotating Precision Mechanisms 513 (**DEPRECATED**)
4 – Sagebrush
5 – Instro Precision WASPII
6 – Rotating Precision Mechanisms PG-2053
7 – QuickSet OPT 130 150
8 – Rotating Precision Mechanisms PT-0517
9 – Orbit AL2613
10 – Atlantic Positioning Systems SPS-1000
11 – Instro Precision Mantis

12 – Aeroflex/ITT Custom (**DEPRECATED**)
13 – Orbit AL1613
14 – Rotating Precision Mechanisms PG-10523
15 – Atlantic Positioning Systems SPS-2000
16 – Rotating Precision Mechanisms PG-1023
17 – Graflex PT-150
18 – Malibu Research P848 HD50
19 – Rotating Precision Mechanisms (Automatic)
20 – Orbit AL-4015
21 – QuickSet/Moog GeminEye
22 – FLIR E-Series PTU
23 – FLIR EVPU MS02
24 – Graflex PT-150 REV2
25 – Telemetry Antenna Corp DACU PD300 (**Not Supported**)

AU: Run an automatic drift calibration.

0 – Do not run an automatic drift calibration
1 – Run an automatic drift calibration

Md: Enter manual drift calibration mode.

0 – Do not enter manual drift calibration mode
1 – Enter manual drift calibration mode

AS: Use analog error outputs for rate drive during track mode (not supported on all mounts).

0 – Serial control only
1 – Use analog error outputs for tracking

AF: Angle format to use when reporting mount position.

0 – Signed angles (+/-180 or greater degrees)
1 – Bearing (0 to 360 degrees)
Default: Signed angles

Azimuth & Elevation Drift:
The analog error output bias to zero the mount movement. Set this value to keep the mount from drifting in azimuth and elevation when the track errors are zero.

Data Format:	16-bit two's complement
Scaling:	LSB = 1 count of the digital to analog converter
Range:	±10,000
Default:	Az: 0, El: 0

Minimum Azimuth & Elevation:

The minimum azimuth and elevation position of the mount. This sets the software stops for the lower (El) left (Az) mount position.

Data Format:	16-bit two's complement
Scaling:	LSB = 1 degree
Range:	±3600 degrees (depends on selected mount)
Default:	Az: -180, El: -180

Maximum Azimuth & Elevation:

The maximum azimuth and elevation position of the mount. This sets the software stops for the upper (El) right (Az) mount position.

Data Format:	16-bit two's complement
Scaling:	LSB = 1 degree
Range:	±3600 degrees (depends on selected mount)
Default:	Az: 180, El: 180

B5.13 Analog Joystick Configuration Message

Reference Appendix C, Section C3.5.7

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 212								Spare							
Word 3	Spare												GO	OA	RT	JE
Word 4	Joystick Y Axis								Joystick X Axis							
Word 5	Offset Aim								Track/Acquire							
Word 6	Spare								Gain Override							
Word 7	Joystick Leftmost ADC															
Word 8	Joystick Rightmost ADC															
Word 9	Joystick Upper ADC															
Word 10	Joystick Lower ADC															
Word 11	Spare															
Word 12	Checksum															

Figure B5.13. Analog Joystick Configuration Message

Sync Word: 0xA5A5

Message Type: 212

JE: Analog joystick enable

0 – Disabled <DEFAULT>
1 – Enabled

RT: Track/Acquire rising edge trigger

0 – Falling edge trigger <DEFAULT>
1 – Rising edge trigger

OA: Offset aim active high

0 – Low level activation <DEFAULT>
1 – High level activation

GO:	Gain override active high 0 – Low level activation <DEFAULT> 1 – High level activation
Joystick X/Y Axis:	Joystick X/Y axis analog channel 0 – Disabled <DEFAULT> 1 to 8 – ADC channel
Track/Acquire:	Track/Acquire button analog channel 0 – Disabled <DEFAULT> 1 to 8 – ADC channel
Offset Aim:	Offset Aim button analog channel 0 – Disabled <DEFAULT> 1 to 8 – ADC channel
Gain Override:	Gain Override button analog channel 0 – Disabled <DEFAULT> 1 to 8 – ADC channel
Joystick Leftmost ADC:	Joystick ADC value in full left position Data Format: 16-bit two's complement Scaling: (volts = analog * 10/32767)
Joystick Rightmost ADC:	Joystick ADC value in full right position Data Format: 16-bit two's complement Scaling: (volts = analog * 10/32767)
Joystick Upper ADC:	Joystick ADC value in full top position Data Format: 16-bit two's complement Scaling: (volts = analog * 10/32767)
Joystick Lower ADC:	Joystick ADC value in full bottom position Data Format: 16-bit two's complement Scaling: (volts = analog * 10/32767)

B5.14 Digital I/O Configuration Message

Reference Appendix C, Section C3.5.9

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 213</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="11">Spare</td><td>EU</td><td colspan="3">Port Setup</td><td>DE</td></tr>
<tr><td>Word 4</td><td colspan="8">Logic 0</td><td colspan="8">Function 0</td></tr>
<tr><td>Word 5
to
Word 18</td><td colspan="8">.
.
.</td><td colspan="8">.
.
.</td></tr>
<tr><td>Word 19</td><td colspan="8">Logic 15</td><td colspan="8">Function 15</td></tr>
<tr><td>Word 20</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.14. Digital I/O Configuration Message

Sync Word: 0xA5A5

Message Type: 213

DE: Enable user digital I/O.

0 – Digital track error outputs <DEFAULT>
1 – User digital I/O

Port Setup: User digital I/O port setup.

0 – 16 inputs <DEFAULT>
1 – 8 inputs and 8 outputs
2 – 16 outputs

UE: Unsolicited field/frame rate digital I/O reads enable.

0 – Disable <DEFAULT>
1 – Enable

Function 0 to 15: Function to map to specific bit

0 – Bit disabled <DEFAULT>
1 – Focus Far
2 – Focus Near
3 – Zoom Narrow
4 – Zoom Wide
5 – Video Select (toggle between source 1 and 2)
6 – Gate Select
7 – Laser Rangefinder Enable
8 – Data Logging
9 – Offset Aim
10 – Return to Boresight
11 – Gain Override
12 – Track/Acquire
13 – Second Gate Slave
14 – Reset Tracker
15 – Velocity Limit Enable
16 – Laser Rangefinder Enable on Track
17 – Zoom to Range
18 – Video Cycle (cycles through video sources which have a configured lens)
19 – Slave FOVs (slaves all configured lens FOVs to the currently selected camera / lens)

Logic 0 to 15: Logic for specific bit

0 – Logic Disabled <DEFAULT>
1 – Active High
2 – Active Low
3 – Rising Edge
4 – Falling Edge

B5.15 Zoom To Range Configuration Message

Reference Appendix C, Section C3.8

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 214</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="10">Spare</td><td>SP</td><td>EN</td><td colspan="4">Video Source</td></tr>
<tr><td>Word 4</td><td colspan="16">Minimum FOV</td></tr>
<tr><td>Word 5</td><td colspan="16">Maximum FOV</td></tr>
<tr><td>Word 6</td><td colspan="16">Minimum Range (least significant word)</td></tr>
<tr><td>Word 7</td><td colspan="16">Minimum Range (most significant word)</td></tr>
<tr><td>Word 8</td><td colspan="16">Maximum Range (least significant word)</td></tr>
<tr><td>Word 9</td><td colspan="16">Maximum Range (most significant word)</td></tr>
<tr><td>Word 10</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.15. Zoom To Range Configuration Message

Sync Word: 0xA5A5

Message Type: 214

Video Source: Video source lens is connected to

0 – Analog 1 <DEFAULT>
1 – Analog 2
2 – Analog 3
3 – Analog 4
4 – Digital 1
5 – Digital 2 (Only on models with HD-SDI)

EN: Enable Zoom-to-Range for this video source

0 – Disabled <DEFAULT>
1 – Enable Zoom-to-Range

SP: Use single point algorithm instead of two points. This algorithm uses only the minimum range and the maximum field-of-view.

0 – Use Two Point Algorithm <DEFAULT>
1 – Use Single Point Algorithm

Minimum FOV:	The minimum field of view of the lens in degrees	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 degree (divide by 100)
	Range:	0 to 360.00 degrees
Maximum FOV:	The maximum field of view of the lens in degrees	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 degree (divide by 100)
	Range:	0 to 360.00 degrees
Minimum Range:	Minimum target range in centimeters (correlates to the maximum FOV)	
	Data Format:	32-bit unsigned integer
Maximum Range:	Maximum target range in centimeters (correlates to the minimum FOV)	
	Data Format:	32-bit unsigned integer

B5.16 Gate Style Configuration Message

Reference Appendix C, Section C3.5.1

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 215</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="12">Spare</td><td>sym</td><td>cor</td><td>trk</td><td>acq</td></tr>
<tr><td>Word 4</td><td colspan="16">Fixed Size X</td></tr>
<tr><td>Word 5</td><td colspan="16">Fixed Size Y</td></tr>
<tr><td>Word 6</td><td colspan="8">Percent Size Y</td><td colspan="8">Percent Size X</td></tr>
<tr><td>Word 7</td><td colspan="16">Minimum Size X</td></tr>
<tr><td>Word 8</td><td colspan="16">Minimum Size Y</td></tr>
<tr><td>Word 9</td><td colspan="16">Maximum Size X</td></tr>
<tr><td>Word 10</td><td colspan="16">Maximum Size Y</td></tr>
<tr><td>Word 11</td><td colspan="16">Spare</td></tr>
<tr><td>Word 12</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.16. Gate Style Configuration Message

Sync Word: 0xA5A5

Message Type: 215

acq: Gate style when in acquire and off-track state

0 – Solid <DEFAULT>
1 – Corners Only

trk: Gate style when in track and coast state

0 – Solid <DEFAULT>
1 – Corners Only

cor: Gate corner type

0 – Fixed Size <DEFAULT>
1 – Automatic Size

sym:	Gate corner symmetry	
	0 – Independent X and Y <DEFAULT> 1 – Symmetric	
Fixed Size X & Y:	Fixed size of gate corners	
	Data Format:	16-bit unsigned integer
	Range:	0 to 1023 pixels/lines
Percent Size X & Y:	Size of gate corners as a percentage of the total gate size	
	Data Format:	8-bit unsigned integer
	Range:	0 to 100 percent
Minimum Size X & Y:	Minimum size of the gate corners when corner type is automatic	
	Data Format:	16-bit unsigned integer
	Range:	0 to 1023 pixels/lines
Maximum Size X & Y:	Maximum size of the gate corners when corner type is automatic	
	Data Format:	16-bit unsigned integer
	Range:	0 to 1023 pixels/lines

B5.17 Gate Reticle Configuration Message

Reference Appendix C, Section C3.5.1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 216								Spare							
Word 3	Spare															En
Word 4	Position X															
Word 5	Position Y															
Word 6	Size X															
Word 7	Size Y															
Word 8	Corner Size X															
Word 9	Corner Size Y															
Word 10	Checksum															

Figure B5.17. Gate Reticle Configuration Message

Sync Word: 0xA5A5

Message Type: 216

En: Enable display of gate reticle. When enabled, this message uses the symbology generator of the second gate as a user controlled reticle. If the second track gate is enabled, this functionality is disabled.

0 – Disable <DEFAULT>
1 – Enable

Position X & Y: Position of the reticle relative to the center of the field of view

Data Format: 16-bit two's complement
Range: ±511 pixels/lines

Size X & Y: Size of the reticle

Data Format: 16-bit unsigned integer
Range: 0 to 1023 pixels/lines

Corner Size X & Y: Size of the reticle corners

Data Format: 16-bit unsigned integer
Range: 0 to 1023 pixels/lines

B5.18 LOS Reticle Configuration Message

Reference Appendix C, Section C3.5.1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 217								Spare							
Word 3	Spare															
Word 4	Left Start															
Word 5	Left Stop															
Word 6	Right Start															
Word 7	Right Stop															
Word 8	Top Start															
Word 9	Top Stop															
Word 10	Bottom Start															
Word 11	Bottom Stop															
Word 12	Checksum															

Figure B5.18. LOS Reticle Configuration Message

Note: This message is used when the LOS Reticle Style is set to Custom (3) in the Symbology Configuration Message (B5.4).

Sync Word: 0xA5A5

Message Type: 217

Left Start & Stop: The left leg of the line-of-sight reticle start and stop pixel. The start point must be less than the stop point.

Data Format: 16-bit two’s complement
Range: -511 to 0 pixels

Right Start & Stop: The right leg of the line-of-sight reticle start and stop pixel. The start point must be less than the stop point.

Data Format: 16-bit two’s complement
Range: 0 to 511 pixels

Top Start & Stop:	The top leg of the line-of-sight reticle start and stop line. The start point must be greater than the stop point.	
	Data Format:	16-bit two's complement
	Range:	0 to 511 lines
Bottom Start & Stop:	The bottom leg of the line-of-sight reticle start and stop line. The start point must be greater than the stop point.	
	Data Format:	16-bit two's complement
	Range:	-511 to 0 lines

B5.19 Track Flag Configuration Message

Reference Appendix C, Section C3.5.1

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 218</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="11">Spare</td><td>Th</td><td colspan="4">Type</td></tr>
<tr><td>Word 4</td><td colspan="16">Left Start</td></tr>
<tr><td>Word 5</td><td colspan="16">Left Stop</td></tr>
<tr><td>Word 6</td><td colspan="16">Right Start</td></tr>
<tr><td>Word 7</td><td colspan="16">Right Stop</td></tr>
<tr><td>Word 8</td><td colspan="16">Top Start</td></tr>
<tr><td>Word 9</td><td colspan="16">Top Stop</td></tr>
<tr><td>Word 10</td><td colspan="16">Bottom Start</td></tr>
<tr><td>Word 11</td><td colspan="16">Bottom Stop</td></tr>
<tr><td>Word 12</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.19. Track Flag Configuration Message

Sync Word: 0xA5A5

Message Type: 218

Type: Track flag reticle type.

0 – Line <DEFAULT>
1 – Crosshair

Th: Thickness of the track flag reticle.

0 – Single <DEFAULT>
1 – Double

Left Start & Stop: The left leg of the crosshair reticle start and stop pixel. The start point must be less than the stop point.

Data Format: 16-bit two's complement
Range: -511 to 0 pixels

Right Start & Stop:	The right leg of the crosshair reticle start and stop pixel. The start point must be less than the stop point. Data Format: 16-bit two's complement Range: 0 to 511 pixels
Top Start & Stop:	The top leg of the crosshair reticle start and stop line. The start point must be greater than the stop point. Data Format: 16-bit two's complement Range: 0 to 511 lines
Bottom Start & Stop:	The bottom leg of the crosshair reticle start and stop line. The start point must be greater than the stop point. Data Format: 16-bit two's complement Range: -511 to 0 lines

B5.20 North Offset Configuration Message

Reference Appendix C, Section C3.5.10.2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 219								Spare							
Word 3	Spare															En
Word 4	Mount Bearing Angle (least significant word)															
Word 5	Mount Bearing Angle (most significant word)															
Word 6	Measured Bearing Angle (least significant word)															
Word 7	Measured Bearing Angle (most significant word)															
Word 8	Checksum															

Figure B5.20. North Offset Configuration Message

Note: This message informs the tracker about an azimuth mount offset which is applied in the mount controller. Currently, this message is only supported for RPM mount types.

Sync Word: 0xA5A5

Message Type: 219

En: Enable the north offset.

0 – Disable <DEFAULT>
1 – Enable

Mount Bearing Angle: The mount azimuth bearing angle as reported by the controller in degrees.

Data Format: 32-bits two's complement
Scaling: LSB = 0.0001 degree (divide by 10,000)
Range: ±360.0000 degrees

Measured Bearing Angle: The measured "true" azimuth bearing angle in degrees.

Data Format: 32-bits two's complement
Scaling: LSB = 0.0001 degree (divide by 10,000)
Range: ±360.0000 degrees

B5.21 Digital Video Configuration Message

Reference Appendix C, Section C3.5.4

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 220</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="2">Spare</td><td>DV</td><td colspan="4">In Pixels per Clock Ex</td><td>iDP</td><td>iFP</td><td>iLP</td><td>iCE</td><td>iPC</td><td colspan="3">In Bits per Pixel</td><td>Sc</td></tr>
<tr><td>Word 4</td><td colspan="15">Spare</td><td>Nuc</td></tr>
<tr><td>Word 5</td><td colspan="4">Spare</td><td>oDP</td><td>oFP</td><td>oLP</td><td>oCE</td><td colspan="4">Out Pixels per Clock</td><td colspan="3">Out Bits per Pixel</td><td>Cst</td></tr>
<tr><td>Word 6</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.21. Digital Video Configuration Message

Note: This message is used to setup the Camera Link digital video interface.

Sync Word: 0xA5A5

Message Type: 220

Sc: Video scan mode.

0 – Progressive <DEFAULT>
1 – Interlaced

In Bits per Pixel: The number of bits per pixel for the incoming data.

0 – 8 bits per pixel <DEFAULT>
1 – 10 bits per pixel
2 – 12 bits per pixel
3 – 14 bits per pixel
4 – 16 bits per pixel

iPC: The number of pixels per clock for the incoming data.

0 – One pixel per clock <DEFAULT>
1 – Two pixels per clock

iCE: The clock edge to use for incoming data. This setting only applies to custom video inputs (Camera Link and HD are fixed standards).

0 – Falling edge <DEFAULT>
1 – Rising edge

iLP: The line valid signal polarity to use for incoming data.

0 – Active low <DEFAULT>
1 – Active high

iFP: The frame valid signal polarity to use for incoming data.

0 – Active low <DEFAULT>
1 – Active high

iDP: The pixel data polarity to use for incoming data.

0 – Normal <DEFAULT>
1 – Inverse

DV: Use data-valid signal to qualify video

0 – Disable <DEFAULT>
1 – Enabled, will delay video by one line

In Pixels Per Clock Ex: The extended number of pixels per clock for the incoming data. This will override the "In Bits Per Pixel" value if set.

0 – Use the "In Bits Per Pixel" variable
1 through 4 – Number of pixels per clock

Nuc: Enable incoming pixel normalization (NUC) and bad pixel correction.

0 – Disable <DEFAULT>
1 – Enable

Cst: Enable custom output settings. If enabled, the output data can be (re)formatted differently than the input.

0 – Disable <DEFAULT>
1 – Enable

Out Bits Per Pixel: The number of bits per pixel for the output data. Only used if "Cst" is enabled.

0 – 8 bits per pixel <DEFAULT>
1 – 10 bits per pixel
2 – 12 bits per pixel
3 – 14 bits per pixel
4 – 16 bits per pixel

Out Pixels Per Clock: The number of pixels per clock for the output data. Only used if "Cst" is enabled.

0 – Not Valid
1 through 4 – Number of pixels per clock

oCE: The clock edge to use for output data. This setting only applies to custom video outputs (CameraLink and HD are fixed standards). Only used if "Cst" is enabled.

0 – Falling edge <DEFAULT>
1 – Rising edge

oLP: The line valid signal polarity to use for output data. Only used if "Cst" is enabled.

0 – Active low <DEFAULT>
1 – Active high

oFP: The frame valid signal polarity to use for output data. Only used if "Cst" is enabled.

0 – Active low <DEFAULT>
1 – Active high

oDP: The pixel data polarity to use for output data. Only used if "Cst" is enabled.

0 – Normal <DEFAULT>
1 – Inverse

B5.22 Annotation 2 Configuration Message

Reference Appendix C, Section C3.5.1.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 221								Spare							
Word 3	Y Location, String 1								Y Location, String 2							
Word 4	Spare												Size Y		Size X	
Word 5	Spare															
Word 6	Checksum															

Figure B5.22. Annotation 2 Configuration Message

Note: This message supersedes the Annotation Configuration message (type 202).

Sync Word: 0xA5A5

Message Type: 221

Y Location 1 & 2: The character row that will contain the string display. There is a Y location field for each of the two (2) display strings.

Scale: Whole Character Positions
Units: Character Rows (8 lines = 1 Character Row)
Range: 0 to 255

String 1 contains MODE, POL, STATE and STATUS displays.
Default: Row 0

String 2 contains AUTO, AZ, EL, and TVAL displays.
Default: Row 26

Size X & Y: The text character annotation size to use for each dimension.

0 – Small <DEFAULT FOR Y>
1 – Medium <DEFAULT FOR X>
2 – Large
3 – Extra Large

B5.23 Serial Ports Configuration Message

Reference Appendix C, Section C3.5.2.5

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 222								Spare							
Word 3	Spare								U7	U6	U5	U4	U3	U2	U1	U0
Word 4	Checksum															

Figure B5.23. Serial Ports Configuration Message

Note: ***This message is used to setup the serial port configurations on the Models 7005, 7015, 7007 and 7010 boards. Other models have physical switches for this function and this message will be ignored. However, UART0 (the GUI port) is setup using a physical switch or jumper on all boards.***

Sync Word: 0xA5A5

Message Type: 222

U0: UART0 GUI (QUERY / READ ONLY)

0 – RS-232
1 – RS-422

U1: UART1 Controller

0 – RS-232
1 – RS-422

U2: UART2 Mount

0 – RS-232
1 – RS-422

U3 : UART3 (typically Lens)

0 – RS-232
1 – RS-422

U4 thru U7: UART4 through UART7 (Models 7005, 7007 and 7010 only)

0 – RS-232
1 – RS-422

B5.24 Control Box Configuration Message

Reference Appendix C, Section C3.5.8

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 223								Spare							
Word 3	Video Select 2								Video Select 1							
Word 4	Spare															
Word 5	Spare															
Word 6	Checksum															

Figure B5.24. Control Box Configuration Message

Sync Word: 0xA5A5

Message Type: 223

Video Select 1: Controls the video source selected when the Model 701 or 702 Controller switch is in the “Video Source 1” position.

0 – Analog Video Source 1 <DEFAULT>
1 – Analog Video Source 2
2 – Analog Video Source 3
3 – Analog Video Source 4
4 – Digital Video Source 1
5 – Digital Video Source 2 (Only on models with HD-SDI)

Video Select 2: Controls the video source selected when the Model 701 or 702 Controller switch is in the “Video Source 2” position.

0 – Analog Video Source 1
1 – Analog Video Source 2 <DEFAULT>
2 – Analog Video Source 3
3 – Analog Video Source 4
4 – Digital Video Source 1
5 – Digital Video Source 2 (Only on models with HD-SDI)

B5.25 AutoThreshold Configuration Message

Reference Appendix C, Section C3.5.6

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 226								Spare							
Word 3	Spare															En
Word 4	Acquire Alpha															
Word 5	Track Alpha															
Word 6	Minimum Contrast															
Word 7	Spare															
Word 8	Checksum															

Figure B5.25. AutoThreshold Configuration Message

Sync Word: 0xA5A5

Message Type: 226

En: Enable the alpha filter for automatic threshold control. The alpha filter provides a smoothing function to the threshold response (ie-low pass filter). When disabled, changes to the automatic threshold are averaged over two frames/fields.

0 – Disable <DEFAULT>
1 – Enable

Acquire Alpha: The alpha filter coefficient applied when the tracker is in acquire mode.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.0001 (divide by 10,000)
Range: 0 to 1.0000

Track Alpha: The alpha filter coefficient applied when the tracker is in track mode.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.0001 (divide by 10,000)
Range: 0 to 1.0000

Minimum Contrast:	Minimum acceptable target contrast level (as a percentage)	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 (divide by 100)
	Range:	0 to 100.00

B5.26 Ethernet Configuration Message

Reference Appendix C, Section C3.5.2.6

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="16">Sync Word</td></tr>
<tr><td>Word 2</td><td colspan="8">Message Type 227</td><td colspan="8">Spare</td></tr>
<tr><td>Word 3</td><td colspan="15">Spare</td><td>En</td></tr>
<tr><td>Word 4</td><td colspan="8">IP Address b2</td><td colspan="8">IP Address b1</td></tr>
<tr><td>Word 5</td><td colspan="8">IP Address b4</td><td colspan="8">IP Address b3</td></tr>
<tr><td>Word 6</td><td colspan="8">Subnet Mask b2</td><td colspan="8">Subnet Mask b1</td></tr>
<tr><td>Word 7</td><td colspan="8">Subnet Mask b4</td><td colspan="8">Subnet Mask b3</td></tr>
<tr><td>Word 8</td><td colspan="8">Gateway b2</td><td colspan="8">Gateway b1</td></tr>
<tr><td>Word 9</td><td colspan="8">Gateway b4</td><td colspan="8">Gateway b3</td></tr>
<tr><td>Word 10</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.26. Ethernet Configuration Message

Note: After changing the Ethernet configuration of the tracker, the new configuration must be saved to flash and then the board must be reset or power cycled in order for the new Ethernet configuration settings to take effect.

Sync Word: 0xA5A5

Message Type: 227

En: Enable Dynamic Host Configuration Protocol (DHCP).

0 – Disable
1 – Enable

IP Address: IP address (from standard IP notation: b1.b2.b3.b4)

Data Format: 8-bit unsigned integers

Subnet Mask: IP subnet Mask (from standard IP notation: b1.b2.b3.b4)

Data Format: 8-bit unsigned integers

Gateway: Gateway IP address (from standard IP notation: b1.b2.b3.b4)

Data Format: 8-bit unsigned integers

B5.27 Digital Video Ext Configuration Message

Reference Appendix C, Section C3.5.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 228								Spare							
Word 3	Spare												ED	EL	EF	En
Word 4	Active Pixels															
Word 5	Active Lines															
Word 6	Line Sync Pixels															
Word 7	Spare															
Word 8	Spare															
Word 9	Spare															
Word 10	Checksum															

Figure B5.27. Digital Video Ext Configuration Message

Note: This message is used to setup the Camera Link digital video interface for certain non-standard camera outputs.

Sync Word: 0xA5A5

Message Type: 228

En: Enable non-standard digital video input support.

0 – Disable
1 – Enable

EF: Enable use of the frame valid signal.

0 – Disable
1 – Enable

EL: Enable use of the line valid signal.

0 – Disable
1 – Enable

ED:	Enable use of the data valid signal 0 – Disable 1 – Enable
Active Pixels:	Pixels per line. Data Format: 16-bit unsigned integer
Active Lines:	Lines per frame. Data Format: 16-bit unsigned integer
Line Sync Pixels:	Number of idle pixels between lines (a..k.a. horizontal sync time). This is used to construct a standard output from the input signal Data Format: 16-bit unsigned integer

B5.28 Digital Preprocessor Configuration Message

Reference Appendix C, Section C3.5.4

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 229								Spare							
Word 3	Spare													EFF	ELF	EC
Word 4	Crop Top															
Word 5	Crop Bottom															
Word 6	Crop Left															
Word 7	Crop Right															
Word 8	Checksum															

Figure B5.28. Digital Preprocessor Configuration Message

Note: This message is used to setup video preprocessing for the Camera Link digital video input.

Sync Word: 0xA5A5

Message Type: 229

En: Enable cropping of the input digital video

0 – Disable
1 – Enable

ELF: Enable the flipping of each video line (horizontal flip)

0 – Disable
1 – Enable

EFF: Enable the flipping of each video frame (vertical flip)

0 – Disable
1 – Enable

Crop Top: Crops to this line (inclusive)

Data Format: 16-bit unsigned integer

Crop Bottom: Crops from this line (inclusive)

Data Format: 16-bit unsigned integer

Crop Left:	Crops to this pixel (exclusive, first pixel = 0)	
	Data Format:	16-bit unsigned integer
Crop Right:	Crops from this pixel (exclusive)	
	Data Format:	16-bit unsigned integer

B5.29 IFF Track Configuration Message

Reference Appendix C, Section C4.3.14

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 230								Spare							
Word 3	Spare													IE	IA	En
Word 4	Spare				Az Error Channel				Az RSS2 Channel				Az RSS1 Channel			
Word 5	Azimuth RSS1 Threshold															
Word 6	Azimuth RSS2 Threshold															
Word 7	Azimuth Proportion															
Word 8	Azimuth Integral															
Word 9	Azimuth Derivative															
Word 10	Azimuth Integral Limit															
Word 11	Azimuth Coast Timeout															
Word 12	Elevation Filter Lambda															
Word 13	Elevation Filter Limit															
Word 14	Elevation Proportional															
Word 15	Elevation Integral															
Word 16	Elevation Derivative															
Word 17	Elevation Integral Limit															
Word 18	Elevation Timeout															
Word 19	Spare															
Word 20	Checksum															

Figure B5.29. IFF Track Configuration Message

<u>This message implements a customer specific function and is not generally supported.</u>

Sync Word: 0xA5A5

Message Type: 230

En: Enable IFF Tracking.

0 – Disable
1 – Enable

IA: Invert the sign for the azimuth drive.

0 – Normal
1 – Invert

IE: Invert the sign for the elevation drive.

0 – Normal
1 – Invert

Azimuth RSS1 Threshold:|
Received signal strength 1 (RSS1) analog threshold value. Voltages below this will indicate an invalid AzPE.

Azimuth RSS2 Threshold:
Received signal strength 2 (RSS2) analog threshold value. Voltages below this will indicate an invalid AzPE.

Azimuth Proportion: Proportional term (P) for the azimuth's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 (divide by 100)

Azimuth Integral: Integral term (I) for the azimuth's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Azimuth Derivative: Derivative term (D) for the azimuth's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Azimuth Integral Limit: Limit for the integrator for the azimuth's PID filter, (0=disabled/no limit).

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.1 (divide by 10)

Azimuth Coast Timeout: Timeout in video fields/frames to stop tracking after RSS1 and RSS2 are no longer valid, (0 = Stop immediately).

Elevation Filter Lambda: Elevation tracking filter's lambda value.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1000)

Elevation Filter Limit:	Elevation tracking filter's error limit.	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.001 (divide by 1000)
Elevation Proportional:	Proportional term (P) for the elevation's PID filter..	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.01 (divide by 100)
Elevation Integral:	Integral term (I) for the elevation's PID filter..	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.001 (divide by 1,000)
Elevation Derivative:	Derivative term (D) for the elevation's PID filter..	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.001 (divide by 1,000)
Elevation Integral Limit:	Limit for the integrator for the elevation's PID filter, (0=disabled/no limit).	
	Data Format:	16-bit unsigned integer
	Scaling:	LSB = 0.1 (divide by 10)
Elevation Timeout:	Timeout in video fields/frames to stop tracking if the tracker does not see a new position message.	
	Data Format:	16-bit unsigned integer

B5.30 Intrusion Detection Configuration Message

Reference Appendix C, Section C3.3.7

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 231								Spare							
Word 3	Algorithm								Spare							En
Word 4	Threshold Count															
Word 5	Threshold Percent															
Word 6	Intrusion Size Y								Intrusion Size X							
Word 7	Spare															
Word 20	Checksum															

Figure B5.30. Intrusion Detection Configuration Message

Sync Word: 0xA5A5

Message Type: 231

En: Enable intrusion detection.

Algorithm: Select algorithm to use.

0 – Intrusion gate pixel count
1 – Percent intrusion gate pixel count
2 – Percent target pixel count

Threshold Count: Absolute threshold count (use depends on algorithm).

Data Format: 16-bit unsigned integer
Scaling: LSB = 1 pixel
Range: 1 to 65535

Threshold Percent: Percentage threshold (use depends on algorithm).

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 percent (divide by 100)
Range: 0.00 to 100.00

Intrusion Size X: Width of intrusion area in pixels.

Data Format: 8-bit unsigned integer
Range: 0 to 255

Intrusion Size Y:	Height of intrusion area in lines.	
	Data Format:	8-bit unsigned integer
	Range:	0 to 255

ELECTRO-OPTICAL IMAGING, INC.

B5.31 Position Track Configuration Message

Reference Appendix C, Section C3.5.11

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 232								Spare							
Word 3	Spare													IE	IA	En
Word 4	Azimuth Threshold															
Word 5	Azimuth Filter Lambda															
Word 6	Azimuth Filter Limit															
Word 7	Azimuth Rejected Points Limit															
Word 8	Azimuth Near Proportion															
Word 90	Azimuth Near Integral															
Word 10	Azimuth Near Integral Limit															
Word 11	Azimuth Far Proportion															
Word 12	Azimuth Far Integral															
Word 13	Azimuth Far Integral Limit															
Word 14	Elevation Threshold															
Word 15	Elevation Filter Lambda															
Word 16	Elevation Filter Limit															
Word 17	Elevation Rejected Points Limit															
Word 18	Elevation Near Proportion															
Word 19	Elevation Near Integral															
Word 20	Elevation Near Integral Limit															
Word 21	Elevation Far Proportion															
Word 22	Elevation Far Integral															
Word 23	Elevation Far Integral Limit															
Word 24	Timeout															
Word 25	Checksum															

Figure B5.31. Position Track Configuration Message

Sync Word:	0xA5A5
Message Type:	232
En:	Enable position tracking (if periodic position messages are received). 0 – Disable 1 – Enable
IA:	Invert the sign for the azimuth drive. 0 – Normal 1 – Invert
IE:	Invert the sign for the elevation drive. 0 – Normal 1 – Invert
Azimuth Threshold:	Azimuth threshold to switch between near and far parameters. Data Format: 16-bit unsigned integer Scaling: LSB = 0.001 (divide by 1,000)
Azimuth Filter Lambda:	Azimuth tracking filter's lambda (smoothing) parameter. Data Format: 16-bit unsigned integer Scaling: LSB = 0.001 (divide by 1,000)
Azimuth Filter Limit:	Azimuth tracking filter error limit in degrees (for point rejection). Data Format: 16-bit unsigned integer Scaling: LSB = 0.001 (divide by 1,000)
Azimuth Rejection Points Limit:	Number of points rejected by the Kalman filter before reset.
Azimuth Near Proportion:	Proportion term (P) for the azimuth's PID filter. Data Format: 16-bit unsigned integer Scaling: LSB = 0.01 (divide by 100)
Azimuth Near Integral:	Integral term (I) for the azimuth's PID filter. Data Format: 16-bit unsigned integer Scaling: LSB = 0.001 (divide by 1,000)

Azimuth Near Integral Limit:
Integrator limit for the azimuth's PID filter, (0=disabled/no limit).

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.1 (divide by 10)

Azimuth Far Proportion: Proportion term (P) for the azimuth's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 (divide by 100)

Azimuth Far Integral: Integral term (I) for the azimuth's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Azimuth Far Integral Limit:
Integrator limit for the azimuth's PID filter, (0=disabled/no limit).

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.1 (divide by 10)

Elevation Threshold: Elevation threshold to switch between near and far parameters.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Elevation Filter Lambda: Elevation tracking filter's lambda (smoothing) parameter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Elevation Filter Limit: Elevation tracking filter error limit in degrees (for point rejection).

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Elevation Rejection Points Limit:
Number of points rejected by the Kalman filter before reset.

Elevation Near Proportion:
Proportion term (P) for the elevation's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 (divide by 100)

Elevation Near Integral: Integral term (I) for the elevation's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Elevation Near Integral Limit:
Integrator limit for the elevation's PID filter, (0-disabled/no limit).

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.1 (divide by 10)

Elevation Far Proportion:
Proportion term (P) for the elevation's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.01 (divide by 100)

Elevation Far Integral: Integral term (I) for the elevation's PID filter.

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.001 (divide by 1,000)

Elevation Far Integral Limit:
Integrator limit for the elevation's PID filter, (0-disabled/no limit).

Data Format: 16-bit unsigned integer
Scaling: LSB = 0.1 (divide by 10)

Timeout: Time in video fields/frames to stop tracking if the tracker does not receive a new position message.

B5.32 Control Box I/O Configuration Message

Reference Appendix C, Section C3.5.8.2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 233								Spare							
Word 3	Spare															En
Word 4	Bit 0 Logic								Bit 0 Function							
Word 5	Bit 1 Logic								Bit 1 Function							
Word 6	Bit 2 Logic								Bit 2 Function							
Word 7	Bit 3 Logic								Bit 3 Function							
Word 8	Bit 4 Logic								Bit 4 Function							
Word 90	Bit 5 Logic								Bit 5 Function							
Word 10	Bit 6 Logic								Bit 6 Function							
Word 11	Bit 7 Logic								Bit 7 Function							
Word 12	Bit 8 Logic								Bit 8 Function							
Word 13	Bit 9 Logic								Bit 9 Function							
Word 14	Bit 10 Logic								Bit 10 Function							
Word 15	Bit11 Logic								Bit 11 Function							
Word 16	Bit12 Logic								Bit 12 Function							
Word 17	Bit 13 Logic								Bit 13 Function							
Word 18	Bit 14 Logic								Bit 14 Function							
Word 19	Bit 15 Logic								Bit 15 Function							
Word 20	Checksum															

Figure B5.32. Control Box I/O Configuration Message

Sync Word: 0xA5A5

Message Type: 233

En: Enable digital inputs.

0 – Disable
1 – Enable

Bit Function: Function mapping for associated digital input (0 – 15).

0 – Disabled
1 – Focus far
2 – Focus near
3 – Zoom Narrow
4 – Zoom Wide
5 – Video select (1 & 2)
6 – Gate select
7 – LRF enable
8 – Data logging
9 – Offset aim
10 – Return boresight
11 – Gain override
12 – Track acquire
13 – Transition select
14 – Reset tracker
15 – Velocity limit enable
16 – LRF enable track only
17 – Zoom to range enable
18 – Video cycle
19 – Set FOV slaving

Bit Logic: Logic for associated digital input (0 – 15).

0 – Disabled
1 – Active high
2 – Active low
3 – Rising edge
4 – Falling edge

B5.33 Video Switch Configuration Message

Reference Appendix C, Section C3.5.13

<table>
<tr><th></th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
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<tr><td>Word 3</td><td colspan="8">Analog Switch Function</td><td colspan="8">Analog Switch Type</td></tr>
<tr><td>Word 4</td><td colspan="6">Spare</td><td>Ae</td><td>Ap</td><td colspan="8">Analog Switch Port</td></tr>
<tr><td>Word 5</td><td colspan="8">Digital Switch Function</td><td colspan="8">Digital Switch Type</td></tr>
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<tr><td>Word 7</td><td colspan="16">Spare</td></tr>
<tr><td>Word 8</td><td colspan="16">Checksum</td></tr>
</table>

Figure B5.33. Video Switch Configuration Message

Sync Word: 0xA5A5

Message Type: 234

Analog Switch Type: Type of analog video switch

0 – None
1 – Extron MMX 42 AV

Analog Switch Function: Associated function assigned to the analog switch

0 – None
1 – Output unselected video

Analog Switch Port: Tracker serial port used to control the analog switch

Range: 3 to 7 (0-2 are reserved)

Ap: Analog switch present

0 – Not present
1 – Present

Ae: Analog switch error

0 – No error
1 – Error (comm-error, NAKs, etc..)

Digital Switch Type:	Type of digital video switch 0 – None 1 – Phrontier CLEVER-SW
Digital Switch Function:	Associated function assigned to the digital switch 0 – None 1 – Output selected video
Analog Switch Port:	Tracker serial port used to control the digital switch Range: 3 to 7 (0-2 are reserved)
Dp:	Digital switch present 0 – Not present 1 – Present
De:	Digital switch error 0 – No error 1 – Error (comm-error, NAKs, etc)

B5.34 Message Acknowledge Message

Reference Appendix C, Section C3.1.9.3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Sync Word															
Word 2	Message Type 254								Acknowledge Type							
Word 3	Error Code															
Word 4	Checksum															

Figure B5.34. Message Acknowledge Message

Sync Word: 0xA5A5

Message Type: 254

Acknowledge Type: Message type of the message being acknowledged.

Data Format: 16-bit unsigned integer

Error Code: Status of acknowledgment

0 – Message OK / No Error
1 – Unknown Message

Appendix C

Graphical User Interface (GUI) Control Program

ELECTRO-OPTICAL IMAGING, INC.

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C1 Graphical User Interface (GUI) Control

The Tracker Control GUI software provides a user-friendly means of generating the required tracker control and configuration messages and sending them to the Series 7000 Tracker. This program runs under Microsoft Windows XP, Vista, 7 or 8. The program can communicate with the tracker over the bus (VME, PCI or PCI Express), serial port (COM) or Ethernet (TCP/IP).

Upon starting the program, a Run-Time Control screen will be displayed (Figure C2.1). This screen contains the tracker controls that are frequently used during a typical tracking scenario. Parameters typically set prior to the scenario may be modified through a series of secondary control screens.

C2 Run-Time Control Screen

The Run-Time Control screen contains controls for many of the tracker features typically used during an active track scenario. The controls on this screen fill the parameters of a *Type 1* message (Run-Time Control Message). Each time one of these run-time parameters is changed, a *Type 1* message is transmitted to the tracker. The controls are grouped into five main areas, as described below.

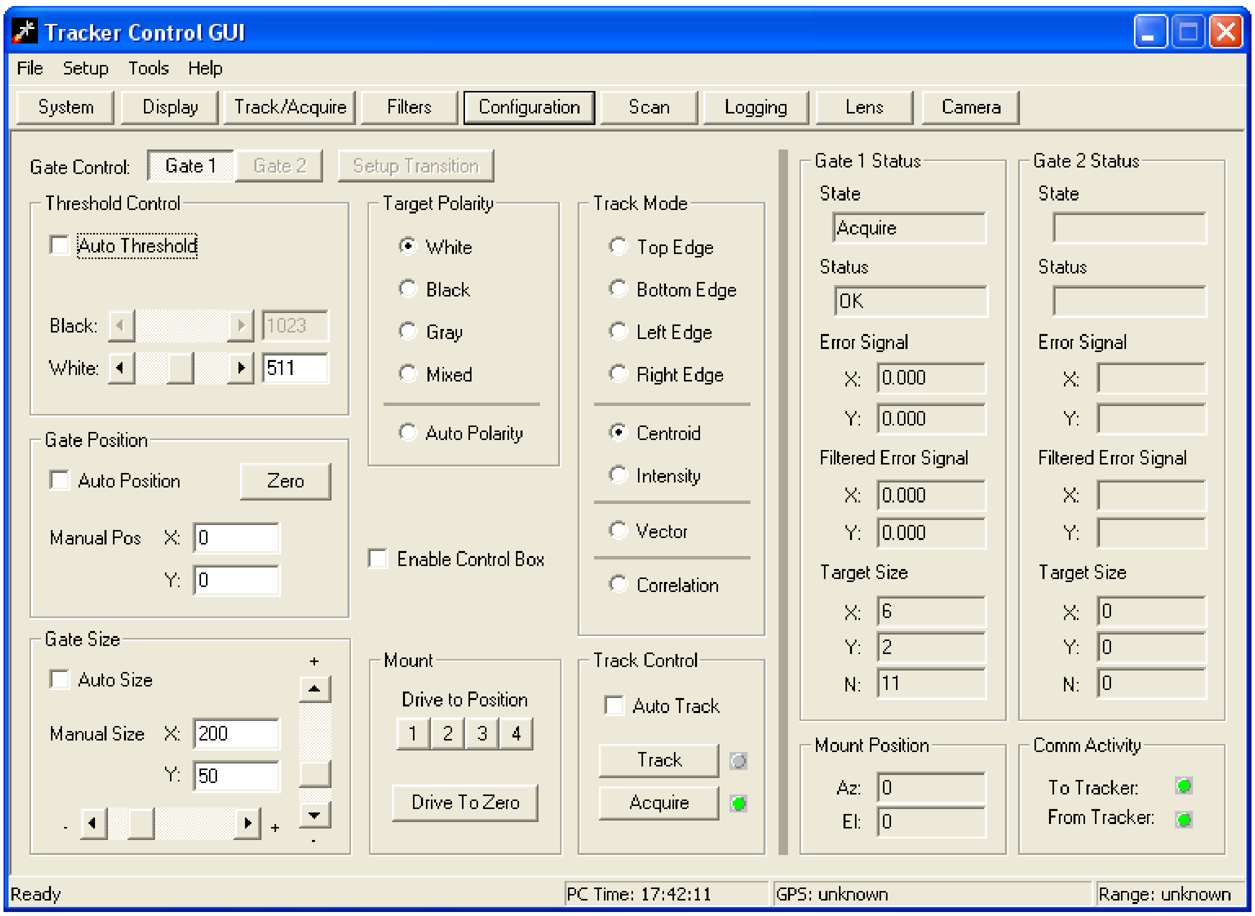

Figure C2.1. Run-Time Control Screen

The Run-Time Control screen is divided into five sections:

- The leftmost portion of the central screen is the active control section, which provides direct access to the main tracker and mounts options.
- The rightmost portion of the central screen provides a real-time data display of tracker and mount activity.
- Directly above the central screen are a series of buttons, which provide access to tracker tuning parameters, as well as equipment-specific options and parameters.

- A windows-standard main menu bar is located at the top of the screen, which provides access to GUI-specific control parameters and features.
- The lower portion of the window provides a real-time display of the tracker's status, including GPS status and display of the IRIG or computer's time (UTC).
- The Model 7412 PCI Express Tracker supports a third gate. The triple-gate Run-Time Control screen is shown here:

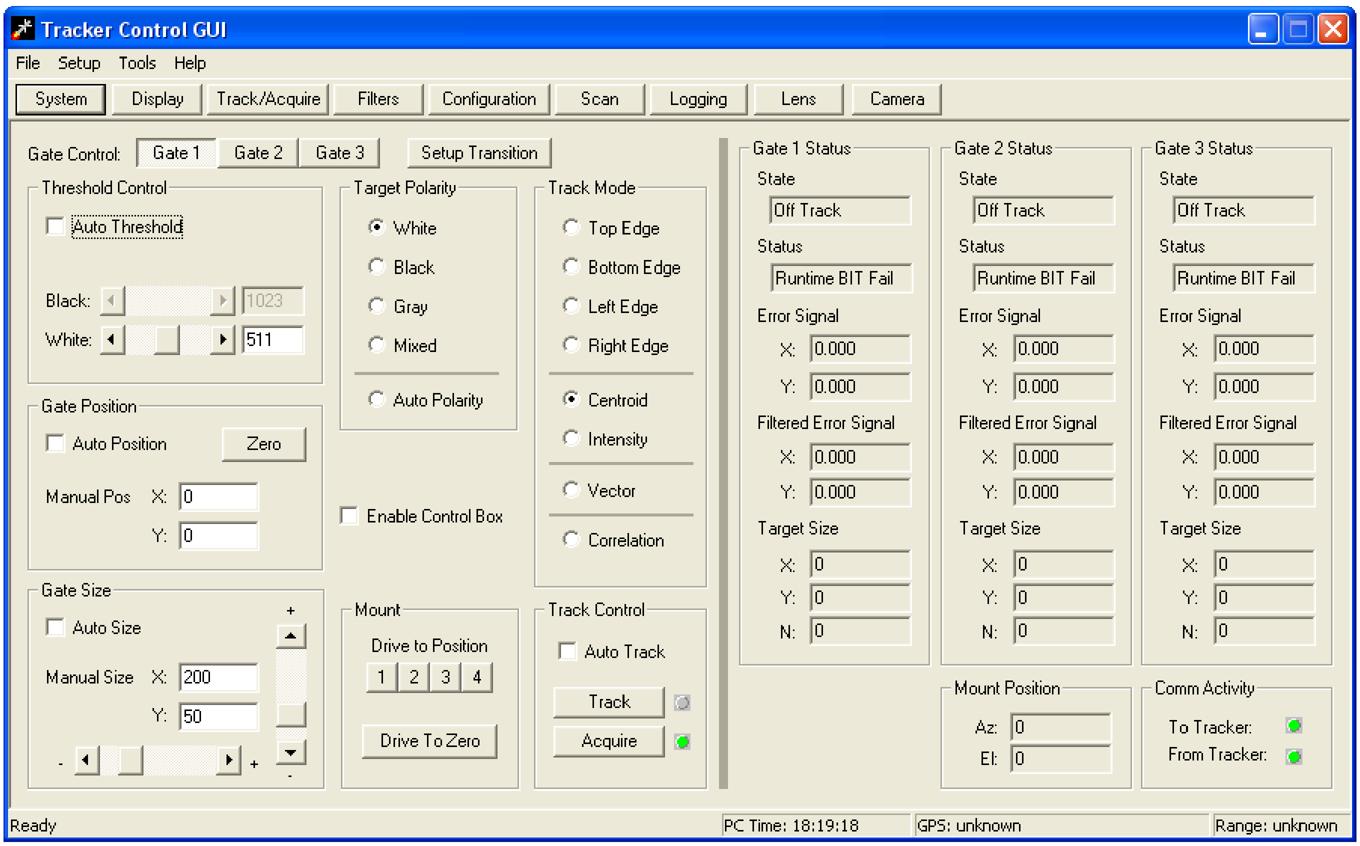

Figure C 2.2 Triple-Gate Run-Time Control Screen

C2.1 Gate Control

Use the Gate Control buttons to select the active (tracking) gate. If the Tracker only supports one gate, the Gate Control buttons are not available and will be grayed-out.

C2.1.1 Setup Transition

The Setup Transition button enables a demonstration of one possible use of the second gate. In a Separation Scenario, the primary gate will be used to track a target while the secondary gate will be slaved in position to the primary gate. Should the target separate into two objects and one of the objects moves into the secondary gate area, a Gate Transition will occur. In this scenario, the secondary gate will then be un-slaved from the primary gate and will be selected to track the second object.

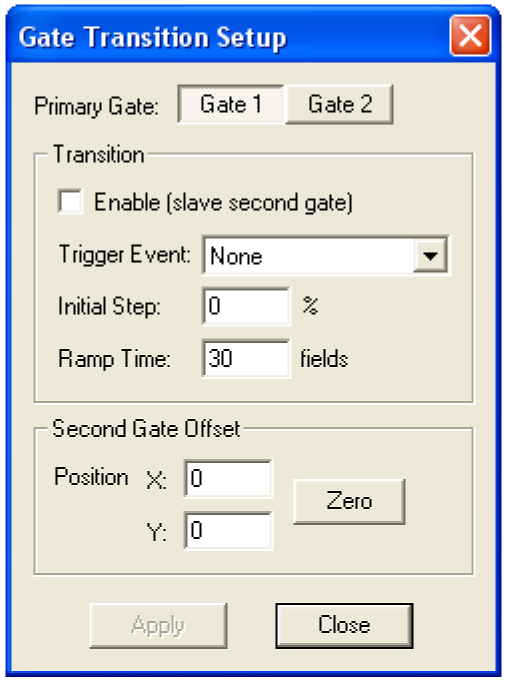

Figure C2.3. Gate Transition Setup Screen

C2.1.1.1 Primary Gate

The ***Primary Gate*** is the gate which will track the initially acquired target.

C2.1.1.2 Transition

Use this checkbox to slave the secondary gate to the primary gate. Select the Trigger Event from the pull-down menu. The ***Initial Step*** and ***Ramp Time*** settings control a ramp filter that can be used to smooth out the transition. ***Reference Section C3.4.5 for a description of the ramp filter.***

C2.1.1.3 Second Gate Offset

The ***Second Gate Offset*** controls determine the location of the secondary gate's upper left-hand corner, relative to the primary gate's upper left-hand corner, prior to separation. A positive X-Offset means (pixels) to the right and a positive Y-Offset means (lines) above.

C2.2 Threshold Control

The ***Auto Threshold*** checkbox determines whether auto thresholding or manual thresholding is to be used. If the checkbox is checked, auto threshold is enabled. If the checkbox is unchecked, manual threshold is used.

The function of the two scroll bars in the threshold control area is determined by the auto/manual selection. If auto thresholding is enabled, the scroll bars will select a thresholding value between 1% and 100%. This percentage is applied to the video level range between peak and average to determine the threshold setting for the next video field. If manual threshold is used, the scroll bars will select a value between 0 and 1023 counts. The counts are sized to fit the range between peak and average video. The manually set threshold count determines the threshold level for the next field.

Based upon the ***Target Polarity*** selection, some controls may be inactive (grayed out). If ***White*** target polarity is selected, only the white scroll bar will be active. If ***Black*** target polarity is selected, only the black scroll bar will be active. If ***Gray*** or ***Mixed*** target polarity is selected, both scroll bars will be active. If ***Auto Polarity*** is selected, threshold levels will be set automatically by the tracker and the entire Threshold Control section of the screen will be inactive.

C2.3 Gate Position

The ***Gate Position*** controls determine how or where the track gate is positioned.

The ***Auto Position*** checkbox determines whether the track gate is positioned automatically based upon target location or manually by the user. If the checkbox is checked, auto gate position is enabled. If the checkbox is unchecked, manual gate position is used.

If manual gate position is selected, a gate position may be entered into the edit boxes, or the track gate can be dragged using the right mouse button. To drag the gate, position the mouse over an inactive gray area of the screen (i.e., not a button or control) and holding down the right mouse button, drag the track gate to the desired location. To manually position the track gate to location 0,0, click on the ***Zero*** button in the gate position area.

If auto gate position is selected, the track gate will automatically center itself over the thresholded target. You can drag the gate to an alternate target during auto position, which temporarily commands the tracker into manual gate position. When you release the right mouse button the tracker is commanded back into auto gate position.

C2.4 Gate Size

The ***Gate Size*** controls determine how the track gate is sized.

The ***Auto Size*** checkbox determines whether the track gate is sized automatically based upon target size and the ratio setting or manually sized by the user. If the checkbox is checked, auto gate size is enabled. If the checkbox is unchecked, manual gate size is used.

Auto gate size should not be used in edge track modes. As the track gate is positioned centered on the track point, using auto size in edge mode can easily cause portions of the target to be forced outside the track gate.

If auto gate size is selected, the size of the track gate is determined by the size of the thresholded target times the selected Auto-Size Ratio that is set under the “System” Parameters button.

If manual gate size is selected, the gate size may be set by entering the desired values in the edit boxes or by setting the scroll bars to the desired size.

C2.5 Target Polarity

The ***Target Polarity*** selection determines how the threshold settings are applied to the video inside the track gate.

If ***White*** target polarity is selected, pixels that are whiter than the white threshold setting are processed as part of the target. If ***Black*** target polarity is selected, pixels that are blacker than the black threshold setting are processed as part of the target. If ***Gray*** target polarity is selected, pixels that are blacker than the white threshold setting and whiter than the black threshold setting are processed as part of the target. If ***Mixed*** target polarity is selected, pixels that are whiter than the white threshold setting and blacker than the black threshold setting are processed as part of the target.

Auto Polarity does not use any of the threshold settings provided by the user. This mode determines which pixel levels that are present in the background near the track gate are not present inside the track gate and sets threshold bands to select these levels as target.

C2.6 Enable Control Box

The ***Enable Control Box*** checkbox determines if the tracker accepts control inputs from a Model 702 Controller. If the checkbox is checked, the Model 702 Controller provides access to tracker functionality supported by both the Model 702 Controller and the currently installed hardware (camera, mount, etc.). If the checkbox is unchecked, all tracker functionality is controlled by the GUI.

C2.7 Mount

The ***Mount*** portion of the Run-Time Control screen provides a means to drive the mount to one of four (4) user-defined mount positions in addition to driving the mount to its zero position. These user-defined positions, including the mount zero position, are set up in the main menu bar's **Configuration→Mount** window. Note that a "Drive To" command will be saved if the tracker is in a track state and executed upon exiting the track state. Additionally, the tracker will abort the current "Drive To" command if another command is received before the current move has completed.

C2.8 Track Mode

The ***Track Mode*** selection determines what point on the target is used to generate the track point or track error point. If enabled, the left end of the track flag symbology will indicate this point.

If ***Centroid*** is selected, the track point is determined by calculating the mass centroid of the thresholded pixels inside the track gate.

If ***Top Edge*** is selected, the track point is determined by the first thresholded pixel that is encountered inside the track gate as the video lines progress down the screen.

If ***Bottom Edge*** is selected, the track point is determined by the last thresholded pixel that is encountered inside the track gate as the video lines progress down the screen.

If ***Left Edge*** is selected, the track point is determined by the first, left-most, thresholded pixel that is encountered inside the track gate.

If ***Right Edge*** is selected, the track point is determined by the last, right-most, thresholded pixel that is encountered inside the track gate.

If ***Intensity*** is selected, the track point is determined by calculating the intensity centroid of the thresholded pixels inside the track gate. This mode weights the brightness of thresholded pixels.

If ***Correlation*** is selected, and you have the correlation option installed, the track point is determined by the location of the center of the best match of the current video field to the captured reference image.

If ***Vector*** is selected, the track edge (***Top***, ***Bottom***, ***Left***, ***Right***) is determined dynamically by using the mount position feedback during track. Note that this track mode is not available unless a known mount is present.

C2.9 Track Control

The ***Track Control*** inputs guide the state that the tracker is in. This is for guidance and not a control, because the state depends upon the presence of a target that meets any specified parameters as well as these track control settings.

The ***Auto Track*** check box enables and disables auto track mode. If Auto Track mode is enabled, the tracker will automatically transition into Track mode when a target is located inside the track gate. If Auto Track is disabled, the user must initiate track unless it is achieved through the auto acquire function.

The ***Track*** button commands the tracker into Track mode. If there is a target inside the track gate, the error position information will be output upon going into Track mode. If there is no target, the tracker will transition out of Track mode into Acquire mode.

The ***Acquire*** button commands the tracker into Acquire mode. This function will stop the tracker from outputting errors if it had been in Track mode, or cause it to exit Auto Acquire mode if Auto Acquire had been selected.

C2.10 Real-Time Data

The ***Real-Time Data*** section of the Run-Time Control screen displays information received from the tracker output. The information displayed in the ***State***, ***Status***, and ***Error Signal*** boxes is the same information that is displayed on the video screen if the annotation display is enabled.

The ***State*** box contains the current track status.

The ***Status*** box contains the current target status.

The ***Error Signal*** box contains the pixel and line errors during track.

The ***Filtered Error Signal*** box contains the filtered pixel and line errors during track.

The ***Target Size*** box contains the height and width of the thresholded pixel area inside the track gate. This information can be used in determining desired settings for target discrimination.

The ***Mount Position*** box contains the current azimuth and elevation position data reported by the mount. This data is relative to the user-defined mount zero position defined in the main menu bar's **Configuration→Mount** window.

The ***Comm Activity*** section of the ***Real Time Data*** area provides user feedback as to the serial communications activity. If the ***To Tracker*** light is green, it indicates messages are being transmitted to the tracker from the Windows GUI program. If the ***From Tracker*** light is green, it indicates that status messages are being received from the tracker. A gray light on either indicates no message traffic (i.e., no communication), and a red light indicates an invalid message or checksum.

C3 Buttons

There are several buttons across the top of the Run-Time Control screen (Figure C3.1. Main Run-Time Control Screen Buttons

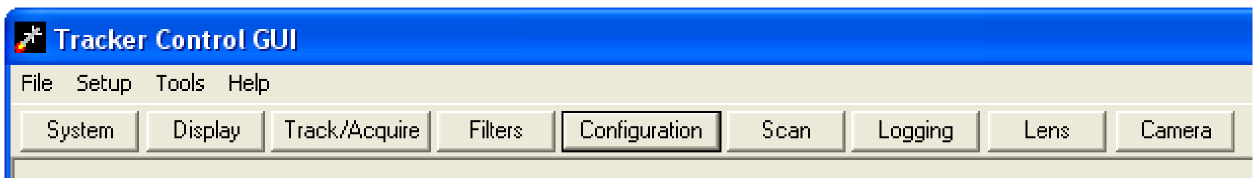

Figure C3.1. Main Run-Time Control Screen Buttons

Each of these buttons display a dialog containing the related function controls. For each of the dialog screens, clicking the ***OK*** button will apply any changes and close the dialog, clicking the ***Cancel*** button will close the dialog without applying any changes made, and clicking the ***Apply*** button will apply any changes made while leaving the dialog open. Clicking ***Apply*** or ***OK*** will send a control message to the tracker. Close the dialog to return to the Run-Time Control screen.

All mouse operations are performed using the left mouse button, unless specified otherwise.

C3.1 System Button

The ***System Parameters*** screen contains controls for functions that are used by the entire tracker. A representation of this screen is depicted in Figure C3.2, and each section of the screen is described in the following paragraphs.

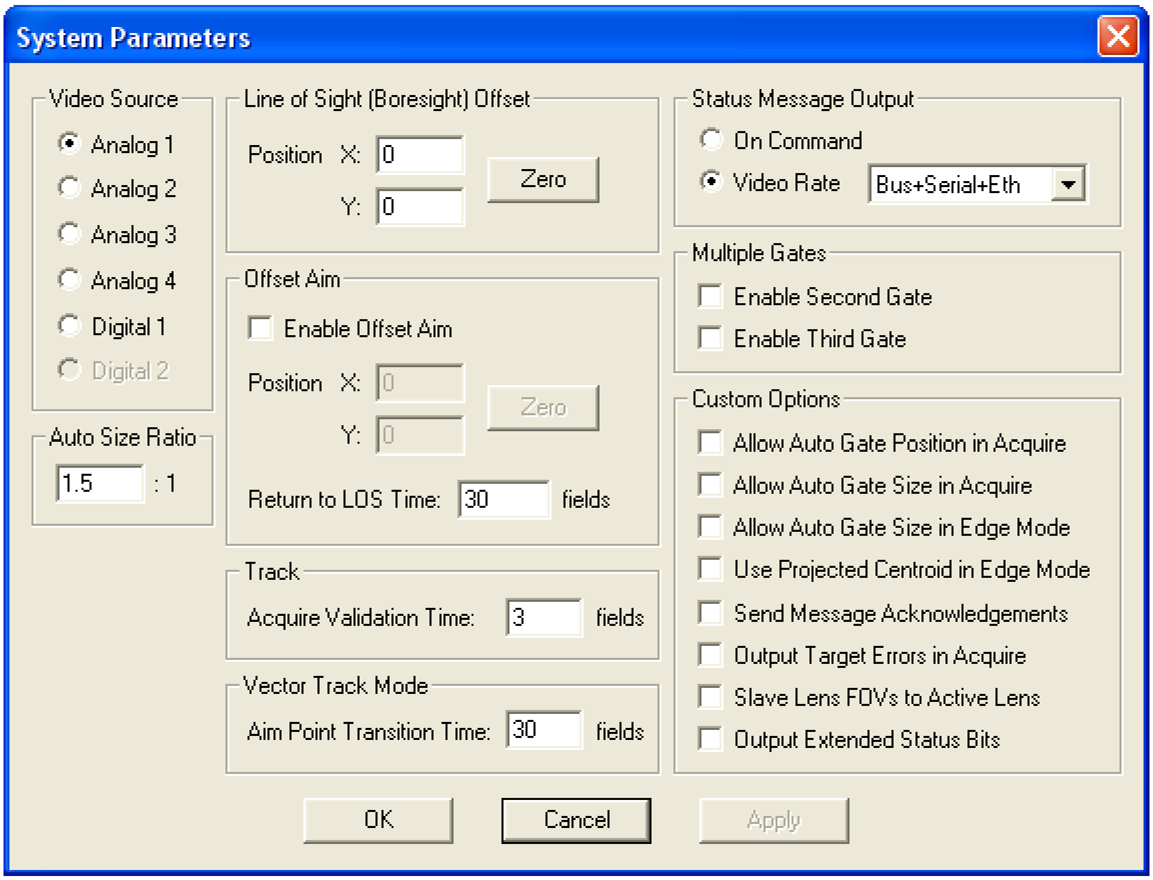

Figure C3.2. System Parameter Control Screen

C3.1.1 Video Source

The ***Video Source*** radio buttons select which video input will be processed by the tracker. ***Analog 1*** through ***Analog 4*** are analog (NTSC/PAL) composite video inputs. ***Digital 1*** and ***Digital 2*** are for the various digital video input(s). The digital video interfaces are described in Appendix A.

C3.1.2 Auto Size Ratio

The ***Auto Size Ratio*** selection determines the target to gate size ratio that will be maintained during auto gate size functions. For example, a 2.00:1 ratio would maintain a gate size that is twice the X and Y dimensions of the thresholded target. You can enter an auto size ratio from 1.00 to 655.35 in increments of 0.01. The default is 1.50.

C3.1.3 Line-Of-Sight Offset

The ***Line-Of-Sight (LOS) Offset*** is used to adjust the (0,0) reference point that will be used by the tracker. The LOS reticle (crosshair) is positioned at this offset location and the Aim Point is referenced relative to this point. Click the ***Zero*** button in the Line-Of-Sight area to set the offset back to the default (0,0) location. The crosshair position may be set by entering values in the edit boxes or by right clicking inside the LOS Offset box and dragging the LOS reticle to the desired location by moving the mouse.

C3.1.4 Offset Aim

The ***Offset Aim*** sets the point in the video to which track errors are referenced. This is nominally the center of the video when Offset Aim is set to (0,0) or disabled and is relative to the LOS Offset (***Reference Section C3.1.3***). This point of reference can be moved when Offset Aim is enabled. The track gate will follow and be centered on the Offset Aim point. Note that the Offset Aim point can be changed during track by using the mouse or Model 702 control box joystick.

There are two methods for setting the Offset Aim point. 1) Check the ***Enable Offset Aim*** checkbox, manually enter the values, and then click the ***Apply*** button, or 2) Check the ***Enable Offset Aim*** checkbox, click the ***Apply*** button and then right click on the mouse and drag the Aim Point by moving the mouse.

The ***Return to LOS Time*** defines the number of fields (1/60th second for NTSC, 1/50th second for PAL) to move the offset aim point back to the center of video during track when the ***Offset Aim*** is disabled. This feature allows for a gradual transition from the current Offset Aim to video center during track. Note that the Offset Aim will return to video center immediately if the tracker is not in a track state when ***Offset Aim*** is disabled.

C3.1.5 Track Acquire Validation Time

The tracker must have valid target data for a minimum number of fields to transition from Acquire to Track when commanded to track. The default value is three (3) fields.

C3.1.6 Vector Track Mode Aim Point Transition Time

The ***Vector Track Mode*** utilizes mount position feedback to determine a target vector. The target vector is then used to determine which edge (Top, Bottom, Left, or Right) to track. The tracker will transition to a new edge after seven (7) samples from the mount indicate a new target direction. The aim point of the mount will then transition from the last edge to the new edge in a period of time defined by the ***Aim Point Transition Time*** (in fields).

Example: The tracker determines it is going to change track mode from Bottom Edge to Right Edge based on the mount position feedback. If Aim Point Transition Time is zero then the tracker will immediately aim the mount to the new right edge pixel potentially resulting in an abrupt mount position change, which in turn could result in loss of track. If the ***Aim Point Transition Time*** is 30 fields, the tracker will transition the Aim Point from the Bottom Edge to the Right Edge using proportionally weighted data obtained from subsequent bottom and right edge data points.

Field Number	New Aim Point
1	$29/30*(X,Y)_{Bottom} + 1/30*(X,Y)_{Right}$
2	$28/30*(X,Y)_{Bottom} + 2/30*(X,Y)_{Right}$
3	$27/30*(X,Y)_{Bottom} + 3/30*(X,Y)_{Right}$
⋮	⋮
29	$1/30*(X,Y)_{Bottom} + 29/30*(X,Y)_{Right}$

C3.1.7 Status Message Output

The ***Status Message Output*** radio buttons allow you to select when the tracker will generate a status output message. While the message data is always updated each field/frame (50/60 Hz), the user can select whether the output will be transmitted at the field/frame rate (***Video Rate***) or only in response to a received message (***On Command***). This allows the host computer to control the volume of information being transmitted. The default is ***Field Rate***.

C3.1.8 Multiple Gates

The Multiple Gates checkboxes allow you to enable more than one gate on tracker models which support this feature.

Check the ***Enable Second Gate*** checkbox to enable the second gate operation. If this option is grayed out, then the tracker does not support dual gates.

Check the ***Enable Third Gate*** checkbox to enable the third gate operation. If this option is grayed out, then the tracker does not support three gates. ***Note: This feature is only available on the Model 7412 Tracker.***

C3.1.9 Custom Options

C3.1.9.1 Acquire Gate Modes

The gate can be automatically positioned and/or sized based upon a target within the gate while remaining in Acquire mode. To automatically position the gate in Acquire mode without transitioning to Track mode, check the ***Allow Auto Gate Position in Acquire*** checkbox. To automatically size the gate in Acquire mode without transitioning to Track mode, check the ***Allow Auto Gate Size in Acquire*** checkbox.

C3.1.9.2 Edge Modes

To automatically size the gate in Edge track mode, check the ***Allow Auto Gate Size in Edge Mode*** checkbox. To use the centroid stabilized projected edge in Edge track mode, check the ***Use Projected Centroid in Edge Mode*** checkbox.

C3.1.9.3 Message Acknowledgements

Check the ***Send Message Acknowledgements*** checkbox to enable sending of the acknowledgement response (type 254) message after the tracker receives a valid message. This function is typically enabled for VMEbus or PCI bus communications when fully interrupt driven operation is desired. The acknowledgement response will generate an interrupt on the bus when the tracker is done processing the current message.

C3.1.9.4 Target Errors in Acquire

Check the ***Output Target Errors in Acquire*** checkbox to enable output of the error signals for the best valid target found when in Acquire mode. By default, the tracker will only output the target error signals when in Track mode.

C3.1.9.5 Slave Lens Field-of-Views

Check the ***Slave Lens FOVs to Active Lens*** checkbox to enable the tracker to drive FOV commands to the secondary lens, based on the FOV status from the primary lens. The primary lens is the lens that is connected to the currently active video source. ***Reference Sections C3.1.1 and C3.8***.

C3.1.9.6 Output Extended Status Bits

Check the ***Output Extended Status Bits*** checkbox to enable additional bits in the Tracker Status Message that alter the format of the message from the previous version. ***Reference Appendix B, Section B2 Tracker Status*** for a detailed list of the extended status bits.

C3.2 Display Button

The ***Display*** button brings up a tabbed dialog box. Each tab brings up the controls for a portion of the tracker display parameters. The tabs available under the ***Display*** button are ***Symbology***, ***Annotation***, and ***User Defined Strings***.

C3.2.1 Symbology Tab

The ***Symbology*** tab contains a series of checkboxes and radio buttons (Figure C3.3). Each box is associated with an element of the tracker symbology on the video overlay. Examples of the various symbols are shown in Figure C3.4. If the box is checked, the specified symbology item will be displayed as long as conditions permit. If the Track Flag and/or Enhancement is enabled, they will be displayed only if there is thresholded target information inside the gate.

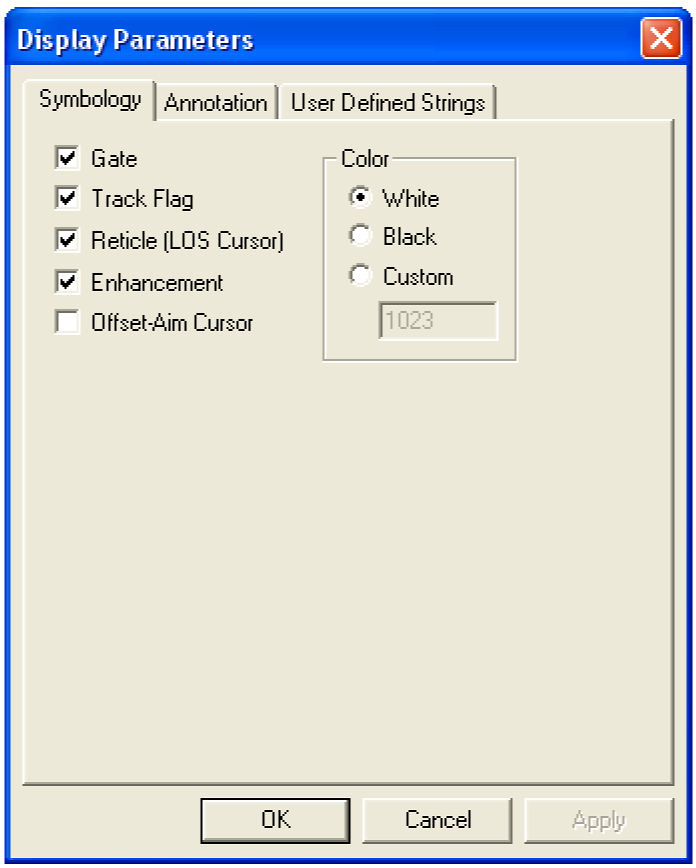

Figure C3.3. Symbology Screen

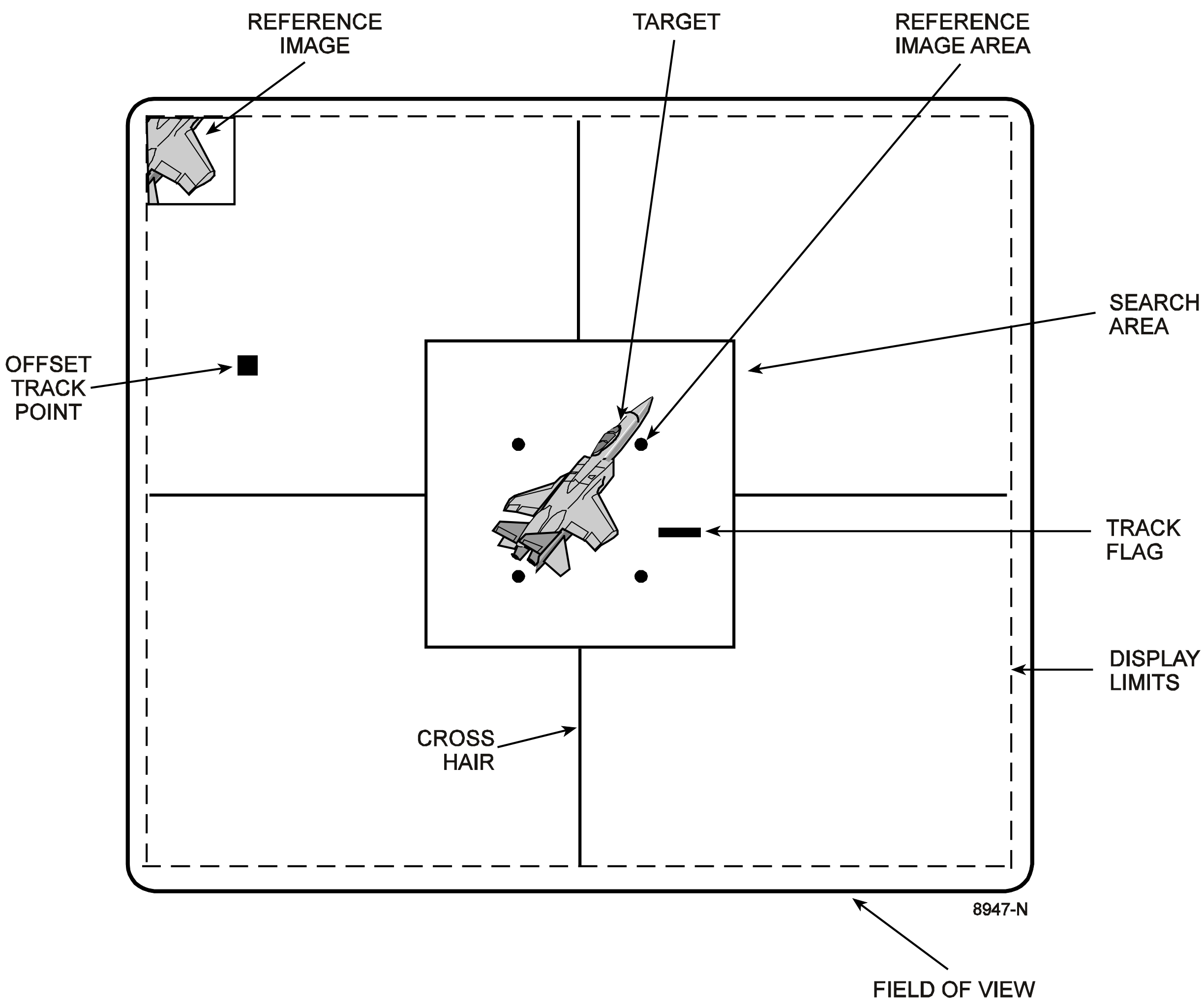

Figure C3.4. Display Symbology

C3.2.2 Annotation Tab

The ***Enable Annotation*** checkbox in the ***Annotation*** tab (Figure C3.5) determines if any of the selected annotations are displayed on the video overlay (Figure C3.6). If the box is not checked, no annotation will be displayed. If the box is checked, the values selected in the ***Display Enables*** section will determine the specific annotations to be displayed. The ***Color*** radio buttons determine if the text is dark characters on white background or white characters on a dark background. Selecting the ***custom*** color option, allows the foreground and background annotation colors to be set independently.

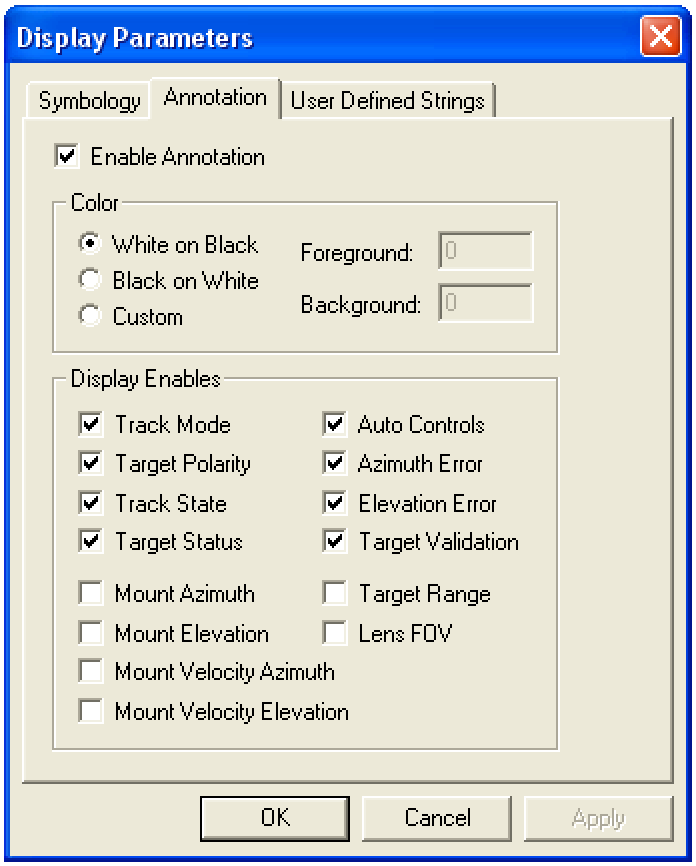

Figure C3.5. Annotation Screen

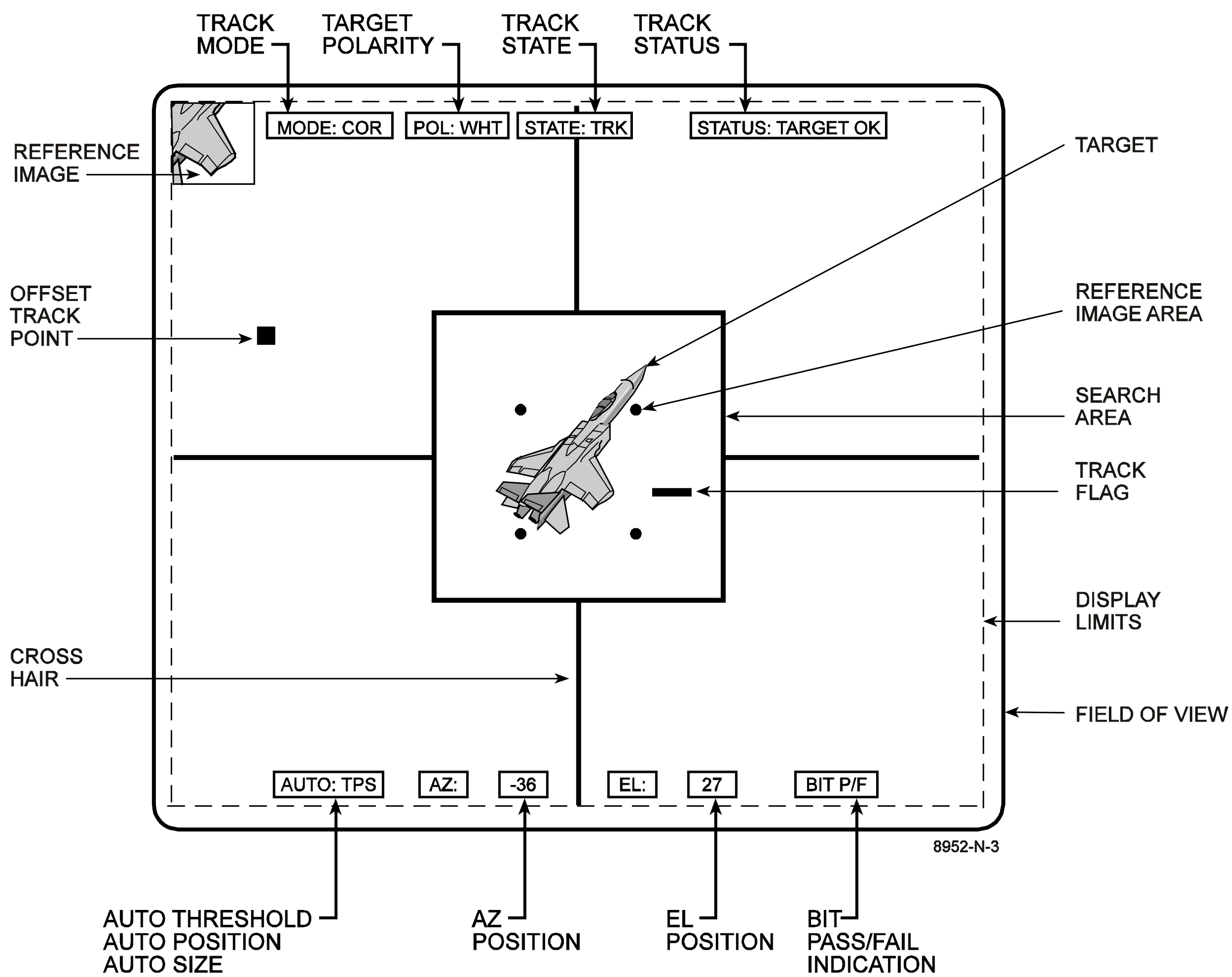

Figure C3.6. Standard Annotation

C3.2.3 User Defined Strings Tab

The ***User Defined Strings*** tab (Figure C3.7) provides a method of adding additional ASCII text to the video overlay. The specified characters are displayed on one of the 31 possible character rows, beginning on one of 63 possible character locations across the video field of view. Writing space characters over previously annotated strings will erase them.

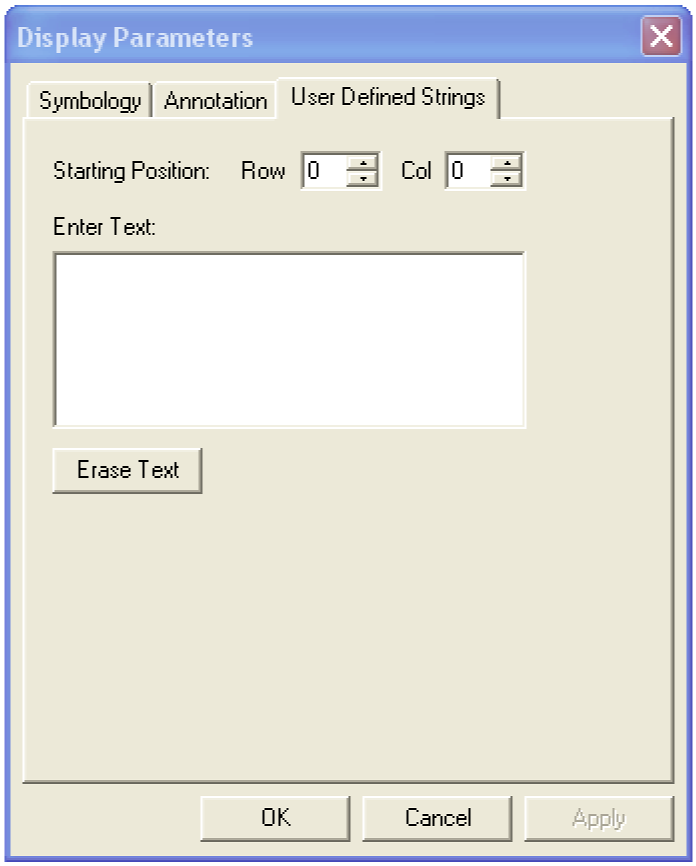

Figure C3.7. User Defined Strings Screen

C3.3 Track/Acquire Button

The ***Track/Acquire*** button brings up a tabbed dialog box. Each tab contains controls for a portion of the tracker's target acquisition and tracking functions. The tabs available under the ***Track/Acquire*** screen are ***MT (Multi-Target) Acquire***, ***MT Track***, ***MT General***, ***Coast***, ***ST (Single Target) Validation, Intrusion*** and ***Correlation***.

The ***MT General*** tab controls apply to all modes of operation when the multi-target hardware engine is enabled.

The ***MT Acquire*** tab controls configure functions used during multi-target Acquire mode. These parameters define the selection criteria for targets of interest. When ***Enable Multi-Target Acquire*** is disabled, the tracker is in single target mode and acquisition parameters are defined by the Run-Time Controls. When ***Enable Multi-Target Acquire*** is enabled, the tracker's multi-target engine is enabled and acquire parameters set under the ***MT Acquire*** and ***MT Track*** tab will be used.

The ***MT Track*** tab enables or disables use of the multi-target engine when in Track mode. If ***Enable Multi-Target Track*** is disabled, the tracker will transition into single target mode when entering Track mode. If ***Enable Multi-Target Track*** is enabled, the tracker will stay in multi-target mode when entering Track mode.

C3.3.1 MT Acquire Tab

The ***MT Acquire*** tab (Figure C3.8) of the Track/Acquire Parameters dialog contains all the acquisition parameters to filter and prioritize up to ten (10) potential targets.

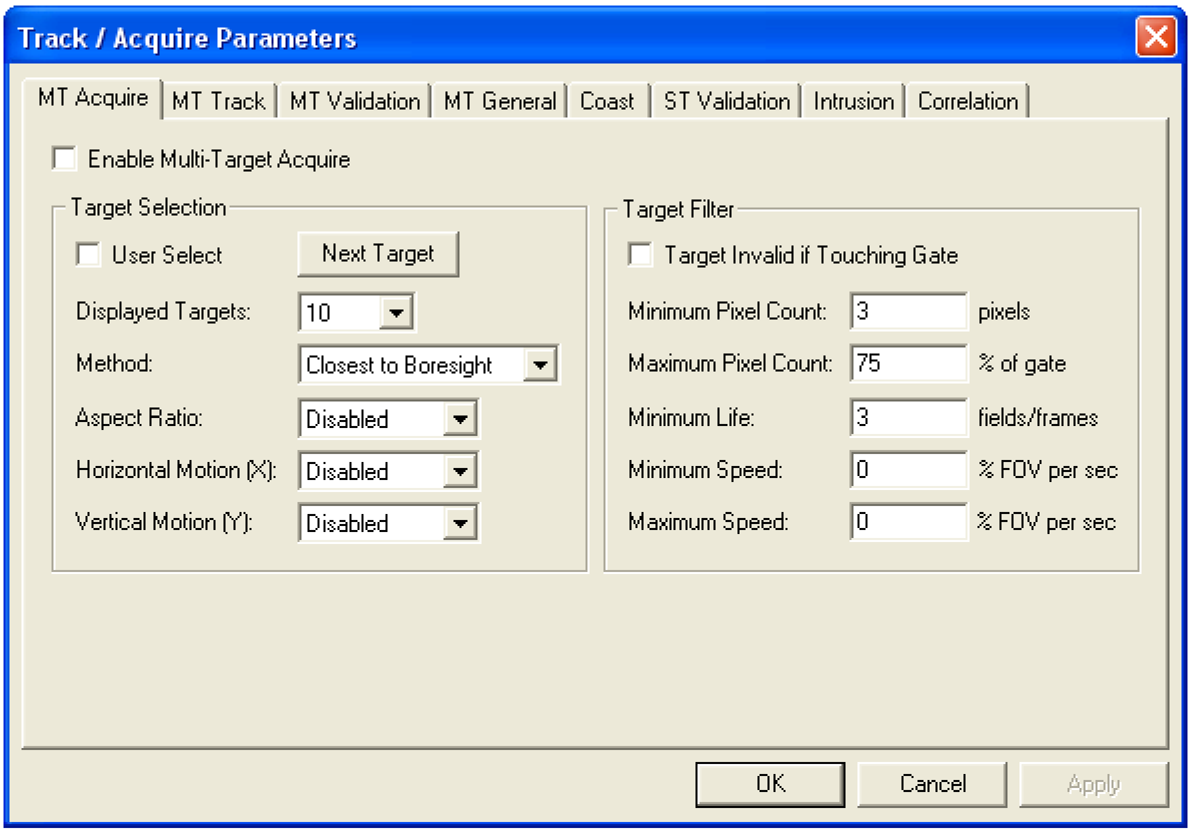

Figure C3.8. MT Acquire Control Screen

C3.3.1.1 Enable Multi-Target Acquire

When checked, the ***Enable Multi-Target Acquire*** checkbox enables the tracker's multi-target acquisition engine.

C3.3.1.2 Target Selection

The Target Selection group of parameters defines the desired characteristics of the intended targets.

The ***User Select*** checkbox works in conjunction with the ***Next Target*** button. These controls allow the user to sequence through the onscreen acquired targets, and select the target of interest. Each detected target will be marked with a graphical crosshair with the primary target's crosshair flashing. Using the ***Next Target*** button the user may visually sequence through the detected targets until the flashing crosshair resides on the desired target of interest. This will be the primary target chosen for tracking.

The ***Displayed Targets*** drop down list controls the maximum number of targets to be considered and is configurable from 1 to 10 targets. This will be the maximum number of valid targets marked with crosshairs during acquisition.

The ***Method*** selection dropdown list defines which of the detections are considered targets based on the characteristic of position, size or speed, and includes ***Closest to Boresight***, ***Closest to Gate***, ***Largest*** in size, ***Fastest*** moving, ***Slowest*** moving, ***Brightest*** and ***Darkest***.

The target ***Aspect Ratio*** may also be used in target selection. This characteristic may be set to either ***Disabled***, ***Square*** targets, ***Tall*** targets or ***Long*** targets.

Target Selection based on motion may be further defined in terms of direction-of-motion, both in the horizontal and vertical domains. ***Horizontal Motion (X)*** may be defined as ***Disabled***, moving from right to ***Left***, or moving from left to ***Right***. Likewise ***Vertical Motion (Y)*** may be defined as ***Disabled***, moving ***Up*** or moving ***Down*** through the field-of-view.

C3.3.1.3 Target Filter

The Target Filter group of parameters defines the target rejection criteria. Targets may be rejected based on their size in terms of ***Minimum Pixel Count*** and ***Maximum Pixel Count*** (as % of gate), by their age in terms of ***Minimum Life*** (in fields or frames), by their apparent speed through the field-of-view as defined by ***Minimum Speed*** (% FOV per sec) or ***Maximum Speed*** (% FOV per sec), or by their position in the gate as selected by ***Target Invalid If Touching Gate***. Potential targets not meeting the filter parameters will be rejected and will not be considered by the target selection criteria to be marked as valid targets.

C3.3.1.4 Apply and OK Buttons

Multi-Target parameters are updated and sent to the tracker upon clicking the ***Apply*** or ***OK*** button.

C3.3.2 MT Track Tab

The ***MT Track*** tab (Figure C3.9) of the Track/Acquire Parameters dialog enables or disables the tracker's multi-target engine during track mode.

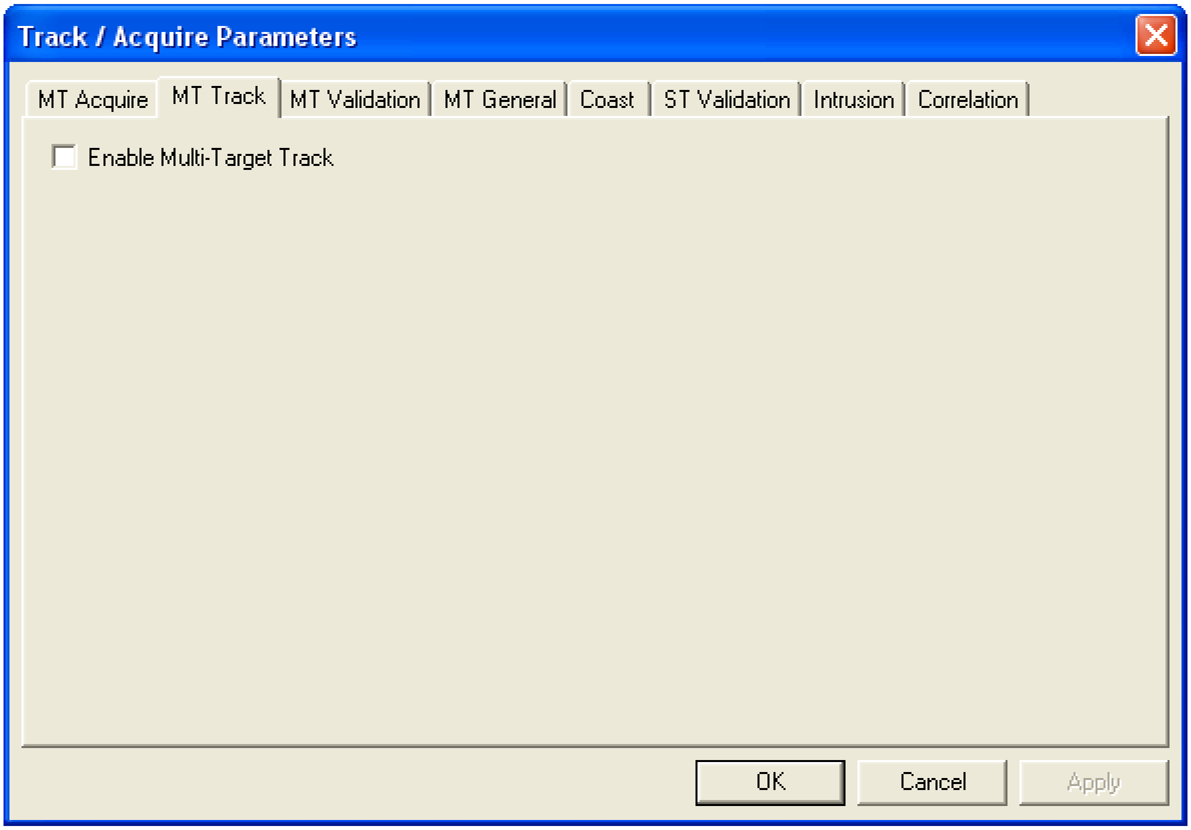

Figure C3.9. MT Track Control Screen

If ***Enable Multi-Target Track*** is unselected, the tracker will transition into single target mode during track. If selected, the multi-target engine will continue to be used during track mode. Using the multi-target engine during track will provide better clutter rejection tolerance, however it may also result in loss of track if the target undergoes rapid changes in size and/or position.

C3.3.3 MT Validation

The ***MT Validation*** tab (Figure C3.10) contains the controls for setting the tracker's multi-target validation parameters.

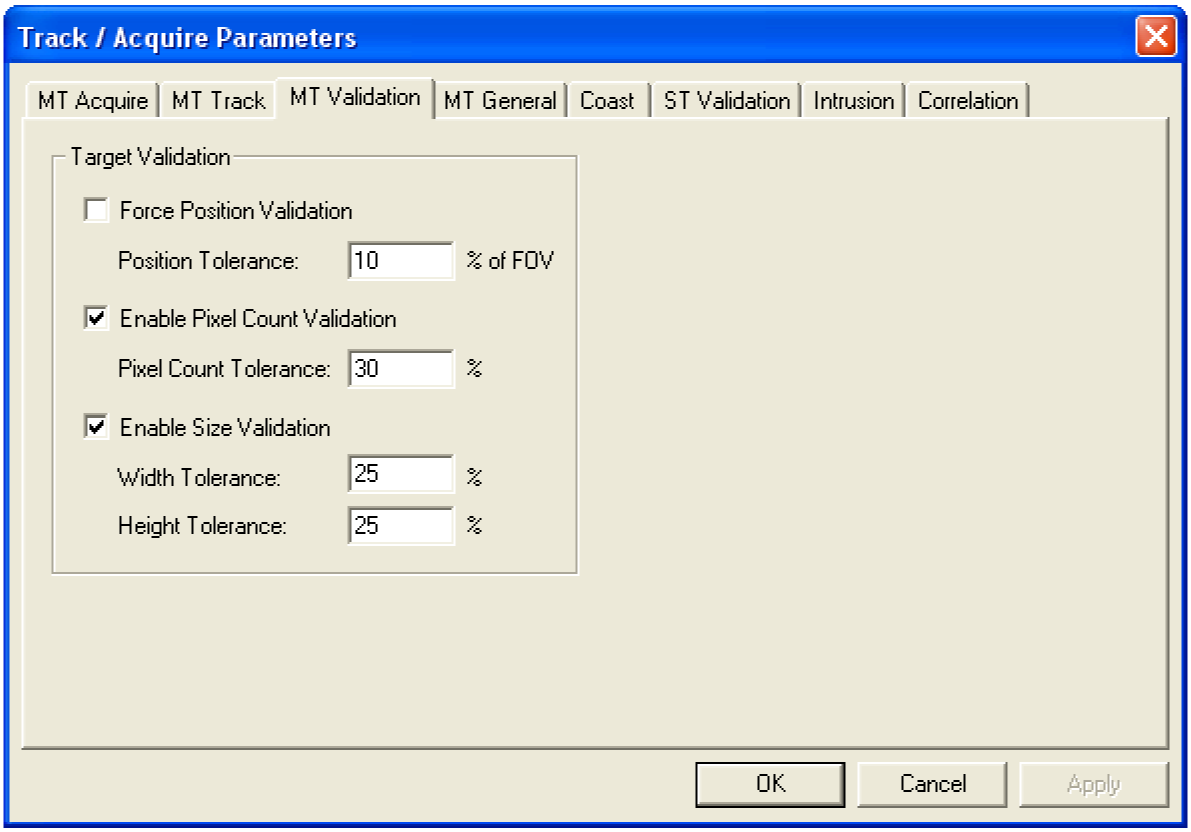

Figure C3.10. MT Validation Screen

C3.3.3.1 Target Validation

Check the ***Force Position Validation*** checkbox to always perform the position validation test even when there are only a few targets detected. Typically, this test is disabled if the target count is low and only enabled when more targets are detected in order to reduce processing time.

The ***Position Tolerance*** field sets the allowable instantaneous target position movement as a percentage of the total field-of-view.

When the ***Enable Pixel Count Validation*** checkbox is checked, the tracker will not match a target if the number of pixels contained within the potential target deviates by more than a set tolerance.

The ***Pixel Count Tolerance*** field sets the allowable match deviation as a percentage of the last known target pixel count.

When the ***Enable Size Validation*** checkbox is checked, the tracker will not match a target if the width and height of the potential target deviates by more than a set tolerance.

The ***Width Tolerance*** and ***Height Tolerance*** fields set the allowable match deviation as a percentage of the last known target width (pixels) and height (lines).

C3.3.4 MT General Tab

The ***MT General*** tab (Figure C3.11) of the Track/Acquire Parameters dialog configures the Target Pre-filter parameters.

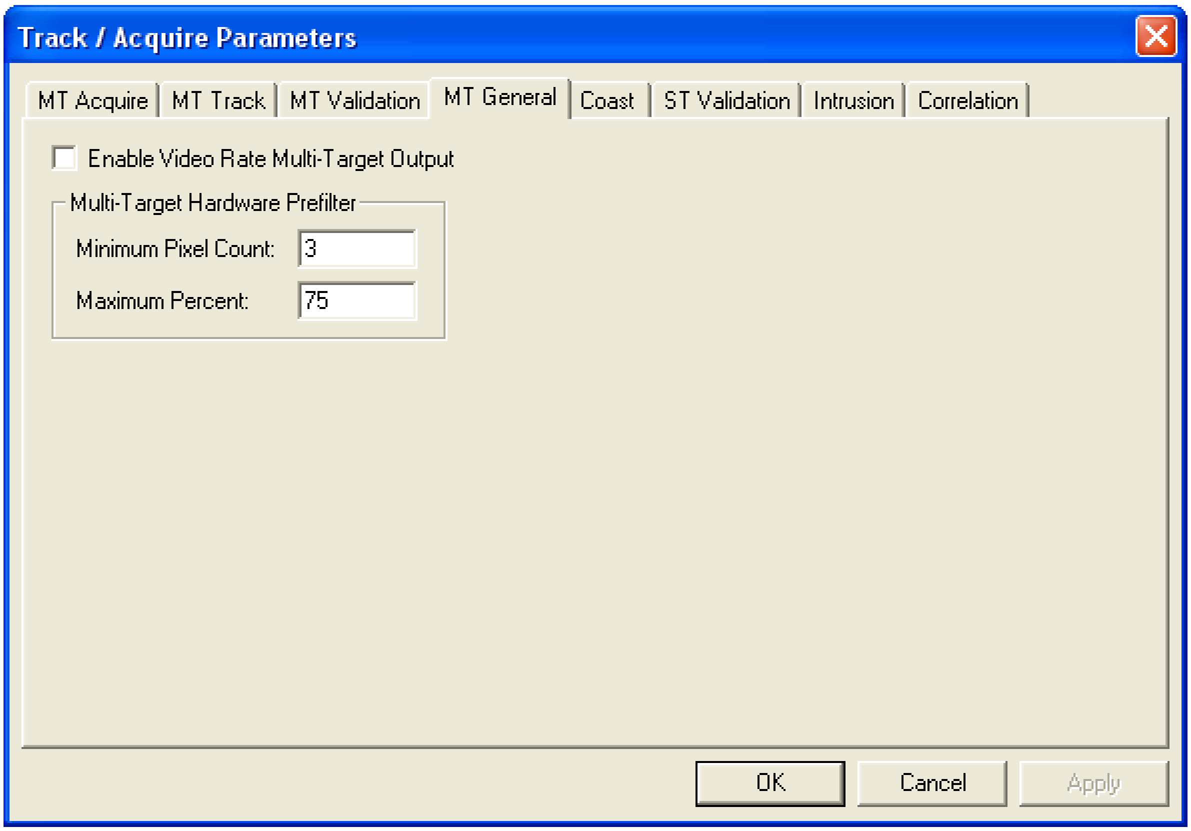

Figure C3.11. MT General Control Screen

C3.3.4.1 Enable Video Rate Multi-Target Output

When the ***Enable Video Rate Multi-Target Output*** checkbox is checked, the tracker will send multi-target data messages to the host at video field/frame rate (typically 50 or 60 Hz).

C3.3.4.2 Multi-Target Hardware Prefilter

These are low level hardware parameters which filter targets before they are transferred to the software multi-target engine. Filtering objects out at this level reduces the load on the software engine. The ***Minimum Pixel Count*** sets the lower size limit for potential targets, whereas ***Maximum Percent*** sets the upper size limit, as a percent of field-of-view. Potential targets falling outside these limits are rejected.

C3.3.5 Coast Tab

The ***Coast*** tab (Figure C3.12) contains the controls for setting tracker parameters used in Coast mode.

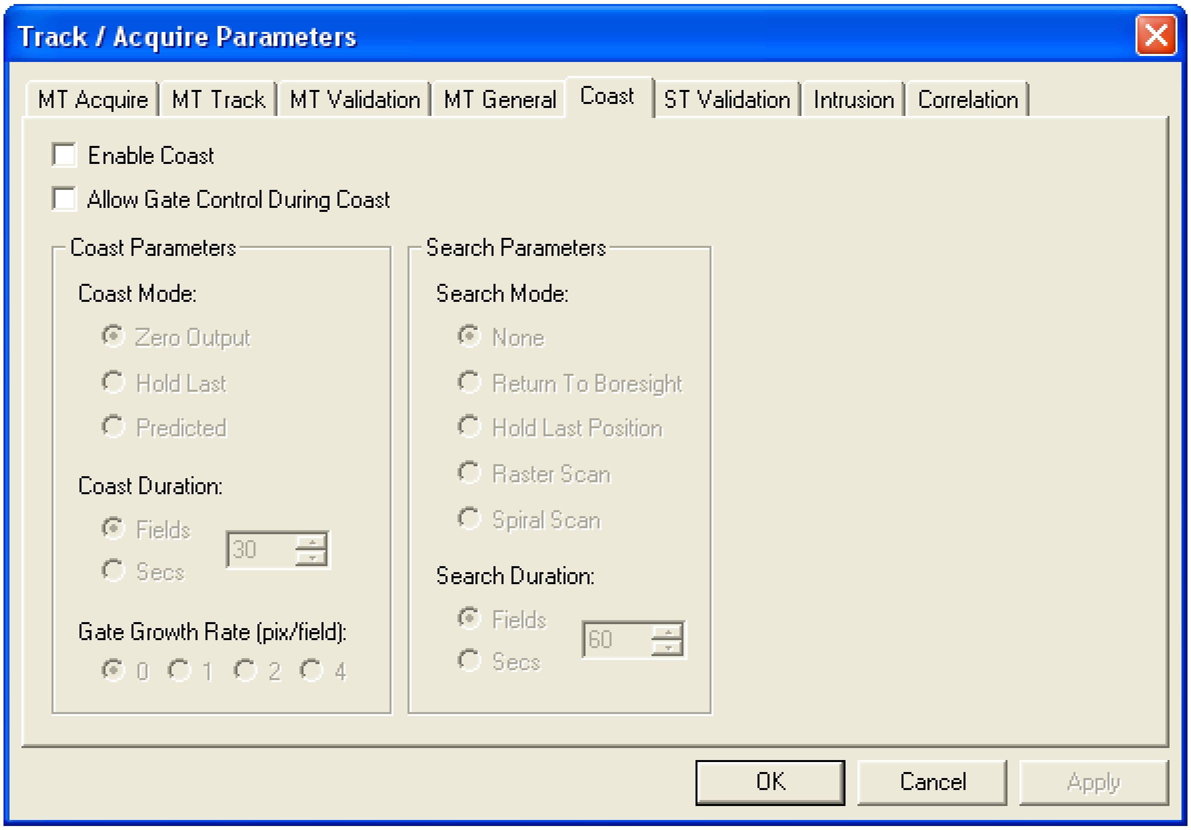

Figure C3.12. Coast Control Screen

C3.3.5.1 Enable Coast

When the ***Enable Coast*** checkbox is checked, if the tracker is in track mode and the target is lost, the tracker will enter coast mode and attempt to recover the target. Threshold levels are maintained and the target's history is used in the attempt to identify the target. If the target is not identified within the set duration, the tracker will use the specified search mode to try to locate the target or return to the selected acquire mode.

C3.3.5.2 Allow Gate Control During Coast

When the ***Allow Gate Control During Coast*** checkbox is checked, the tracker will allow the host to position the gate during coast using the run-time control message. This is typically only useful for custom applications where the controlling system has additional knowledge of the target location or predicted location in the video scene.

C3.3.5.3 Coast Parameters

C3.3.5.3.1 Coast Mode

Radio buttons are used to select the desired ***Coast Mode***.

If ***Zero Output*** is selected, when the tracker enters coast mode, the track error output will contain (0,0) until track is recovered. This mode indicates no error/drive to the mount during coast.

If ***Hold Last*** is selected, when the tracker enters coast mode, the track error output will remain the same as it was on the last field of valid data. This mode continues the same error/drive to the mount as was given on the last sight of the target.

If ***Predicted*** is selected, when the tracker enters coast mode, the tracker will output errors based upon where the target is predicted to be. This prediction is based upon the target's past motion.

C3.3.5.3.2 Coast Duration

The ***Coast Duration*** determines how many fields or seconds the tracker will remain in coast. If a target is found, the tracker will return to track mode. If the target is not found in the specified time, the tracker will go off track, or to auto acquire if it is enabled. Target speed and mount stability are determining factors in the selection of Coast Duration time.

C3.3.5.3.3 Coast Growth Rate

The ***Coast Growth Rate*** defines how quickly the track gate will grow in size while the tracker is in coast mode. The setting specifies the number of pixels and lines per field that the gate will grow. If a growth rate of zero is selected, the gate will not grow during coast. This feature can be useful for locating a lost target that is near, but outside, the gate.

C3.3.5.4 Search Parameters

C3.3.5.4.1 Search Mode

Radio buttons are used to select the desired Search Mode.

Select ***None*** to disable the search feature.

When ***Return to Boresight*** is selected, the track gate will be positioned at the Line Of Sight (LOS) when coast times out.

When ***Hold Last Position*** is selected, the track gate will remain at the last valid position when coast times out.

When ***Raster Scan*** is selected, when coast times out, the track gate will begin at the upper left and scan across the video, from the top down, attempting to locate the target.

When ***Spiral Scan*** is selected, when coast times out, the track gate will begin at the last valid target location and scan around the video, an increasing distance from the starting point, attempting to locate the target. If the gate fails to locate a target before reaching the edge of the field of view, it will return to the starting point and try again.

C3.3.5.4.2 Search Duration

The ***Search Duration*** determines how many fields or seconds the tracker will remain in search mode. If a target is found, the tracker will return to track mode. If the target is not found within the specified time, the tracker will go off track, or to auto acquire if it is enabled. If the search duration is zero, then the tracker will stay in search mode until the target is found or until commanded into Acquire.

C3.3.6 ST Validation Tab

The ***ST Validation*** tab (Figure C3.13) contains the controls for setting the tracker's single target validation parameters.

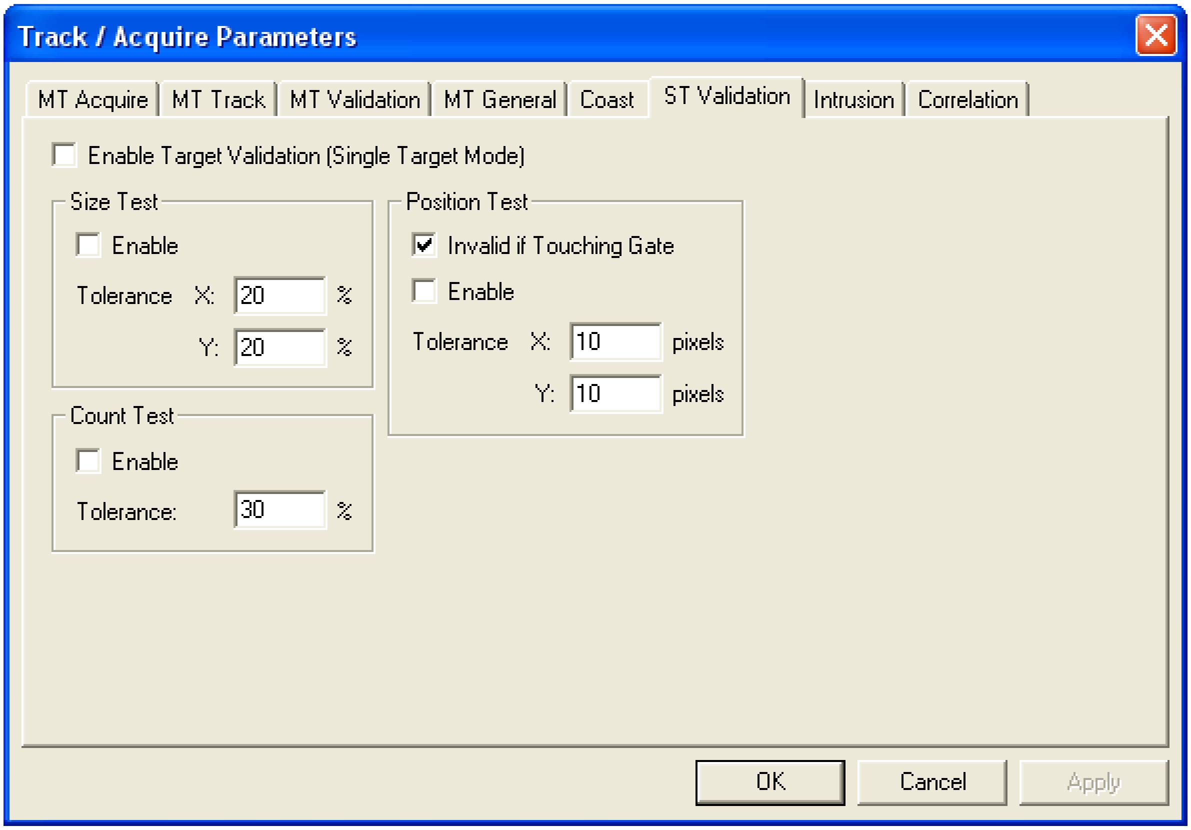

Figure C3.13. Validation Control Screen

When ***Enable Target Validation (Single Target Mode)*** is selected, the tracker will monitor the target during track mode for deviation from the target's history profile in order to break track lock or enter coast mode until the target is recovered. This option is typically enabled when coast mode is enabled in order to detect loss or obscuration of the target.

C3.3.6.1 Size Test

C3.3.6.1.1 Enable

When target ***Enable Size Test*** is checked, the tracker will cause a loss of track if the target size changes more than a user-defined amount from one field to the next.

C3.3.6.1.2 Tolerance

The ***Tolerance*** in the X and Y direction are entered as percentages of the target size.

C3.3.6.2 Position Test

C3.3.6.2.1 Invalid If Touching Gate

When the ***Invalid If Touching Gate*** checkbox is checked, the tracker will cause a loss of track if the target touches one or more of the gate edges.

C3.3.6.2.2 Enable

When target ***Enable Position Test*** is checked, the tracker will cause a loss of track if the target position changes more than a user-defined amount from one field to the next.

C3.3.6.2.3 Tolerance

The ***Tolerance*** in the X and Y direction are entered as the number of pixels. One reason this test may be used, is to watch for foreign objects entering the track gate and affecting the track point.

C3.3.6.3 Count Test

C3.3.6.3.1 Enable

When target ***Enable Count Test*** is checked, the tracker will cause a loss of track if the number of pixels contained within the target changes more than a user-defined amount from one field to the next.

C3.3.6.3.2 Tolerance

The ***Tolerance*** is entered as a percentage of the number of pixels contained within the target.

C3.3.7 Intrusion Tab

The ***Intrusion*** tab (Figure C3.14) contains the controls for setup of the tracker's intrusion detection function.

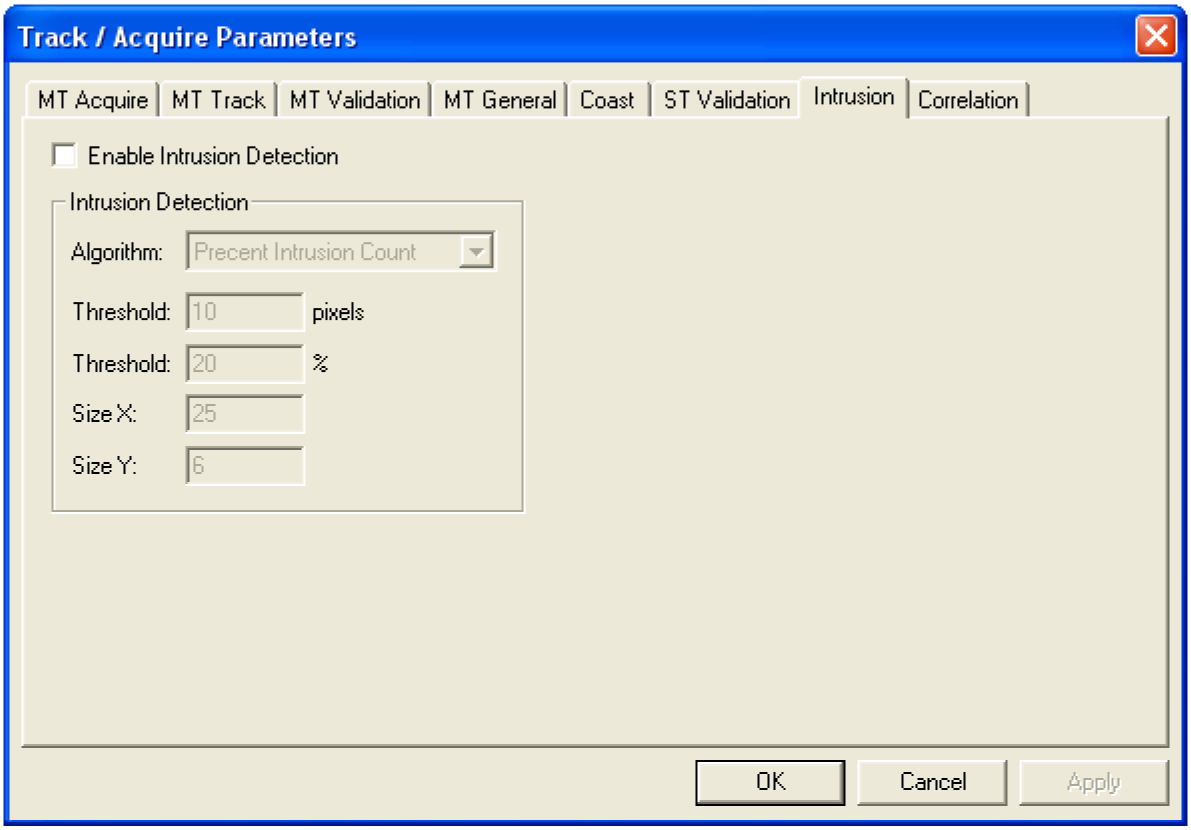

Figure C3.14. Intrusion Control Screen

C3.3.7.1 Enable Intrusion Detection

When the ***Enable Intrusion Detection*** checkbox is checked, the tracker will transition into coast mode whenever an intrusion is detected. An intrusion is detected when the area directly outside the gate region contains target data (ie-pixel intensities which match the currently thresholded target) that meets the criteria of the selected intrusion detection ***Algorithm***. The tracker will be allowed to transition out of coast mode when the intrusion condition is no longer detected. Coast (***Reference Section C3.3.5***) should be enabled and configured when using this function.

C3.3.7.2 Intrusion Detection Parameters

There are three algorithm choices for intrusion detection; Intrusion Pixel Count, Percent Intrusion Count and Percent Target Count.

C3.3.7.2.1 Intrusion Pixel Count

The ***Intrusion Pixel Count*** algorithm allows the user to specify the minimum number of pixels in the intrusion gate that must meet the target threshold criteria in order for the tracker to declare an intrusion detect condition. The value is in number of pixels and is entered into the ***Threshold (pixels)*** box.

C3.3.7.2.2 Percent Intrusion Count

The ***Percent Intrusion Count*** algorithm allows the user to specify the minimum number of pixels in the intrusion gate that must meet the target threshold criteria needed to declare an intrusion detect condition. The minimum number of pixels is expressed as a percentage of the overall intrusion gate area that must meet the target threshold criteria and is entered into the ***Threshold %*** box.

C3.3.7.2.3 Percent Target Count

The ***Percent Target Count*** algorithm allows the user to specify the minimum number of pixels in the intrusion gate that must meet the target threshold criteria needed to declare an intrusion detect condition. The minimum number of pixels is expressed as a percentage of the current target pixel count that must meet the target threshold criteria and is entered into the ***Threshold %*** box.

C3.3.8 Correlation Tab

The ***Correlation*** tab (Figure C3.15) contains the controls for setting the tracker's parameters used in Correlation mode.

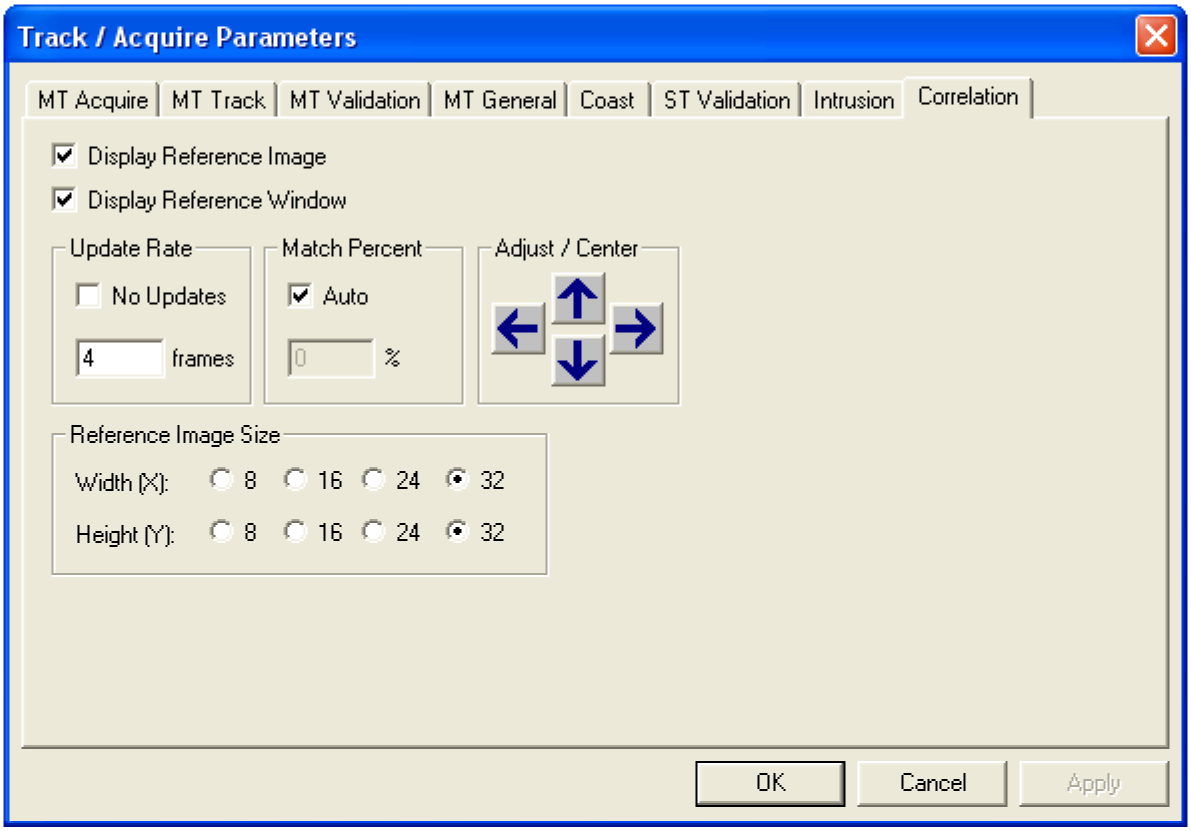

Figure C3.15. Correlation Control Screen

C3.3.8.1 Display Reference Controls

There are checkboxes on the ***Correlation*** tab for ***Display Reference Image*** and ***Display Reference Window***. These controls determine whether or not the Reference Image and/or Reference Window are displayed. They do not directly affect the correlation track process. Both of these display options are normally left enabled.

The Reference Image is the image that is being tracked. This display indicates what the target is. The Reference Image is displayed over the live video image, normally in a corner. The position of the Reference Image is configurable. ***Reference Section C3.5.1***.

The Reference Window is four dots that are displayed during acquire mode. They are located inside the search area rectangle. They indicate what portion of the search area is to be captured for use as a reference image. The size of the Reference Window is the same as the reference image size and will change with reference image size selections.

C3.3.8.2 Reference Image Size

The ***Reference Image Size*** values define the size of the reference image that becomes the target during correlation track. The default size is 32 x 32. Other size settings may be useful in eliminating background from the reference image. Background around your desired target inside the reference image causes the tracker to attempt to match the background as part of the target. As the target moves against the background, the correlation match value will be diminished due to changes in the background. This may lead to loss of track so the reference image should be sized appropriately to minimize the problem.

C3.3.8.3 Update Rate

The ***Update Rate*** is the rate at which the reference image is updated. This feature allows the target to change and still maintain track. The number of frames between updates should be set based upon the rate at which the target may change. Higher update rates allow more change in the target, but also risk allowing more noise into the image. This noise could be video noise, atmospheric variations such as passing shadows, or foreign objects passing through the field of view. The default Update Rate is 4 frames. This means that every 4^{th} frame the reference image is recaptured based upon the best match location.

C3.3.8.4 Match Percent

The ***Match Percent*** selection defines how tightly the correlation match must be. The higher the percentage, the more closely the target must match the reference image to maintain track. ***Auto Match Percent*** is the default. It monitors the best match in the search area over time, setting its own match level.

C3.3.8.5 Adjust / Center

The ***Adjust / Center*** buttons allow for fine adjustment to the correlation aim point during track by shifting the reference image update location. These controls can be used to refine the track point as the target changes shape or aspect over time.

C3.4 Filter Parameters Button

The ***Filter Parameter*** control screen (Figure C3.16) provides the inputs used to control a digital filter and separate software-based custom Proportional Integral Derivative (PID) filter. See Figure C3.17 for a graphical representation of the PID Filter and its components as a control loop diagram. Additionally, there is a hardware PI filter available in the Vinten HS-2010ME mount which can operate independent of, or in series with, the software PID filter.

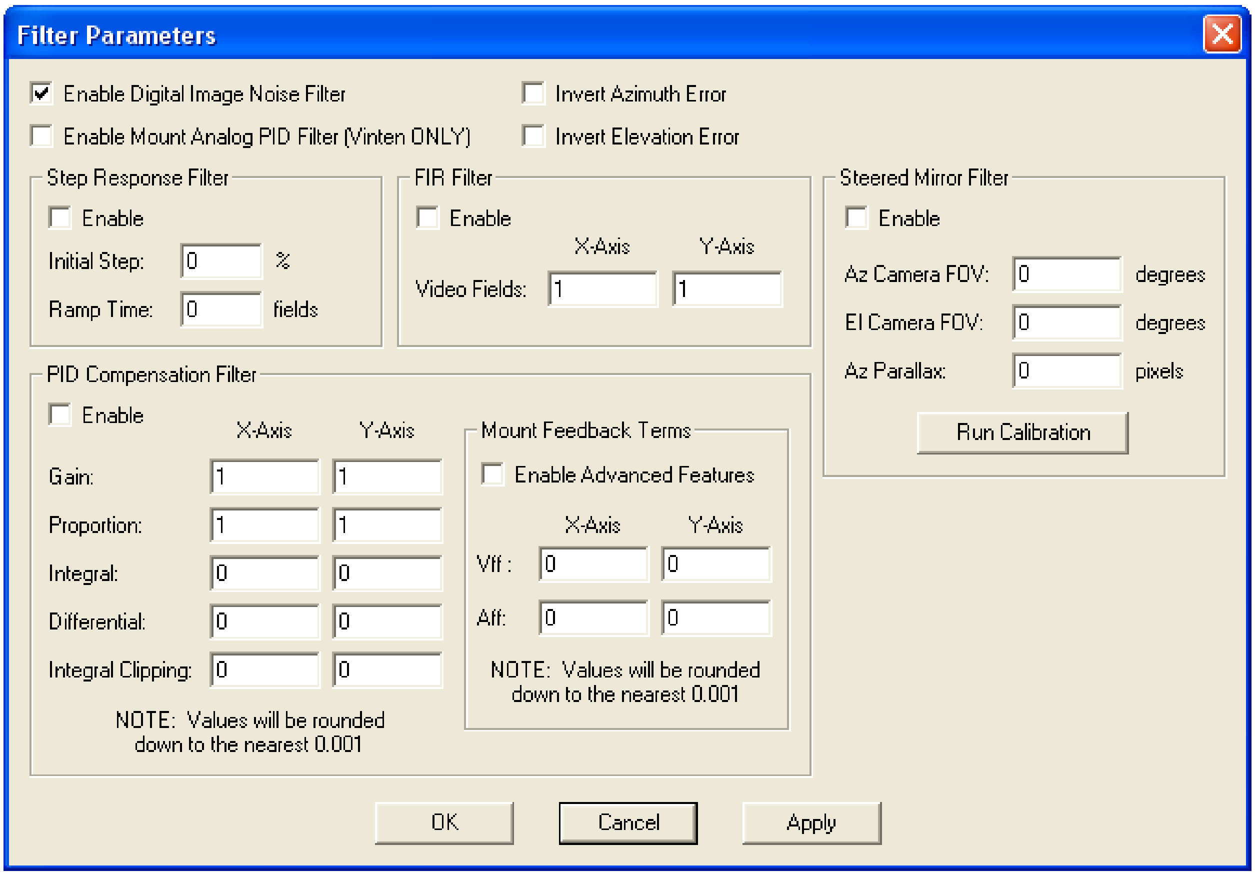

Figure C3.16. Filter Parameter Control Screen

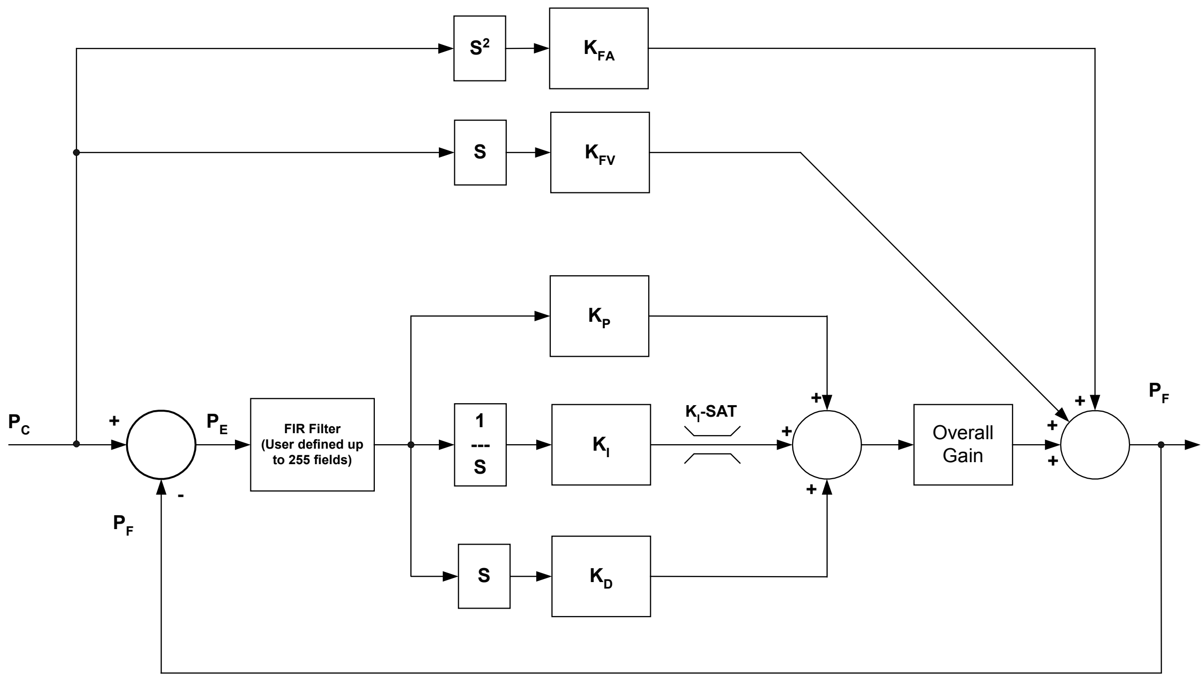

Figure C3.17. Filter Control Loop Diagram

C3.4.1 Enable Digital Image Noise Filter

This filter is used to filter out random noise from the video signal. When the digital filter is enabled, single pixels of thresholded video are not included as target data.

C3.4.2 Enable Mount Analog PI Filter

Checking this box will enable a hardware PI (proportion and integral) filter in the HS-2010ME mount. Note that this can be enabled in addition to the software PID filter described below for maximum user flexibility.

C3.4.3 Invert Azimuth Error

Checking this box will invert the polarity of the azimuth error signal.

C3.4.4 Invert Elevation Error

Checking this box will invert the polarity of the elevation error signal.

C3.4.5 Step Response Filter

The ***Enable Step Response Filter*** allows for smoothing of the instantaneous error signal when transitioning from acquire to track mode. The ***Initial Step*** is entered as a percentage of the initial raw error signal, with the remaining raw error distributed as a ***Ramp Time*** over a specific number of fields.

C3.4.6 Enable FIR Filter

Checking the ***Enable FIR Filter*** box will enable the software-based Finite Impulse Response (FIR) filter. This filter can be enabled/disabled independently of all other filters. The tracker applies the FIR filter prior to the track errors being input to the PID filter. The filter is effectively a moving average of a user-defined number of fields and acts as a low-pass filter. Use this filter with care as it will add latency into the system.

C3.4.6.1 Video Fields

The FIR filter can be up to 255 fields in depth and has unique values for both the X and Y-axis. Filter length is dependant upon the target's speed; for fast-moving targets, a filter length greater than several fields may lead to system instability. The default value is one (1) field.

C3.4.7 Enable PID Compensation Filter

Checking the ***Enable PID Compensation Filter*** box will enable the software-based PID (proportion, integral and differential) filter. Note that this can be enabled in addition to the hardware PI filter located in the Vinten HS-2010ME mount. A description of the software PID filter parameters follows.

C3.4.7.1 Gain

The overall ***Gain*** is simply a multiplier applied to the output of the PID filter. Overall Gain may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X- and Y-axis. The default value is 1.0.

C3.4.7.2 Proportion

Proportion is a multiplier applied directly to the X and Y track errors. Increasing values of proportion will increase "stiffness" of the mount and decrease the response time of the mount. Values that are too large will cause overshoot and result in oscillation. Setting proportion to 1 results in unity gain of the track errors. Proportion may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X and Y-axis. The default value is 1.0.

C3.4.7.3 Integral

The ***Integral*** term is determined by summing all track errors over the duration of the track period. The integral term may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X- and Y-axis. The default value is 0.0.

C3.4.7.4 Differential

The ***Differential*** term is simply the difference between the current track error and the previous field's track error ($\Delta error / \Delta t$ with Δt equal to one field time). The derivative term may range from -32.768 to 32.767 in increments of 0.001 and has unique values for both X- and Y-axis. The default value is 0.0.

C3.4.7.5 Integral Clipping

The ***Integral Clipping*** term provides a hard limit to the ***Integral*** term to prevent saturation. The ***Integral Clipping*** term may range from 0.0 to 6553.5 in increments of 0.1. Note that clipping is applied to the absolute value of the integral term and does not affect the sign of the integral term.

C3.4.7.6 Enable Advanced Features

Checking the Enable Advanced Features box will do the following when mount position feedback is available:

- Clear the integration term on axis direction change.
- Preload the integration term when transitioning into track mode.

C3.4.7.7 Mount Velocity Feed-Forward (V_{ff})

The tracker acquires the mount position at the end of every field. The velocity is then determined and a portion may be added to the output of the PID filter. Typical values are small since the mount angle delta can be relatively large compared to the track error in pixels. The mount velocity feed-forward term may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X- and Y-axis. The default value is 0.0.

C3.4.7.8 Mount Acceleration Feed-Forward (A_{ff})

The mount acceleration is determined by using the mount velocity over the last four fields and can be added to the output of the PID filter. Typical values are small since the mount angle delta can be relatively large compared to the track error in pixels. The mount acceleration feed-forward term may range from –32.768 to 32.767 in increments of 0.001 and has unique values for both X- and Y-axis. The default value is 0.0.

C3.4.8 Enable Steered Mirror Filter (DEPRECATED)

The *Steered Mirror Filter* operations no longer supported.

C3.5 Configuration Button

The **Configuration Parameter** control screen contains twelve tabs. Each tab dialog contains a set of parameters that cover a portion of the configurable features of the tracker. Tracker configuration information may be set up and run for a single session or may be saved to flash where it will be loaded on power up or reset. The contents of the tabbed dialog screens are described below.

C3.5.1 Display Tab

The ***Display*** tab (Figure C3.18) provides control of reticle style, track flag style, correlation reference image position, annotation position and size, and track gate style.

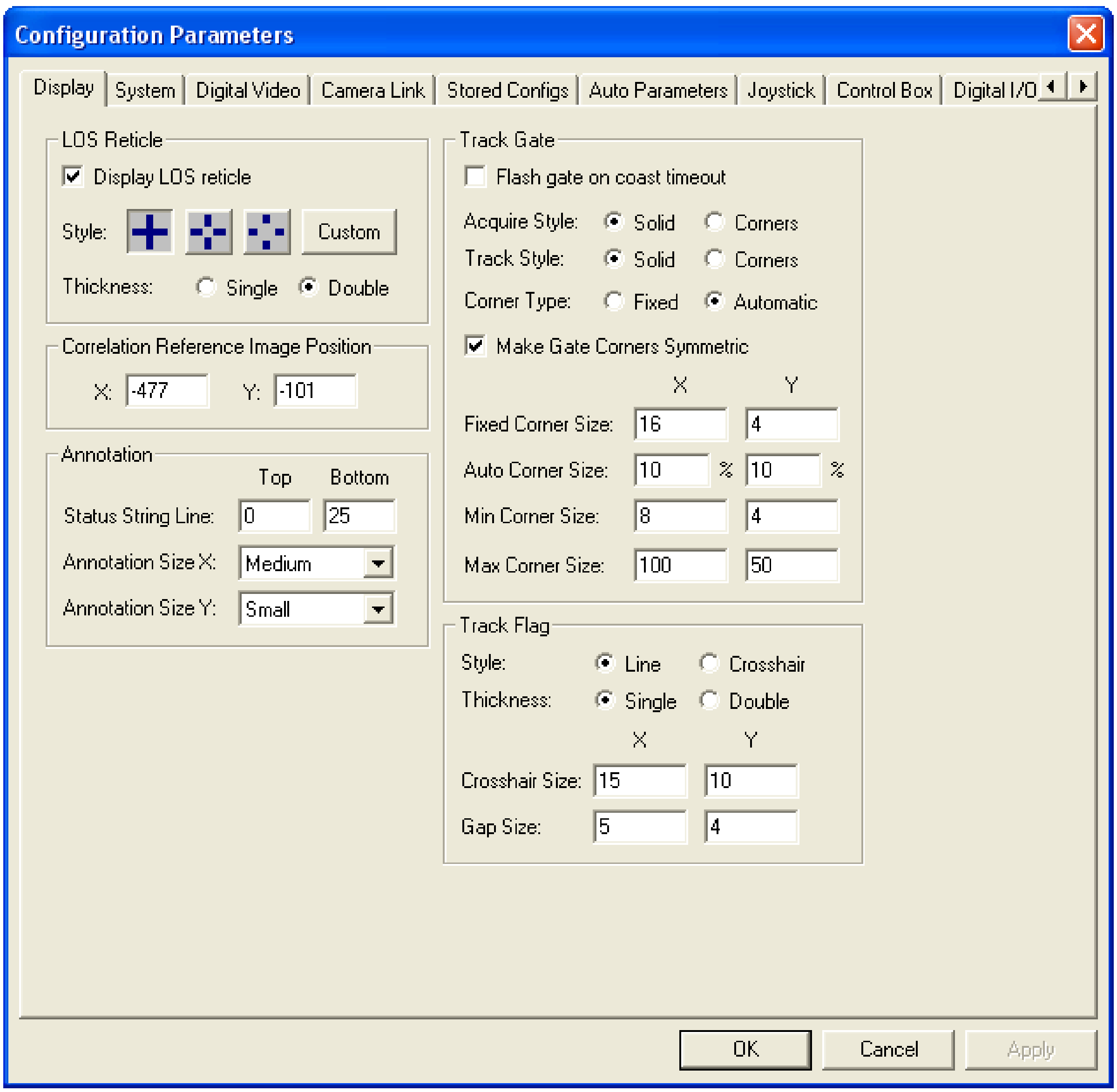

Figure C3.18. Display Configuration Screen

C3.5.1.1 LOS Reticle

Checking the ***Display LOS reticle*** checkbox will cause the tracker to display the reticle for configuration only. The reticle style can be selected by pressing one of the reticle style buttons. A custom reticle can also be configured, using the ***custom*** reticle button. Enable/Disable during operation is managed through the ***Display*** button on the Run-Time control screen.

C3.5.1.2 Track Gate

Checking the ***Flash gate on coast timeout*** checkbox will cause the tracker to flash the gate upon the timeout of the selected coast duration. If a search pattern is selected for auto acquire, the gate will be displayed to show the search, whether or not this box is checked. Different track gate styles can also be selected when in acquire and track modes. The track gate can be further customized by using the corner configuration fields.

C3.5.1.3 Correlation Reference Image Position

The ***Correlation Reference Image Position*** box allows the user to specify the position of the correlation reference image display. It can be used to move the image to a low-activity portion of the video field of view.

C3.5.1.4 Annotation

The position of the status line display can be controlled by setting the ***Top*** and ***Bottom*** locations. These values are in text lines/spaces and are dependent on annotation size. Annotation size can be selected by the ***Annotation X*** and ***Annotation Y*** drop down lists.

Top status string contains:

MODE: ▒▒ POL: ▒▒ STATE: ▒▒ STATUS: ▒▒▒

Bottom status string contains:

MTAZ: ▒▒ MTEL: ▒▒ (if a mount is present)

AZ: ▒▒ EL: ▒▒

where ▒ is the state of the tracker and mount.

C3.5.1.5 Track Flag

Track flag style and thickness can be selected. If using a crosshair as the track flag, the size and style of the crosshair can be customized using the ***Crosshair Size*** and ***Gap Size*** fields.

C3.5.2 System Tab

The ***System*** tab (Figure C3.19) contains configuration parameters that affect the whole system.

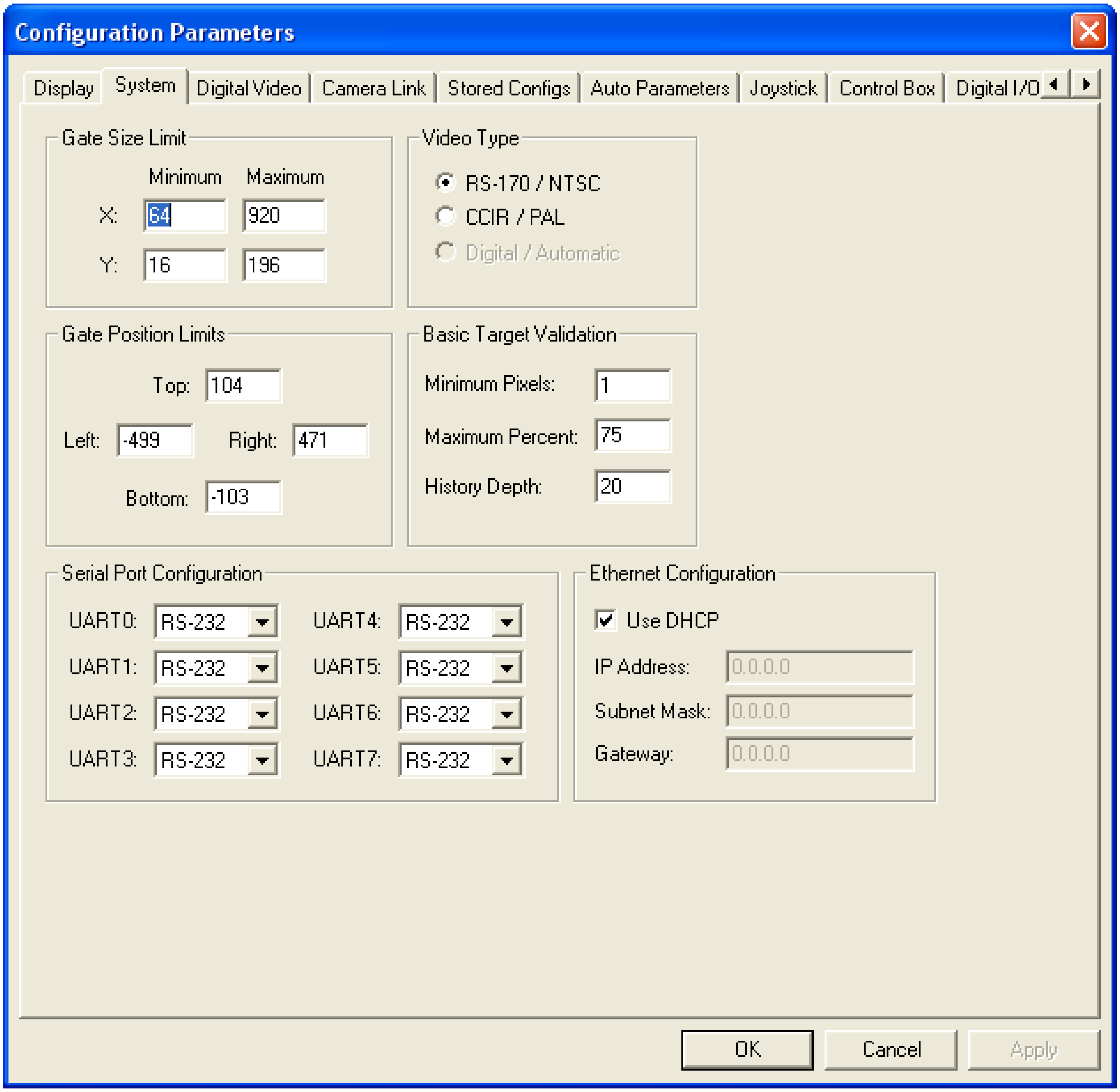

Figure C3.19. System Configuration Screen

C3.5.2.1 Gate Size Limit Configuration

The ***Minimum Gate Size Limit*** controls how small the gate may be sized in manual mode and how small it could get while in auto size mode. This feature can be used to prevent the gate from sizing down onto non-target or partial target features and missing the target.

The ***Maximum Gate Size Limit*** controls how large the gate may be sized in manual mode and how large it could get while in auto size mode. This feature can be used to prevent the gate from sizing up onto non-target or background features and losing the target.

C3.5.2.2 Gate Position Limit Configuration

The ***Gate Position Limits*** allow the user to limit the portions of the field of view where the gate will be allowed. This feature can be used to prevent the gate from auto positioning and tracking on stationary objects (e.g., a text overlay) that are not of interest.

C3.5.2.3 Video Type Configuration

The ***Video Type*** radio buttons allow the user to configure the tracker to process RS-170/NTSC (60Hz), CCIR/PAL video (50Hz), or digital video.

C3.5.2.4 Basic Target Validation

The ***Basic Target Validation*** controls allow the user to set a minimum and maximum target size for the tracker to consider an object a valid target. The ***Minimum Pixels*** control sets the minimum number of threshold pixels an object must occupy within the gate to be considered a valid target. The default is 1 pixel. The ***Maximum Percent*** is the maximum percentage of pixels within the gate that an object may occupy to be considered a valid target. The default is 75% of the gate area.

History Depth controls the depth of the target history queue used to calculate target statistics. This parameter is used to control the response (ie-how fast/slow the target can change) for target validation.

C3.5.2.5 Serial Port Configuration

The ***Serial Port Configuration*** allows the user to set the type of the seven UARTS to either RS-232 or RS-422.

C3.5.2.6 Ethernet Configuration

The ***Ethernet Configuration*** allows the user to setup the Ethernet configuration of the tracker. By default, the tracker uses DHCP to obtain IP address information. Changes are not dynamic. Any modifications to the Ethernet configuration must be applied, saved to flash (Bank 0) and the tracker must be reset or power cycled before taking effect.

C3.5.3 Digital Video Tab

The ***Digital Video*** tab (Figure C3.20) provides status feedback on the currently selected digital video input.

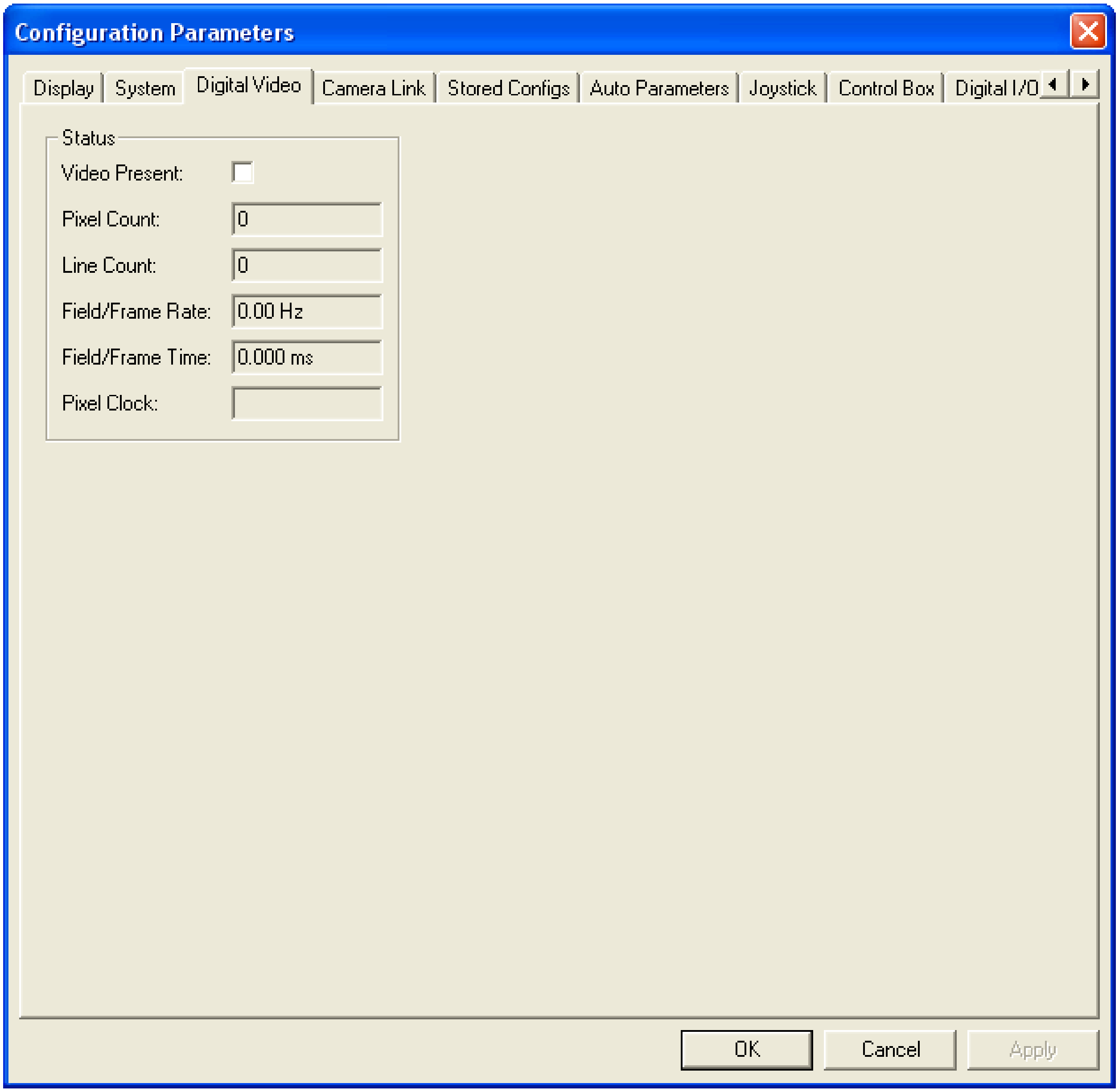

Figure C3.20. Digital Video Status Screen

C3.5.3.1 Status

The ***Video Present*** box is checked when digital video is detected.

The ***Pixel Count*** field shows the number of pixels per line detected.

The ***Line Count*** field shows the number of lines per field/frame detected.

The ***Field/Frame Rate*** field shows the video update/refresh rate in Hz.

The ***Field/Frame Time*** field shows the video update/refresh period in milliseconds.

The ***Pixel Clock*** field shows the video pixel clock rate in MHz.

C3.5.4 Camera Link Tab

The ***Camera Link*** tab (Figure C3.21) provides facilities for the user to setup the Camera Link digital video interface. This tab will only appear for tracker boards which support this interface.

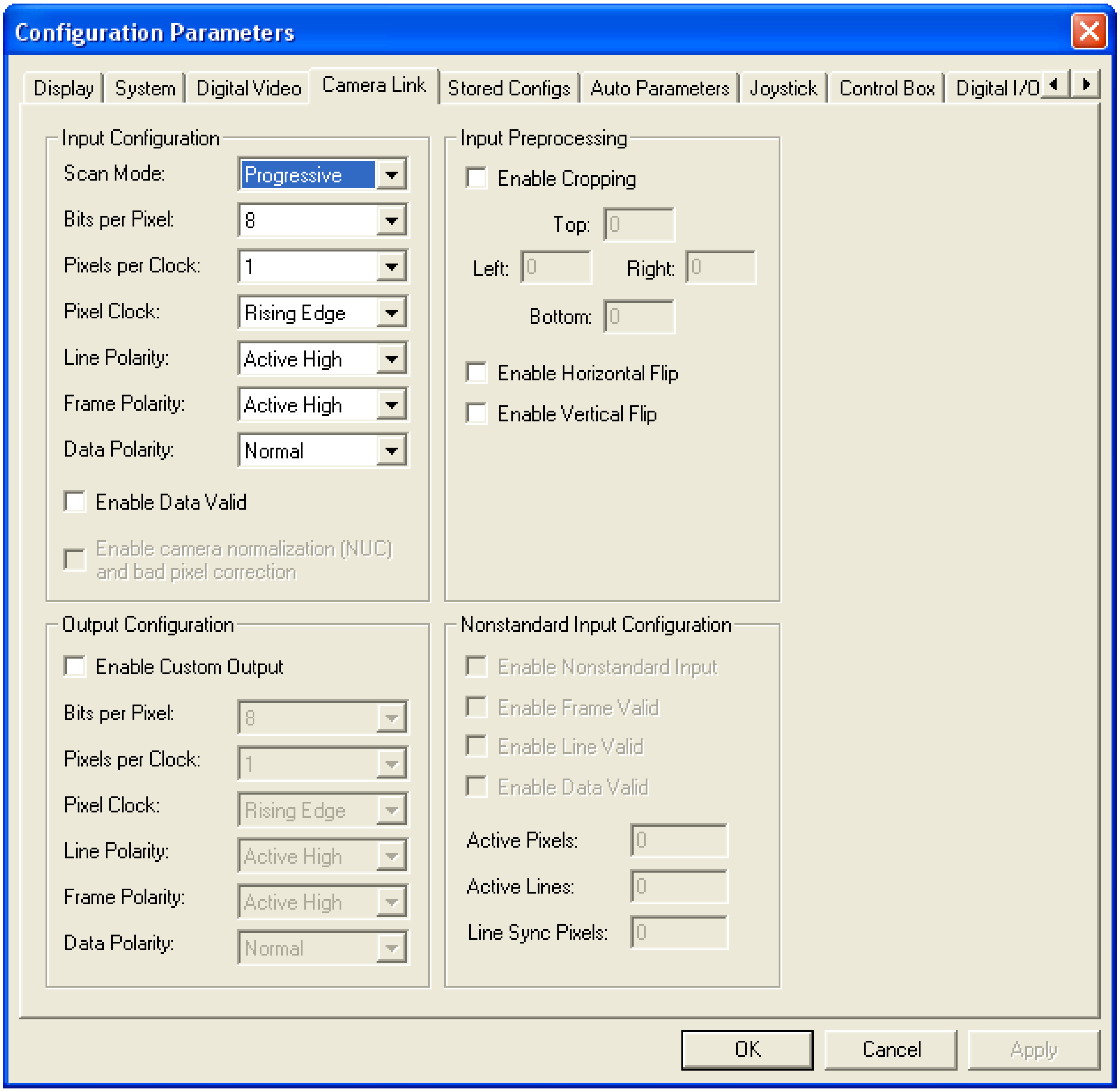

Figure C3.21. Camera Link Configuration Screen

C3.5.4.1 Input Configuration

The controls in this section are used to configure the Camera Link digital video input to match the connected camera's output specification. Typically, only the ***Bits per Pixel*** and ***Pixels per Clock*** fields are modified. Camera output can vary greatly, so please contact E-O Imaging customer support for assistance on configuration of these parameters.

C3.5.4.2 Output Configuration

When a camera has a very uncommon and/or non-standard video output, it may be desirable or necessary to modify the output signaling. The controls in this section are used on an application specific basis. Please contact E-O Imaging customer support if you may need this functionality.

C3.5.4.3 Input Preprocessing

The input video source can be cropped to remove unused or black columns and rows. Enabling cropping will result in a video output signal which does not match the original camera video input signal. The input video may also be flipped horizontally and/or vertically to compensate for different camera orientations.

C3.5.4.4 Nonstandard Input Configuration

The controls in this section are not currently supported.

C3.5.5 Stored Configs Tab

The ***Stored Configs*** tab (Figure C3.22) provides facilities for the user to ***Save***, ***Load***, and ***Clear*** to default any of ten (10) configurations stored in FLASH memory. The tracker also allows the user to define which configuration in FLASH to load during the next hardware/software reset or power-up.

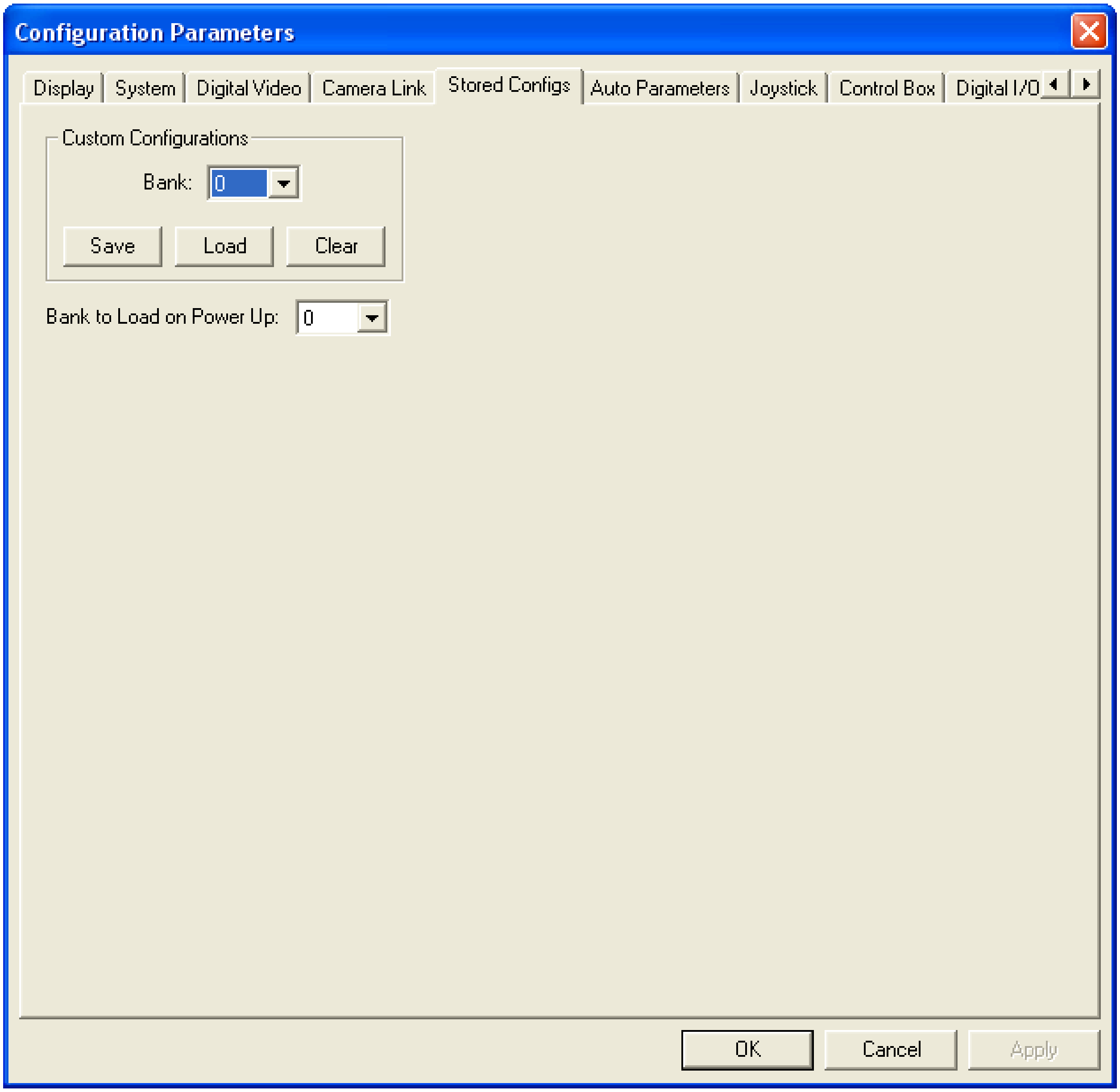

Figure C3.22. Stored Configurations Screen

C3.5.5.1 Custom Configurations

C3.5.5.1.1 Bank

The user can ***Save***, ***Load***, and ***Clear*** to default, any of ten (10) configurations stored in FLASH memory.

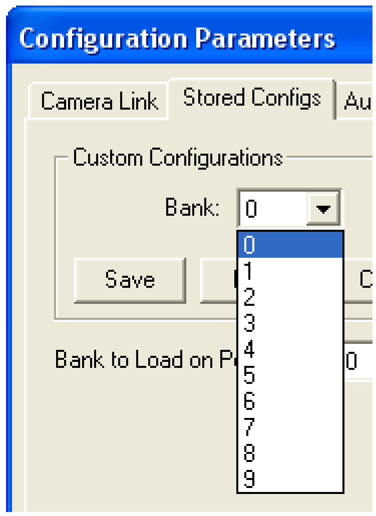

Figure C3.23. Bank Selection

C3.5.5.1.2 Save Button

Pressing the ***Save*** button will store the current tracker configuration to the selected ***Bank*** of FLASH memory. Up to ten configurations can be stored in FLASH. All user definable variables are stored in FLASH when ***Save*** is pressed. Additionally, the current focus setting for each field-of-view of the Indigo Tri-Field-Of-View camera (if installed) is also stored in FLASH.

C3.5.5.1.3 Load Button

Pressing the ***Load*** button will load the tracker with the configuration stored in the selected ***Bank*** of FLASH.

C3.5.5.1.4 Clear Button

Pressing the ***Clear*** button will set the configuration stored in the selected ***Bank*** of FLASH to default values. Note that other configurations stored in flash will be unaffected and the current state of the tracker will be unaffected.

C3.5.5.2 Bank To Load On Power UP

The tracker can load any one of ten (10) user-defined configurations upon power up or software/hardware reset. Select the configuration/bank number to load on next boot sequence from the pull down menu and then press ***Apply***.

C3.5.6 *Auto Parameters Tab*

The ***Auto Parameters*** tab (Figure C3.24) contains configuration parameters that further customize the automatic size and threshold algorithms used.

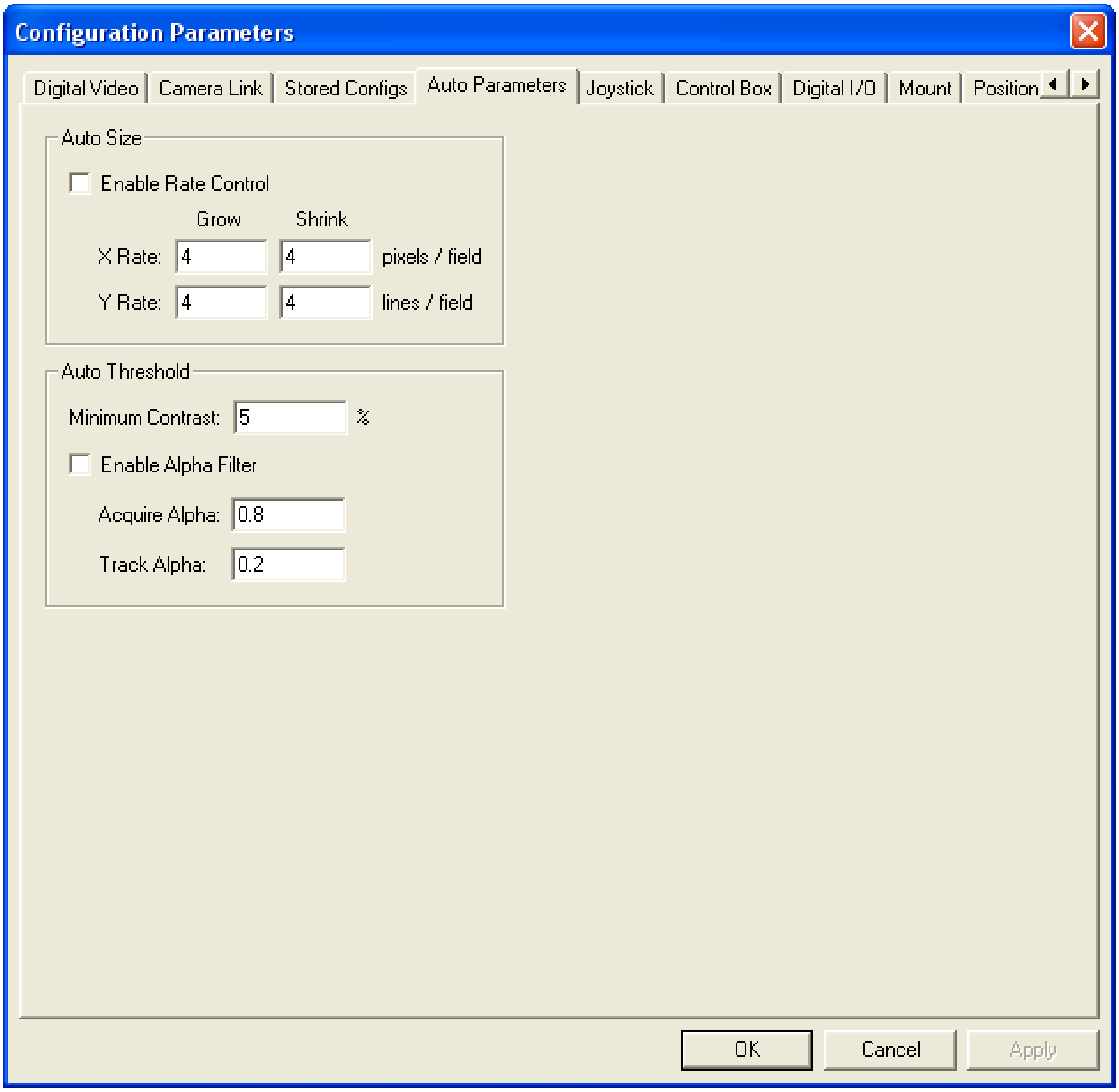

Figure C3.24. Auto Parameters Configuration Screen

C3.5.6.1 Auto Size Rate Control

Checking the ***Enable Auto Size Rate Control*** checkbox allows control of the rate at which the tracker can grow or shrink the gate size when automatic gate size mode is enabled. Separate controls are provided for X (pixels) and Y (lines), as well as separate rates for gate growth or shrinkage. The limits are defined as the maximum number of pixels the gate size may change per video field/frame. The default values for all four rates are 4 pixels per field/frame. However this feature is typically used to reduce the rate of change and values of 2 down to 0.5 are typical.

C3.5.6.2 Auto Threshold Minimum Contrast

The ***Minimum Contrast*** value sets the noise floor for the automatic threshold algorithm. A target will not be detected if the target to background contrast level is below this value. The target contrast is expressed as a percentage calculated as follows.

$$Contrast = \frac{|Average\ Target\ Intensity - Average\ Background\ Intensity|}{Maximum\ Pixel\ Intensity} \times 100$$

The desired minimum contrast level will be depend on the noise level of the camera, video scene and other various factors. Typical minimum contrast values range from 3% to 7%.

C3.5.6.3 Auto Threshold Alpha Filter

Checking the ***Enable Auto Threshold Alpha Filter*** checkbox allows the user to customize the response of the auto-threshold algorithm. The ***Acquire Alpha*** controls auto-threshold response during acquire and the ***Track Alpha*** filter controls auto-threshold response during track. Lower alpha values yield more filtering and a slower/smoother threshold response. The default alpha value for both is 0.5. However, this feature is typically used to speed up the threshold dynamics during acquire (a value of 0.8 is typical) and slow down dynamics during track (a value of 0.2 is typical).

C3.5.7 Joystick Tab

The ***Joystick*** tab (Figure C3.25) contains configuration parameters for customization of joystick functionality. The tracker supports both the E-O Imaging Model 701 and 702 Controller which provide the user a physical interface for real-time control of the tracker configuration (via switches and dials) and mount movement (via a joystick). Analog joysticks with ranges up to ±10 volts are also supported via the tracker's analog inputs.

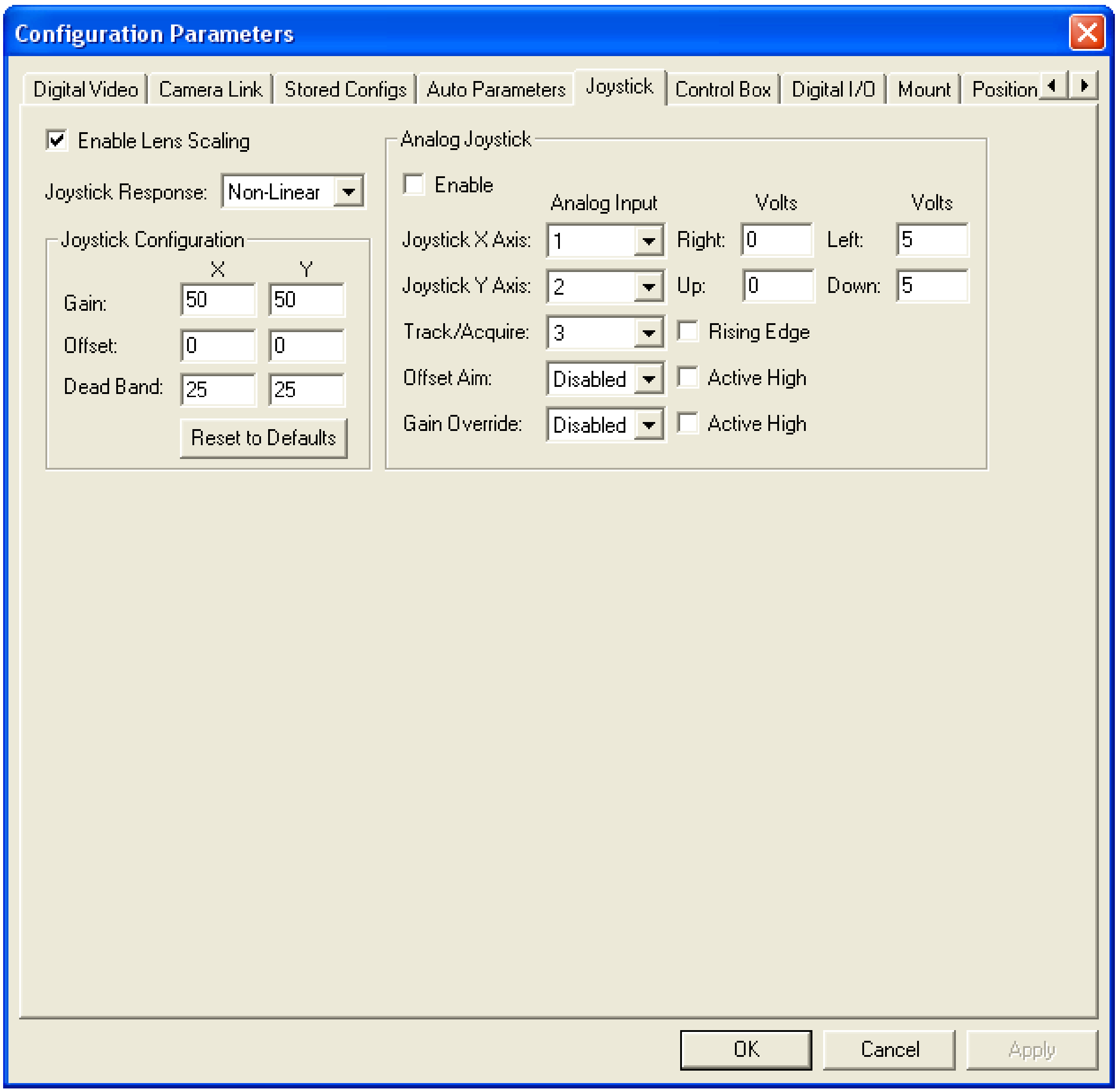

Figure C3.25. Joystick Configuration Screen

C3.5.7.1 Gain

For the 701 and 702 Controllers, the joystick provides analog signals to the control box that are digitized and sent to the tracker as a 10-bit number. This number is then converted to mount commands to control azimuth and elevation. ***Gain*** is the scale factor for the conversion from the 10-bit number to the mount command. The user can modify the gain to customize the mount response to joystick input. The default value is 50.

C3.5.7.2 Offset

For the 701 and 702 Controllers, the nominal value for the joystick in its home position is 512 ($2^{10}/2$) for both azimuth and elevation. All joysticks will exhibit a small offset from the home position, so the tracker takes an average of the first seven messages sent from the control box to determine what offset exists. The value displayed is the digital ***Offset*** value determined by the tracker and may be adjusted by the user by typing over the values and pressing the ***Apply*** button.

C3.5.7.3 Dead Band

The tracker will ignore joystick changes below a certain threshold, or ***Dead Band***, to control the joystick sensitivity before sending movement commands to the mount. The default value is 25.

C3.5.7.4 Enable Lens Scaling

Checking the ***Enable Lens Scaling*** checkbox will scale the mount movement commands from the joystick based upon the current zoom position. This means that the mount will move less when the camera is at a narrow FOV for a given joystick input versus when at a wide FOV. This scaling as a function of zoom can be disabled, if desired. The default value is enabled.

C3.5.7.5 Analog Joystick Enable

The analog joystick provides the user a physical interface for real-time control of the tracker configuration (typically via switches mounted to the joystick) and mount movement. Checking the ***Enable Analog Joystick*** checkbox will enable the external joystick's functionality and allow it to control the mount.

C3.5.7.6 Joystick X/Y Axis Input Line Configuration

The ***Joystick X Axis*** and ***Joystick Y Axis*** inputs are separately configurable to one of eight (8) analog input (ADC) lines. The default ADC channels are 1 and 2 for the X and Y axes, respectively.

C3.5.7.7 Joystick X/Y Axis Output Voltage Configuration

Since the output voltage range will vary between joystick types, and even between axes of the same joystick, the user may enter the proper voltage range for the end of each axis. The maximum range for the analog input lines is ±10 volts. The ***Right***/***Left*** and ***Up***/***Down*** voltage ranges may also be swapped to invert the operation of the corresponding axis. The defaults are set to 0.000V and 4.998V for the Right/Left ranges, respectively, and 0.000V and 4.998V for the Up/Down ranges, respectively.

C3.5.7.8 Track/Acquire Input Configuration

The ***Track/Acquire*** input toggles the tracker between Track and Acquire mode. The input is configurable to one of eight (8) analog input (ADC) lines. This input is typically a button (i.e. a digital input) but can be attached to an analog input for ease of configuration. The default analog input channel is 3. Checking the ***Rising Edge*** checkbox will toggle between Track and Acquire modes on the rising edge of the input signal. The default is to toggle on the falling edge.

C3.5.7.9 Offset Aim Configuration

The joystick controls the offset aim point while the ***Offset Aim*** input is active. This input is typically a button (i.e. a digital input) but can be attached to an analog input for ease of configuration. The default analog input channel is 4. Checking the ***Active High*** checkbox will select an active signal when the input is high. The default is an active signal for a low input.

C3.5.7.10 Gain Override Configuration

The lens scaling and gain settings are temporarily disabled while the ***Gain Override*** input is active to give maximum velocity control to the joystick. This input is typically a button (i.e. a digital input) but can be attached to an analog input for ease of configuration. The default analog input channel is 5. Checking the ***Active High*** checkbox will select an active signal when the input is high. The default is an active signal for a low input.

C3.5.8 Control Box Tab

The ***Control Box*** tab (Figure C3.26) contains configuration parameters to customize the behavior of 702 Controller connected to the tracker. The 702 Controller can be connected directly to the tracker (via UART1) or through a software proxy using the standard tracker protocol and various tracker communication interfaces.

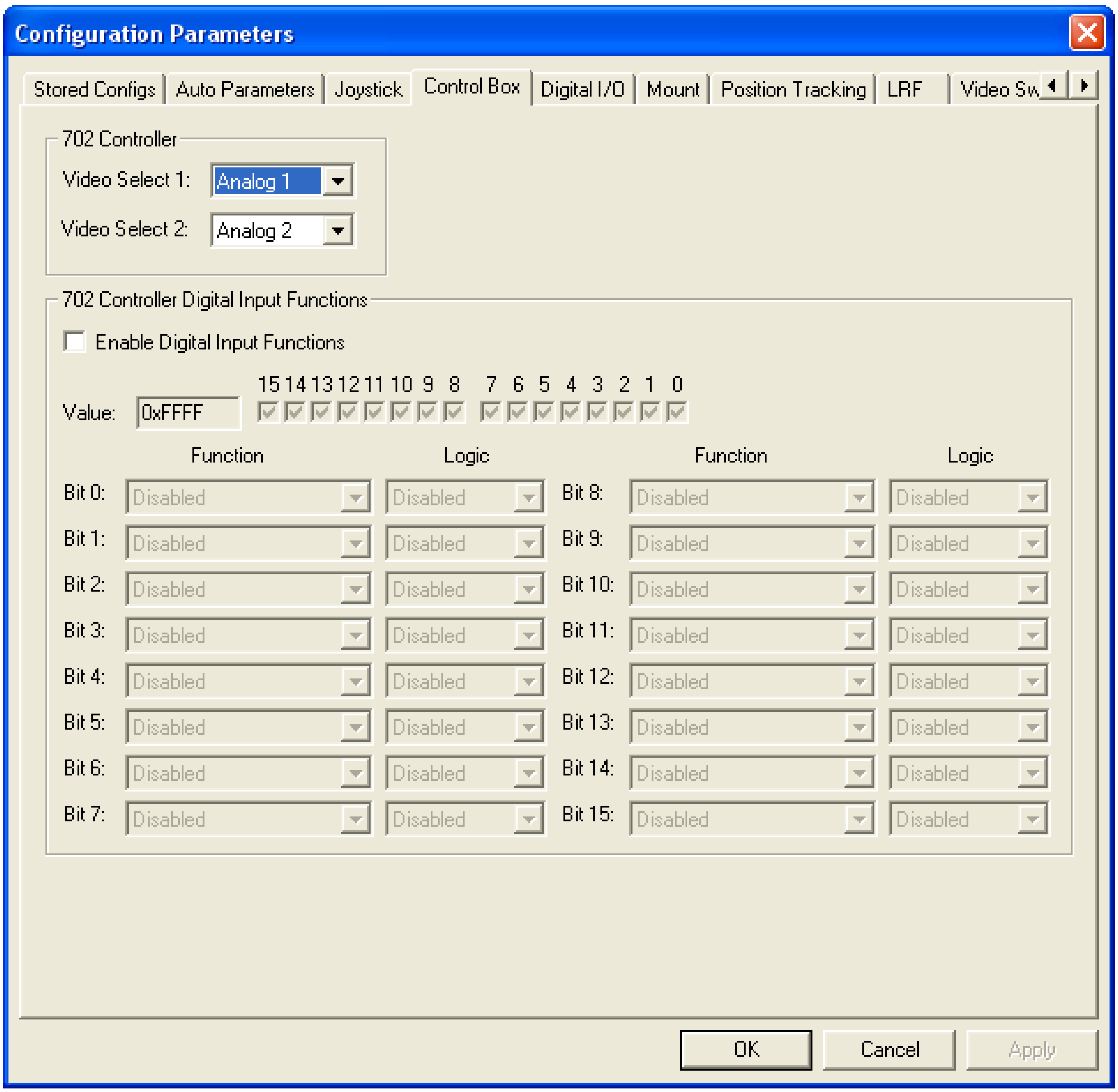

Figure C3.26. Control Box Configuration Screen

C3.5.8.1 702 Controller

The video sources controlled by the 702 control box can be mapped to any of the tracker video inputs. This allows the user to customize which video source is selected when the control box video source select switch is toggled.

C3.5.8.2 702 Controller Digital Input Functions

C3.5.8.2.1 Enable Digital Input Functions

Checking the ***Enable Digital Input Functions*** checkbox allows tracker and mount functions to be mapped to the digital input pins on the 702 Controller's rear connector (which is a DB44 type connector labeled *User I/O*). There are sixteen (16) digital input/output pins.

C3.5.8.2.2 Value

This is a display, in hexadecimal and of each individual bit, of the current state of the User Input pins. This can be used to verify conductivity and the proper connection to the connector on the control box rear panel.

C3.5.8.2.3 Functions

The tracker supports 20 different map-able functions:

Disabled – The digital I/O bit is not mapped to a function and has no effect on the tracker or mount. This is the default setting for all functions.

Focus Far – Focuses the currently selected camera to far objects.

Focus Near – Focuses the currently selected camera to near objects.

Zoom Narrow – Narrows the zoom for the currently selected camera.

Zoom Wide – Widens the zoom for the currently selected camera.

Video Select (1 & 2) – Toggles between Analog Video Source 1 and Analog Video Source 2 as the currently selected video source. This function controls the Video Source bits in the System Control Message. ***Reference Appendix B, Section B3.3 System Control Message.***

Gate Select – Toggles between Gate 1 and Gate 2 as the currently selected gate.

LRF Enable – Toggles the laser rangefinder firing on/off.

Data Logging – Toggles the data logging function on/off.

Offset Aim – Enables the Offset Aim mode using the joystick. This function controls the Offset Aim Enable bits in the Offset Aim (or Offset Track) Control Message. ***Reference Appendix B, Section B3.5 Offset Aim Control Message.***

Return to Boresight – Returns the aim point to boresight.

Gain Override – Overrides the mount velocity gain factor (i.e., mount speed is not based upon current lens field-of-view)

Track/Acquire – Toggles the tracker between Track and Acquire mode.

Second Gate Slave – Toggles coupling the second track gate to the first. When the gates are coupled, the transition occurs, as setup using the *Gate Transition Setup* dialog.

Reset Tracker – Resets the tracker.

Velocity Limit Enable – Toggles enabling the mount velocity limit within the tracker.

LRF Enable (Track Only) – This function arms/disarms the Laser Range Finder. Firing will occur only if armed and the tracker is actively tracking a target.

Zoom to Range – Toggles enabling of the zoom-to-range function. Zoom-to-range will behave as configured in the *Lens* dialog.

Video Cycle (Lenses) – Toggling this function will switch the video source to the next available source which has a lens assignment.

Slave Lens FOVs – This function enables a other configured lens FOVs to be driven by (slaved to) the FOV setting of the primary (currently selected) lens.

Any of the above functions may be mapped to one of 16 User Input pins. The default value is disabled for all functions.

C3.5.8.2.4 Logic

Each function may be mapped to one of five possible logic states. Note that when applying new settings, the GUI will automatically reject certain combinations of Function and Logic, when either a prerequisite configuration has not been set (eq. Slave Lens FOV when zero or only one lens is configured) or if the setting would not be useful (eq. Focus Far on Rising Edge would move *very* slowly).

Disabled – The mapped function has no effect on the tracker or mount. This is the default setting for all function logic states.

Active High – The mapped function is enabled while the pin input is high (+5V). For functions that are properly mapped as Rising Edge signals (i.e., function toggle), Active High will act as a Rising Edge signal.

Active Low – The mapped function is enabled while the pin input is low (0V). For functions that are properly mapped as Falling Edge signals (i.e., function toggle), Active Low will act as a Falling Edge signal.

Rising Edge – The mapped function is enabled on the rising edge of the pin's input.

Falling Edge – The mapped function is enabled on the falling edge of the pin's input.

C3.5.9 Digital I/O Tab

The ***Digital I/O*** tab (Figure C3.27) contains configuration parameters for customization of the tracker's discrete digital I/O for joystick button and other functionality. The joystick provides the user a physical interface for real-time control of the tracker configuration (typically via switches mounted to the joystick) and mount movement. This is accomplished through the linking of various functions to any available switch, allowing the user to create a flexible physical interface for real-time control of the tracker configuration and mount movement. The parameters in this tab allow the user to link a specific function to a specific switch on a controller or joystick. Up to 16 different switches or buttons may be linked in this manner.

The Digital I/O interface can also be configured for up to 16 digital outputs, which can be used to drive an indicator or enable/disable external hardware. When used as output, checkboxes allow the user to manually set or clear each individual bit and the mapping of tracker and mount functions to those bits are disabled (grayed-out).

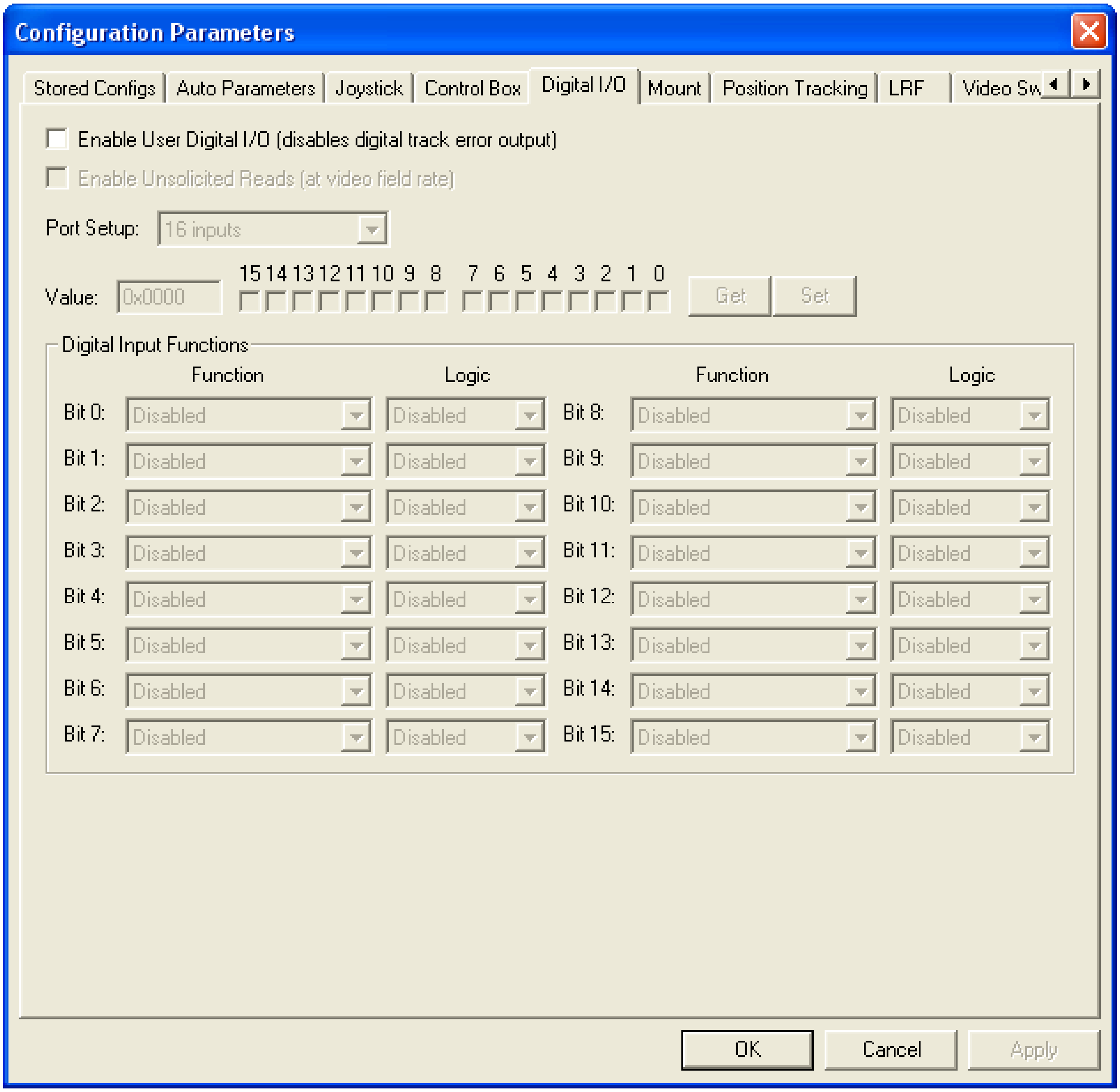

Figure C3.27. Digital I/O Configuration Screen

C3.5.9.1 Enable User Digital I/O

Checking the ***Enable User Digital I/O*** checkbox allows target and mount functions to be mapped to switches on a controller or joystick. When this box is checked, the standard tracker digital error outputs are disabled. The default value is disabled.

C3.5.9.2 Enable Unsolicited Reads

Enabling this check box, allows the tracker to send unsolicited digital I/O bit status to the GUI without being polled. When the tracker detects a change in one or more digital inputs, it will send a digital I/O status message to the GUI.

C3.5.9.3 Port Setup

This allows the user to select the desired combination of inputs and outputs. The digital I/O can be configured as 16 inputs, 8 inputs/8 outputs, or 16 outputs. When configured as 8 inputs/8 outputs, the user can only map 8 of the bits (inputs, highlighted) to real-time tracker control. When configured as 16 outputs, the user cannot map any of the bits to real-time tracker control.

C3.5.9.4 Value

This is a display, in hexadecimal and of each individual bit, of the current state of the Digital I/O pins. This can be used to verify conductivity and the proper connection to the interface connector. When (8 or 16 pins are) configured as inputs, the individual bit checkboxes are grayed-out, indicating that they cannot be manually set by the user, but will still show the proper state of the input pins. When (8 or 16 pins are) configured as outputs, the user can select the state of the individual output pins via the hexadecimal Value or (highlighted) individual bit checkboxes.

C3.5.9.5 Get / Set

When configured as 16 inputs or 8 inputs/8 outputs, the GET button will initiate an immediate read of the state of the digital input pins (switches) and update the display. When configured as 8 inputs/8 outputs or 16 outputs, the SET button will update the digital output pins to the state of the bits as chosen using the (highlighted) hexadecimal Value or individual bit checkboxes.

C3.5.9.6 Digital Input Functions

C3.5.9.6.1 Function

The tracker supports 20 different map-able functions:

Disabled – The digital I/O bit is not mapped to a function and has no effect on the tracker or mount. This is the default setting for all functions.

Focus Far – Focuses the currently selected camera to far objects.

Focus Near – Focuses the currently selected camera to near objects.

Zoom Narrow – Narrows the zoom for the currently selected camera.

Zoom Wide – Widens the zoom for the currently selected camera.

Video Select (1 & 2) – Toggles between Analog Video Source 1 and Analog Video Source 2 as the currently selected video source. This function controls the Video Source bits in the System Control Message. ***Reference Appendix B, Section B3.3 System Control Message.***

Gate Select – Toggles between Gate 1 and Gate 2 as the currently selected gate.

LRF Enable – Toggles the laser rangefinder firing on/off.

Data Logging – Toggles the data logging function on/off.

Offset Aim – Enables the Offset Aim mode using the joystick. This function controls the Offset Aim Enable bits in the Offset Aim (or Offset Track) Control Message. ***Reference Appendix B, Section B3.5 Offset Aim Control Message.***

Return to Boresight – Returns the aim point to boresight.

Gain Override – Overrides the mount velocity gain factor (i.e., mount speed is not based upon current lens field-of-view)

Track/Acquire – Toggles the tracker between Track and Acquire mode.

Second Gate Slave – Toggles coupling the second track gate to the first. When the gates are coupled, the transition occurs, as setup using the *Gate Transition Setup* dialog.

Reset Tracker – Resets the tracker.

Velocity Limit Enable – Toggles enabling the mount velocity limit within the tracker.

LRF Enable (Track Only) – This function arms/disarms the Laser Range Finder. Firing will occur only if armed and the tracker is actively tracking a target.

Zoom to Range – Toggles enabling of the zoom-to-range function. Zoom-to-range will behave as configured in the *Lens* dialog.

Video Cycle (Lenses) – Toggling this function will switch the video source to the next available source which has a lens assignment.

Slave Lens FOVs – This function enables a other configured lens FOVs to be driven by (slaved to) the FOV setting of the primary (currently selected) lens.

Any of the above functions may be mapped to one of 16 inputs (as available). The default value is disabled for all functions.

C3.5.9.6.2 Logic

Each function may be mapped to one of five possible logic states. Note that when applying new settings, the GUI will automatically reject certain combinations of Function and Logic, when either a prerequisite configuration has not been set (eq. Slave Lens FOV when zero or only one lens is configured) or if the setting would not be useful (eq. Focus Far on Rising Edge would move *very* slowly).

Disabled – The mapped function has no effect on the tracker or mount. This is the default setting for all function logic states.

Active High – The mapped function is enabled while the pin input is high (+5V). For functions that are properly mapped as Rising Edge signals (i.e., function toggle), Active High will act as a Rising Edge signal.

Active Low – The mapped function is enabled while the pin input is low (0V). For functions that are properly mapped as Falling Edge signals (i.e., function toggle), Active Low will act as a Falling Edge signal.

Rising Edge – The mapped function is enabled on the rising edge of the pin's input.

Falling Edge – The mapped function is enabled on the falling edge of the pin's input.

C3.5.10 Mount Tab

The ***Mount*** tab (Figure C3.28) contains configuration parameters for customizing mount-specific functionality. Contact E-O Imaging if your application requires support for a mount not listed below.

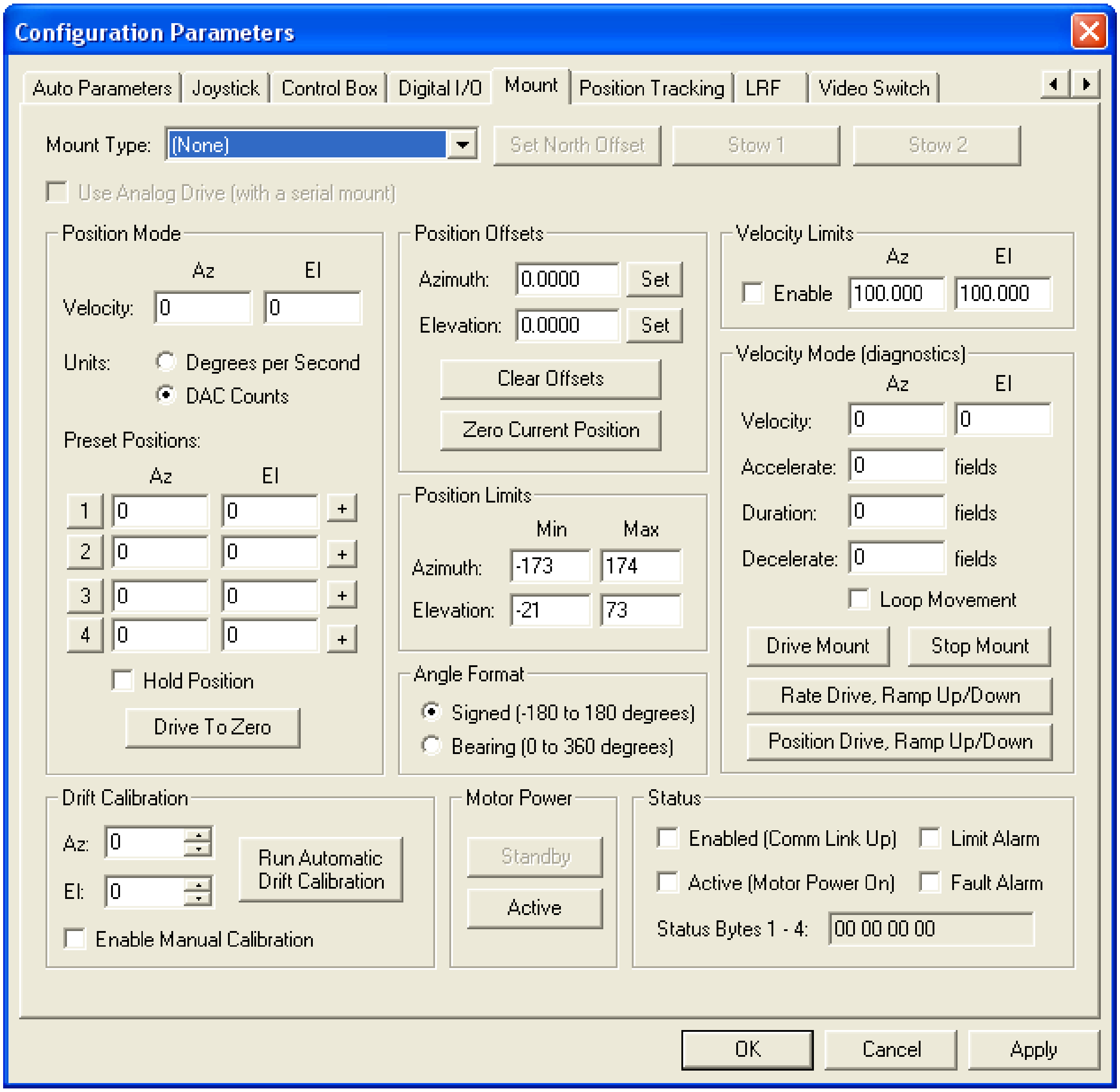

Figure C3.28. Mount Configuration Screen

C3.5.10.1 Mount Type

The tracker currently supports twenty five different mount types (Figure C3.29):

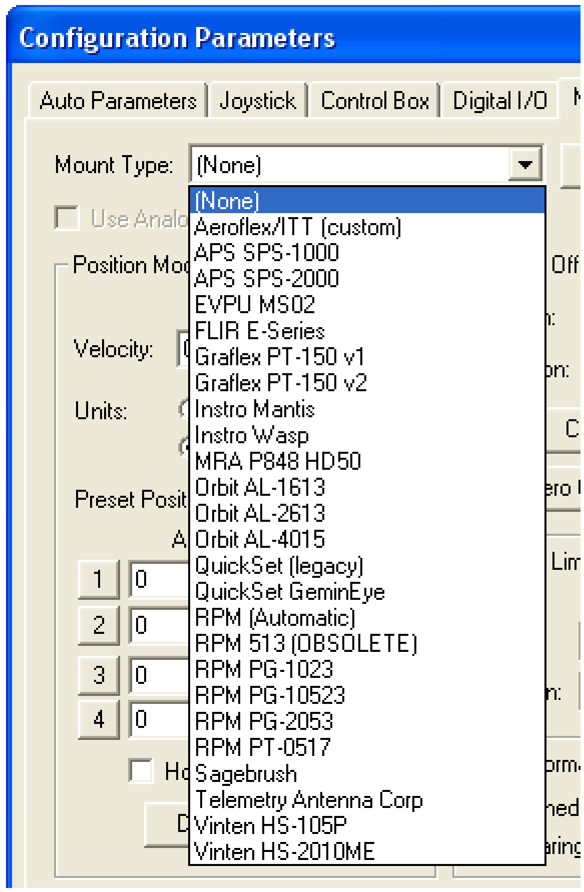

Figure C3.29. Mount Types

Select the desired mount type and press ***Apply***. The default value is **(None)**.

C3.5.10.2 North Offset Button

Some mounts provide a built-in method to correct the azimuth pointing angle for true or magnetic North. If the chosen mount supports this feature, the ***Set North Offset*** button will be enabled. Pressing ***Set North Offset*** will open a dialog box that prompts the user to enter the current mount bearing and the current True bearing, and calculates the correct North Offset using these values. In the dialog box, check the ***Enable North Offset*** checkbox to enable the function. The calculated North Offset is shown at the bottom. Press ***OK*** to accept the values shown and send the data to the mount.

C3.5.10.3 Stow Buttons

Some mounts support a special command that moves the pedestal to a specific Azimuth and Elevation for properly stowing the unit, for insertion of stow pins, or for shipping lockdown. If the mount supports this feature, one or both ***Stow Buttons*** will be enabled. Pressing ***Stow 1*** will send this request to the mount. If the mount supports both a primary and secondary stow command, pressing ***Stow 1*** will send the primary Stow command to the mount and pressing ***Stow 2*** will send the secondary Stow command to the mount. The mount automatically transitions into standby after the stow command has been sent. The Azimuth and Elevation angles for these commands are pre-configured in the mount and cannot be changed from the GUI.

C3.5.10.4 Position Mode

Four (4) sets of azimuth and elevation presets, which are stored in the Windows system registry, can be accessed both through the Mount tab and the Run-Time Control screen. When the associated button is pressed (***1***, ***2***, ***3, 4 or Drive To Zero***), the tracker will drive the mount to the stored position. The mount will be driven at the velocity defined in the ***Velocity Az*** and ***Velocity El*** user boxes. The velocity terms may be specified in ***Degrees per Second*** or ***DAC Counts*** using the radio buttons.

C3.5.10.5 Drift Calibration

The tracker can move the mount during track using either serial messages or directly with analog error outputs (depending on the mount configuration). Mounts driven by analog voltages often have DC offsets that can cause drift. The tracker can automatically determine the DC offsets if the mount is under software control or the user can manually provide the DC offsets by entering the values in the ***Az*** and ***El*** boxes.

Pressing the ***Perform Automatic Cal*** button initiates the automatic DC offset calibration process. The offsets will be displayed after the process is completed.

The user may enter decimal values for each axis and then test them by checking the ***Enable Manual Cal*** check box and then clicking the ***Apply*** button. The tracker will output the values for five seconds for the user to observe the effect and then output zero volts. The values can be entered manually or by using the up/down arrow associated with each axis. The values can range from –32768 to 32767.

C3.5.10.6 Position Offsets

The tracker provides a user-definable zero position for the mount. The tracker will display/report the current mount position relative to the user-defined mount zero position. The default value is zero for both Azimuth and Elevation, which is also the mount home position at power up.

Pressing the ***Zero Current Position*** button will set the current mount position as the zero for subsequent movements.

Pressing the ***Clear Offsets*** button will set the mount zero position back to defaults for both the Azimuth and Elevation.

Pressing ***Set*** for either Azimuth or Elevation will set the zero position for the appropriate axis.

C3.5.10.7 Position Limits

The tracker has soft positions limits and will halt movement if these limits are exceeded at any time and display "MOUNT LIMIT REACHED" in the video when this occurs. The default ***Min*** and ***Max*** values for ***Az*** and ***El*** are mount-specific.

C3.5.10.8 Angle Format

This setting allows the user to define the format for mount angles that are both entered and displayed by the GUI. The ***Bearing*** (angle) setting restricts mount angles to between 0 and 359.9999 degrees. The ***Signed*** (angle) setting allows for a much wider range – up to the capacity of the mount. ***Signed (***angles) is the default and is required when using mounts that support multiple turns (cable-wrap). This setting does not affect the way the tracker communicates with the mount, which is based on the selected mount's specific communication protocol.

C3.5.10.9 Motor Power

The ***Standby*** and ***Active*** buttons only appear when any of the RPM or APS mounts are selected.

The ***Standby*** button places the mount in safe mode. While in safe mode, motor power is disabled and the mount will ignore any drive commands.

The ***Active*** button places the mount in operate mode which enables motor power and allows the mount to act upon drive commands.

C3.5.10.10 Velocity Limits

The tracker has soft velocity limits and will not allow the mount to be driven at a velocity greater than these limits, if enabled.

C3.5.10.11 Velocity Mode (diagnostics)

The tracker allows the user to drive the mount in either axis for a specified amount of time for diagnostic purposes.

Pressing the ***Drive Mount*** button will cause the mount to be driven at the speed defined by the ***Velocity*** terms for a number of fields defined by ***Duration***.

Pressing the ***Stop Mount*** button will cause the mount to terminate the current move command and stop the mount.

The mount ***Velocity*** is controlled by a 16-bit value, which is in the form of either a serial message to the mount or a 16-bit DAC value output directly by the tracker. Zero represents no velocity. Maximum velocity is represented by 32767 and –32768.

The ***Accelerate*** input defines the number of fields over which to accelerate the mount to full velocity when the ***Drive Mount*** button is pressed.

The ***Duration*** input defines the number of fields to drive the mount (once it has reached full velocity) when the ***Drive Mount*** button is pressed.

The ***Decelerate*** input defines the number of fields over which to decelerate the mount from full velocity to zero velocity when the number of ***Duration*** fields has expired.

The ***Rate Drive, Ramp Up/Down*** button linearly accelerates the mount to full velocity and back to zero velocity over the number of fields defined by the ***Duration*** input.

The ***Position Drive, Ramp Up/Down*** button continually commands the mount to change its position for the number of fields defined by the ***Duration*** input.

C3.5.10.12 Status

The status checkboxes and fields provide feedback during active communications with the mount.

The ***Enabled*** checkbox is checked when there is active communications between the tracker and the mount.

The ***Active*** checkbox is checked when the mount is in operate mode (ie-not in safe mode). This checkbox pertains only to the RPM and APS mounts listed above.

The ***Limit Alarm*** checkbox is checked whenever the mount is actively at the limits of its travel in either Azimuth or Elevation.

The ***Fault Alarm*** checkbox is checked during general fault conditions.

The ***Status Bytes*** field gives general feedback on the condition of the mount. This field pertains only to the RPM and APS mounts listed above.

C3.5.11 Position Tracking Tab

The ***Position Tracking*** tab (Figure C3.28) contains configuration parameters for the position tracking (also called slaving) functionality. This function is used to develop a velocity/movement profile when azimuth and elevation position angles are sent to the tracker at a periodic rate. The source of this data is typically a radar, estimated trajectory profile or other external tracking sensor. If the source angles are in a global coordinate system (such as ECEF or LLA), they must be first be transformed into polar coordinates at the surveyed location of the mount.

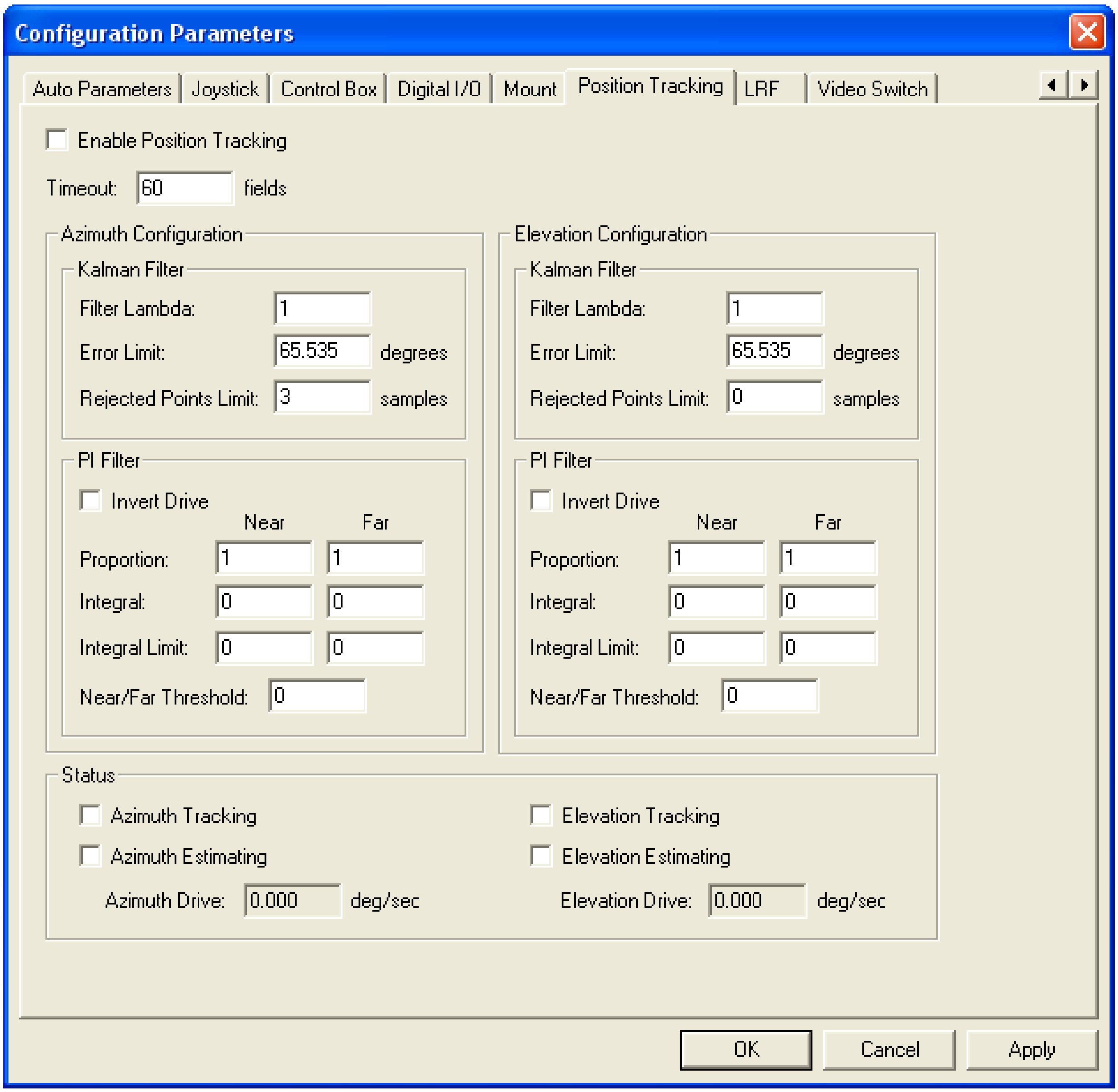

Figure C3.30. Position Tracking Configuration Screen

C3.5.11.1 Enable Position Tracking

Checking the ***Enable Position Tracking*** checkbox enables the position tracking function. If position angle commands are being periodically received by the tracker and the tracker is not in Track or Coast mode, the connected mount will be driven at the output velocity of the tracking PI filters (as configured below). Position command updates must be sent to the tracker at a periodic rate (typically 1 to 100 per second) in order to enable this function. Position command rates greater than 100 per second may exceed the tracker's processing ability.

C3.5.11.2 Timeout

A delay of ***Timeout*** video fields/frames or more between receipt of consecutive position commands will cause the filter to reset and disable position tracking control of the mount. This parameter should be set for a slightly longer period of time than the expected position command update rate.

C3.5.11.3 Azimuth/Elevation Configuration

The azimuth and elevation position tracking filters are independently configurable.

C3.5.11.3.1 Kalman Filter

The periodic position messages received by the tracker are fed into a Kalman filter which is used to calculate a smoothed trajectory model of the input data. At any given time, the Kalman filter can provide a predicted position, velocity and acceleration estimate for the target being tracked.

The ***Filter Lambda*** parameter controls the amount of smoothing with smaller numbers providing more filtering and a smoother response. This value can range from 0.001 to 1.0 with a default value of 1.0 (no smoothing).

The ***Error Limit*** parameter sets the trajectory model deviation tolerance for incoming position commands. New position commands are compared to the predicted filter position and any position different over the ***Error Limit*** will result in the rejection of the position update. When a position update is rejected, it is not used to update the filter trajectory model and the count of points is updated to keep track of how many consecutive points are rejected. Rejecting "wild points" is desirable for some types of inputs which can bounce between different targets or reflections. Setting the ***Error Limit*** parameter too small/tight can result in the filter oscillating in and out of reset.

The ***Rejected Points Limit*** parameter sets the number of rejected points allowed before the filter is reset and future position commands will provide the basis of a new trajectory model. This commonly happens when a different target or source is selected.

C3.5.11.3.2 PI Filter

The position error, which is the difference between the output of the Kalman filter and the current mount position, is fed into a PI (proportion and integral) filter. The PI filter's output (velocity in degrees per second) is used to drive the mount. Both ***Near*** and ***Far*** filter parameters are provided and automatic switched between according to the ***Near/Far Threshold*** parameter. When the position error is less than the threshold, the near filter settings are used. When the position error is greater than the threshold, the far filter settings are used. The ***Far*** filter parameters are typically used during acquisition of a target where little to no ***Integral*** is desired and a large ***Proportion*** is used to quickly converge to the trajectory model. The ***Near*** filter parameters are used during position tracking when the trajectory model is closely followed.

C3.5.11.4 Status

When position tracking is enabled, the status of the position tracking filters is reported independently for both azimuth and elevation.

The ***Azimuth Tracking*** and ***Elevation Tracking*** checkboxes will be checked when the tracker is receiving periodic position data and the Kalman filter has enough data to sufficiently calculate a trajectory model. The ***Azimuth Estimating*** and ***Elevation Estimating*** checkboxes will be checked if the Kalman filter has rejected or not received an expected incoming position update and is currently estimating the trajectory output.

The ***Azimuth Drive*** and ***Elevation Drive*** status fields display the current PI filter output velocity drive in degrees per second to the mount.

C3.5.12 Laser Rangefinder (LRF) Tab

The ***Laser Rangefinder (LRF)*** tab (Figure C3.31) contains configuration parameters for various models of laser rangefinders. Contact E-O Imaging if your application requires support for a laser rangefinder not listed below.

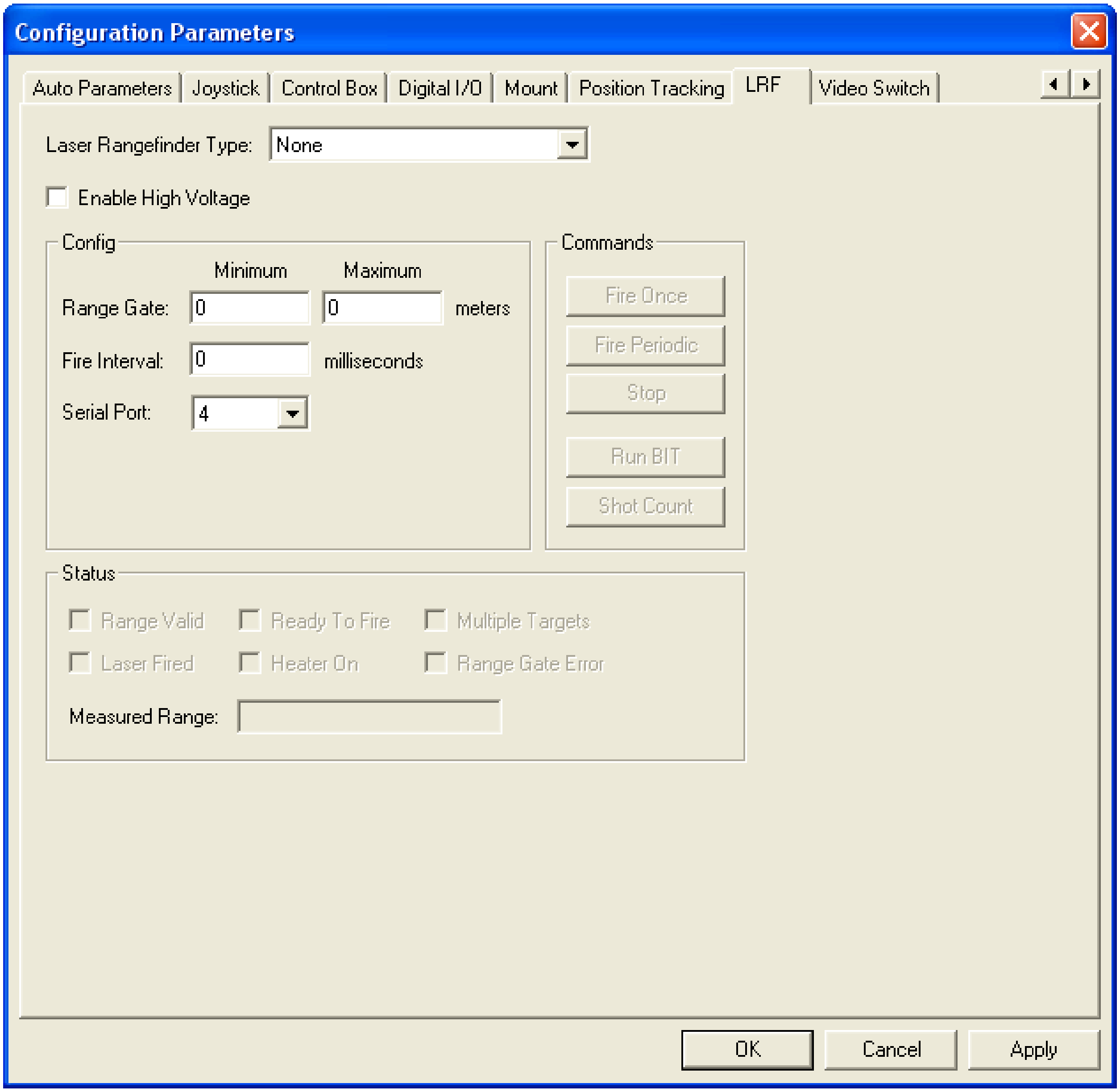

Figure C3.31. Laser Range Finder (LRF) Configuration Screen

C3.5.12.1 Laser Rangefinder Type

The tracker supports three laser rangefinders from ALST and two from Newcon Optik:

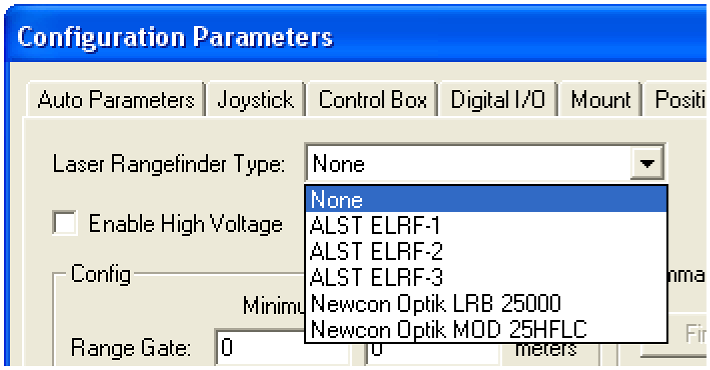

Figure C3.32. Laser Range Finder Type

C3.5.12.2 Enable High Voltage

Checking the ***Enable High Voltage*** checkbox enables the LRF.

C3.5.12.3 Configuration

The window for a valid target may be defined using the ***Minimum*** and ***Maximum*** fields of the ***Range Gate***. The values are defined in meters.

The ***Fire Interval*** defines the time between successive firings when the ***Fire Periodic*** button has been pressed. The ***Fire Interval*** time is entered in milliseconds.

The ***Serial Port*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the LRF. The default tracker serial port is 3.

C3.5.12.4 Command

The ***Fire Once*** button will activate the LRF for a single pulse.

The ***Fire Periodic*** button will continually fire an LRF pulse at the beginning of every interval defined by the ***Fire Interval*** field. The pulses can be stopped by pressing the ***Stop*** button.

C3.5.12.5 Status

The ***Status*** checkboxes and fields provide feedback during active communications with the LRF.

The ***Range Valid*** checkbox is checked when a target is within the ***Range Gate*** specified in the ***Config*** section. Objects detected outside of this range will be ignored.

The ***Laser Fired*** checkbox is checked when the LRF has successfully fired.

The ***Ready To Fire*** checkbox is checked when the LRF is ready to fire.

The ***Heater On*** checkbox is checked when the LRF's heater is active.

The ***Multiple Targets*** checkbox is checked when the LRF detects multiple targets within the ***Range Gate*** specified in the ***Config*** section. Target returns must be separated by a minimum distance (LRF model specific) to be properly classified as multiple targets.

The ***Range Gate Error*** checkbox is checked when the ***Range Gate Maximum*** is less than or equal to the ***Range Gate Minimum***. If this occurs, then the ***Range Gate Minimum*** is set to 0 and the ***Range Gate Maximum*** is set to the chosen model's maximum range.

The ***Measured Range*** field provides range-to-target feedback from the LRF.

C3.5.13 Video Switch Tab

The ***Video Switch*** parameter screen (Figure C3.33) provides the controls for configuring an analog video display routing switch and a digital video input switch.

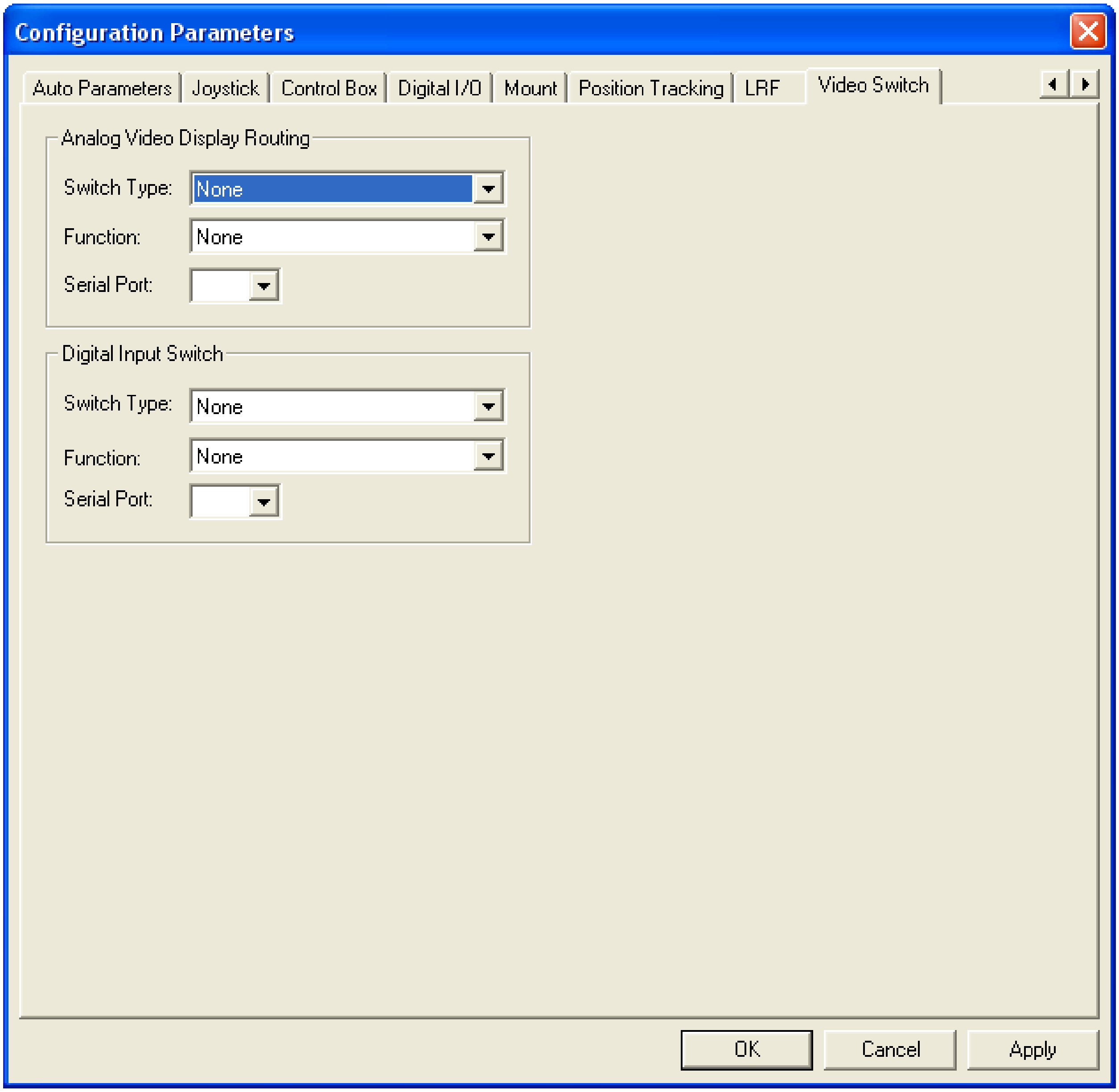

Figure C3.33. Video Switch Parameters Control Screen

C3.5.13.1 Analog Video Display Routing

These settings allow the user to configure the tracker to control an analog video switch. Once the ***Switch Type***, ***Function*** and ***Serial Port*** are selected, press either the ***Apply*** or ***OK*** button.

C3.5.13.1.1 Switch Type

Use this dropdown menu to select the type of video switch connected to the tracker.

Note: Currently only the ***Extron MMX 42 AV*** video switch is supported.

C3.5.13.1.2 Function

Use this dropdown menu to select the type of functionality desired from the video switch

Output Unselected Video -This function commands the video switch to route the currently selected tracker video input to the tracker and route the unselected video input directly to an external monitor. When the user changes the tracker video input selection, the video switch is reversed.

Note: Currently only the ***Output Unselected Video*** function is supported.

C3.5.13.1.3 Serial Port

Use this dropdown menu to select the tracker's ***Serial Port*** used to communicate with the selected video switch.

C3.5.13.2 Digital Input Switch

These settings allow the user to configure the tracker to control a digital video input select switch. Once the ***Switch Type***, ***Function*** and ***Serial Port*** are selected, press either the ***Apply*** or ***OK*** button.

C3.5.13.2.1 Switch Type

Use this dropdown menu to select the type of digital video switch connected to the tracker.

Note: Currently only the ***Phrontier CLEVER_SW*** video switch is supported.

C3.5.13.2.2 Function

Use this dropdown menu to select the type of functionality desired from the video switch

Output Selected Video - This function commands the video switch to route one of two connected digital video sources to the tracker. When the user changes the tracker video input selection, the video switch is reversed.

Note: Currently only the ***Output Selected Video*** function is supported.

C3.5.13.2.3 Serial Port

Use this dropdown menu to select the tracker's ***Serial Port*** used to communicate with the selected video switch.

C3.6 Scan Button

In the scan mode the system will scan a prescribed area in horizontal or vertical raster, horizontal or vertical zig-zag, and step or continuous spiral.

The Scan Parameter screen (Figure C3.34) provides the controls for the scan process. To use the scan function, the user should first set up the information for the Scan Log File. This defines the name and location where scan log data will be stored.

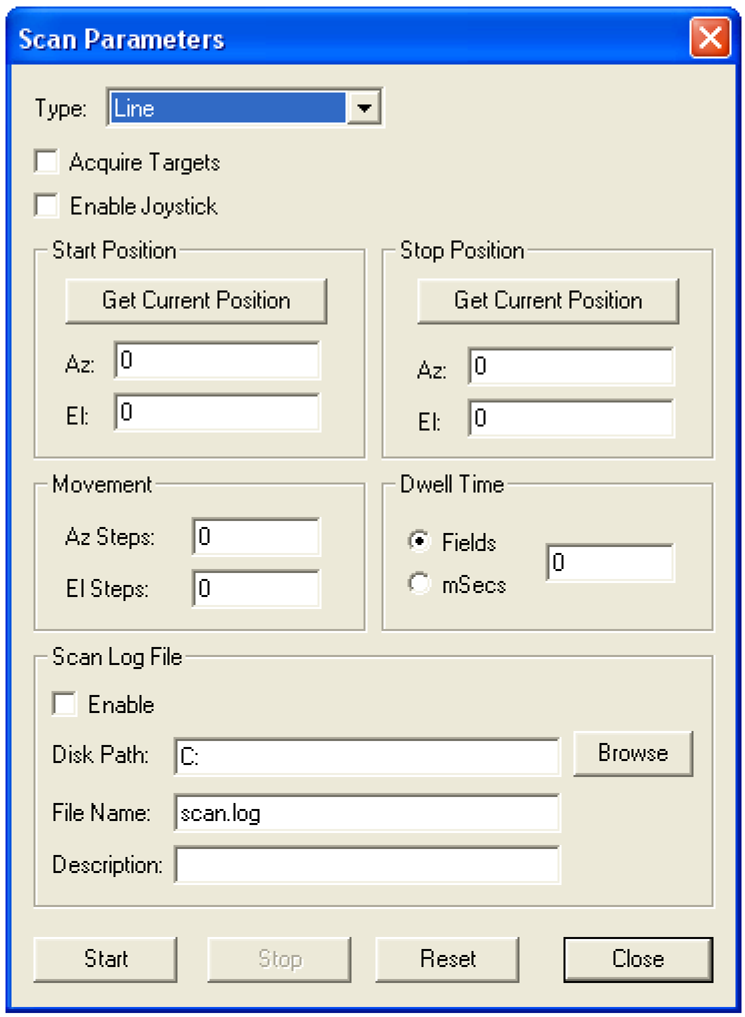

Figure C3.34. Scan Parameters Control Screen

C3.6.1 Scan Type

The ***Scan Type*** dropdown box defines the pattern of the scan steps that will be taken during the scan process. The tracker supports seven scan types:

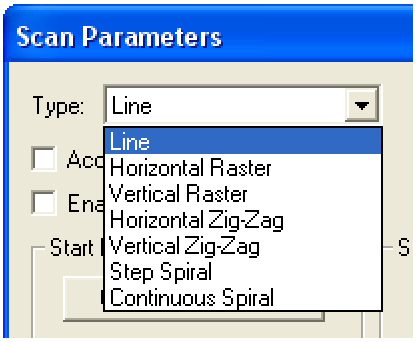

Figure C3.35. Scan Types

Other functions of the scan process are not affected by the ***Scan Type*** selection. The scan pattern is defined by the combination of selections.

Pattern Selection	Example
Horizontal/Raster	Figure C3.36
Horizontal/Zigzag	Figure C3.37
Vertical/Raster	Figure C3.38
Vertical/Zigzag	Figure C3.39
Step Spiral	Figure C3.40
Continuous Spiral	Figure C3.41

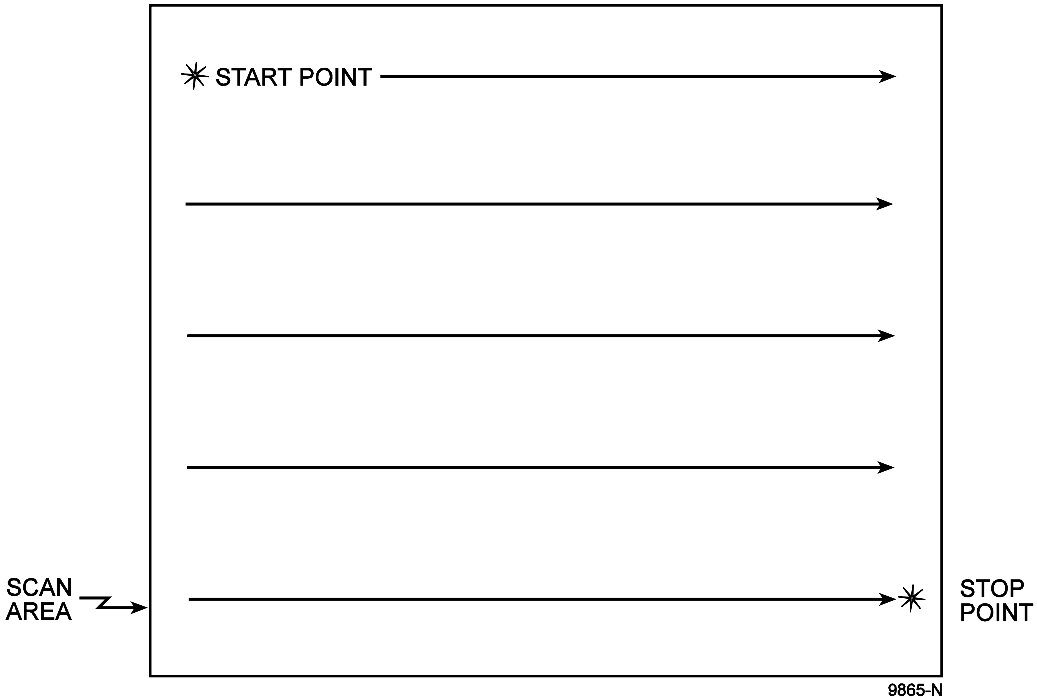

Figure C3.36. Horizontal/Raster Scan Pattern

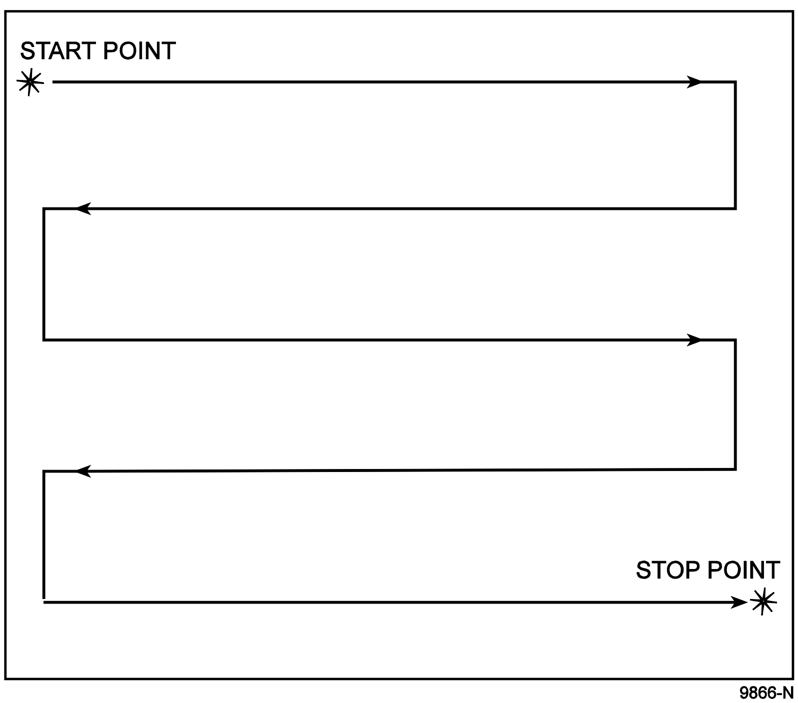

Figure C3.37. Horizontal/Zigzag Scan Pattern

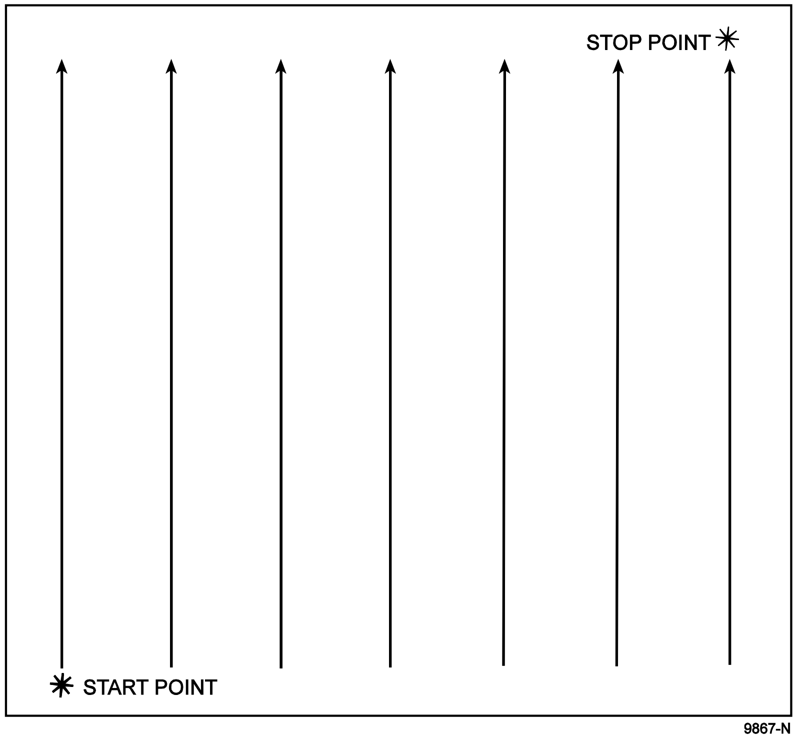

Figure C3.38. Vertical/Raster Scan Pattern

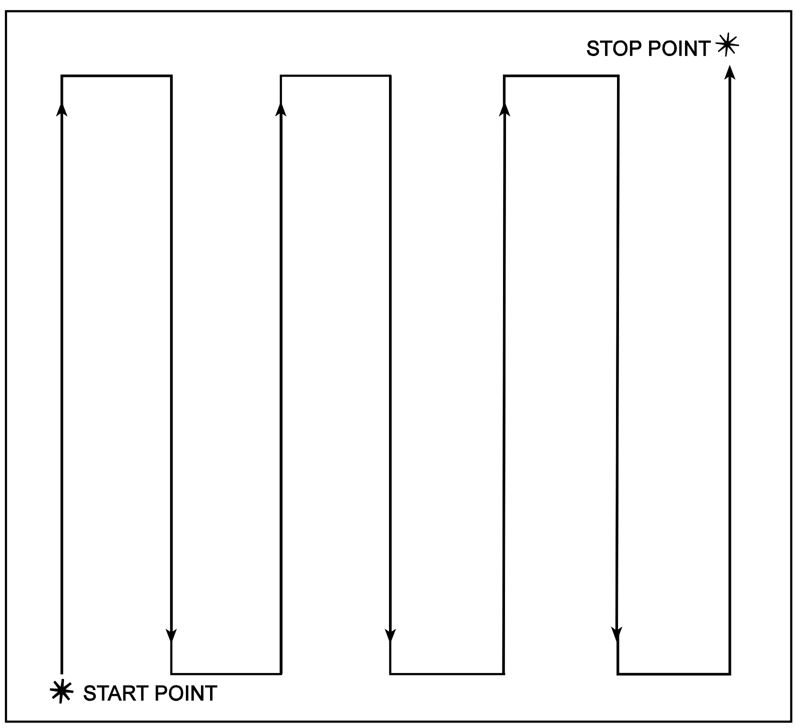

Figure C3.39. Vertical/Zigzag Scan Pattern

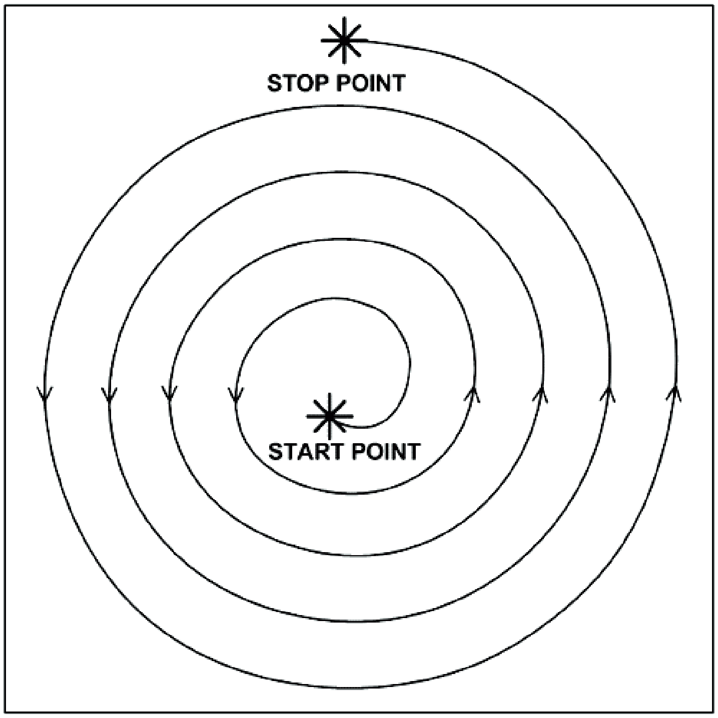

Figure C3.40. Step Spiral Scan Pattern

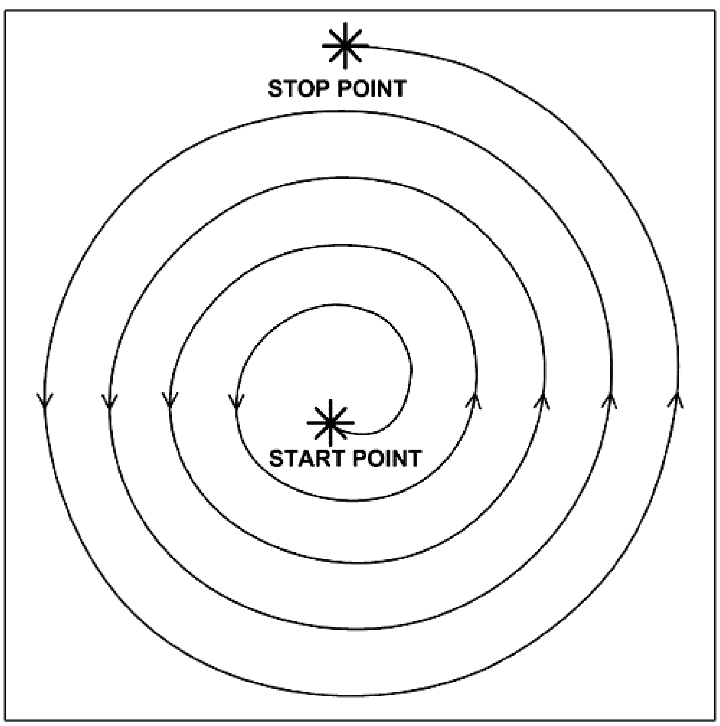

Figure C3.41. Continuous Spiral Scan Pattern

C3.6.2 Acquire Targets

Checking the ***Acquire Targets*** checkbox will allow the tracker to exit the current scan mode and track a target whenever a valid target is detected within the gate.

C3.6.3 Enable Joystick

The ***Enable Joystick*** checkbox enables the use of the joystick to override the current scan mode and position the mount. The joystick can be used in tandem with the ***Get Current Position*** buttons in the ***Start Position*** and ***Stop Position*** controls.

C3.6.4 Start Position

The ***Start Position*** is the location in Azimuth and Elevation the scan should start.

The ***Get Current Position*** button will apply the mount's current Azimuth and Elevation to the Start Position Azimuth and Elevation values.

C3.6.5 Stop Position

The ***Stop Position*** is the location in Azimuth and Elevation the scan should stop.

The ***Get Current Position*** button will apply the mount's current Azimuth and Elevation to the Stop Position Azimuth and Elevation values.

C3.6.6 Movement

The ***Movement*** is the number of scan steps (up to 255) that are to be taken in the Azimuth and Elevation directions.

C3.6.7 Dwell Time

The ***Dwell Time*** is the number of ***Fields*** or ***Milliseconds*** spent at each location before the next step is initiated.

C3.6.8 Scan Log File

Checking the ***Enable Scan Log File*** checkbox instructs the GUI to save time-stamped Azimuth and Elevation data for every mount step.

The ***Disk Path*** is the location of the log file to be stored. The location may be either typed in directly or browsed to by clicking the ***Browse*** button. The default location is "C:".

The ***File Name*** is the file name of the log file. The default filename is "scan.log".

The ***Description*** is a user-defined description stored within the log file.

C3.6.9 Start/Stop/Reset Buttons

Clicking on the ***Start*** button will cause the system to drive to the Start Position and begin stepping through the selected pattern, dwelling the specified time at each location.

When the Stop Position is reached, the next step will take the system to the Start Position. The pattern repeats until the ***Stop*** button is clicked. The ***Close*** button should then be clicked on, indicating that scan logging is complete and the file is to be closed and saved.

The ***Reset*** button clears the currently open log file and begins the logging process again using the same filename.

C3.7 Logging Button

Using the parameters of the ***Data Logging*** screen (Figure C3.42), the GUI can log a complete list of time-stamped status messages between the tracker and GUI and save it to a file.

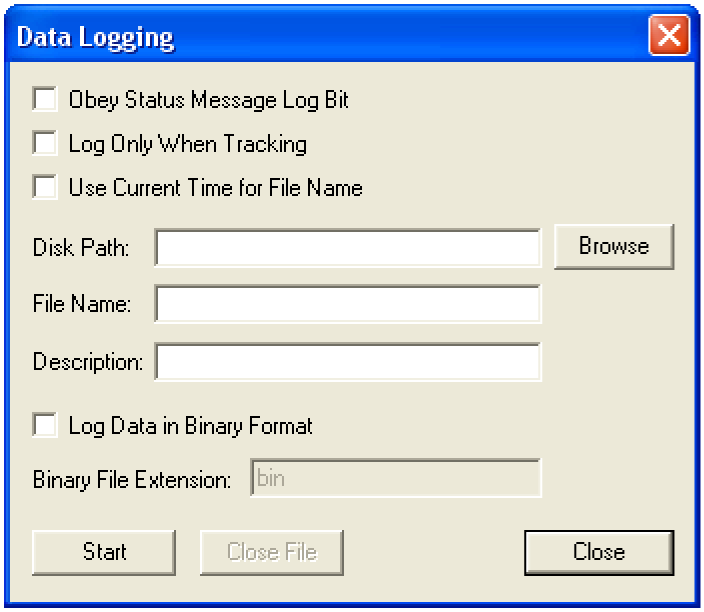

Figure C3.42. Data Logging Control Screen

C3.7.1 Obey Status Message Log Bit

When the ***Obey Status Message Log Bit*** checkbox is checked, the log file will contain only status messages that have the Status Message Log bit set. When unchecked, the log file will contain all status messages, regardless of the Status Message Log bit state. The Status Message Log bit can be set/reset using a joystick-mounted switch set up in the ***Digital I/O*** tab of the ***Configuration*** button control screen.

C3.7.2 Log Only When Tracking

When the ***Log Only When Tracking*** checkbox is checked, and the ***Start*** button is pressed, the GUI will only log data when the tracker is actively tracking a target. When unchecked the GUI will start logging when the ***Start*** button is pressed.

C3.7.3 Use Current Time for File Name

When the ***Use Current Time for File Name*** checkbox is checked, the log file will be saved with the current time as the file name.

C3.7.4 Disk Path

The ***Disk Path*** is the location of the log file to be stored. The location may be either typed in directly or browsed to by clicking the ***Browse*** button. The default location is “C:”.

C3.7.5 File Name

The ***File Name*** is the file name to use for the log file. Typical filenames end in a ".txt" or ".log" extension.

C3.7.6 Description

The ***Description*** is a user-defined description stored within the log file.

C3.7.7 Data Format

Data is logged to disk in standard ASCII text format. Lines are carriage return and line feed terminated (CRLF) and fields within each line are tab delimited. This format is easy to import into a spreadsheet application or parse via software. Any line beginning with a pound character (#) is a comment or part of the header information. Below is a sample of the first few lines of a typical log file.

```
# 2007-10-12
# N035 49'01.645"  W117 35'34.812"
# 0 0
# 44 -3
#
#
# Time(hh:mm:ss.xxx)    Gate    State   Azimuth Elevation   Raw Err X   Raw Err Y   Filtered Err X  Filtered Err Y  Mode    X
Size  Y Size  Left    Top Pixel Count Status  Range   Digital I/O
03:05:51.366    0   pending 308.2427    -3.0602 -155.00 -263.00 -158.09 -268.25 right   23  6   378 773 92  0   0.00    0x0000
03:05:51.375    0   pending 308.2427    -3.0604 -144.00 -262.00 -146.88 -267.22 right   30  10  382 769 202 0   0.00    0x0000
03:05:51.400    0   pending 308.2379    -3.0775 -94.00  -187.00 -95.88  -190.72 right   65  19  397 728 3053    0   0.00
0x0000
03:05:51.408    0   pending 308.2283    -3.0993 -74.00  -180.00 -75.47  -183.59 right   47  37  435 681 1162    0   0.00
0x0000
03:05:51.417    0   pending 308.2104    -3.1304 -58.00  -181.00 -59.16  -184.59 right   49  30  449 679 1027    0   0.00
0x0000
03:05:51.425    0   on  308.2063    -3.1294 -44.00  -162.00 -44.88  -165.22 right   46  39  466 666 1173    0   0.00    0x0000
03:05:51.433    0   on  308.2048    -3.1373 -29.00  -115.00 -29.56  -117.28 right   42  61  485 624 1677    0   0.00    0x0000
03:05:51.441    0   on  308.1952    -3.1795 -10.00  -54.00  -10.19  -55.06  right   44  74  502 565 1989    0   0.00    0x0000
03:05:51.448    0   on  308.1849    -3.2276 10.00   -2.00   10.19   -2.03   right   46  65  520 513 1843    0   0.00    0x0000
03:05:51.456    0   on  308.1699    -3.2873 31.00   33.00   31.59   33.66   right   49  52  538 475 1528    0   0.00    0x0000
03:05:51.464    0   on  308.1627    -3.3103 50.00   49.00   51.00   49.97   right   50  35  556 457 1170    0   0.00    0x0000
03:05:51.472    0   on  308.1560    -3.3204 68.00   52.00   69.34   53.03   right   53  31  571 448 1098    0   0.00    0x0000
```

The first four lines consist of header information and read as follows:

Header Line	Description
# 2007-10-12	The date the file was created in the format 'year-month-day'.
# N035 49'01.645" W117 35'34.812"	The GPS location (only if supporting hardware is present)
# 0 0	The line-of-sight (boresight) offset (x y)
# 44 -3	The offset aim (x y)

The final comment line documents the format of each data field within a line. Using the first line as an example, the data fields in each line read as follows:

Data Field	Description
03:05:51.366	IRIG or PC time stamp in the format 'hours:minutes:seconds.milliseconds'
0	The gate number where 0='Gate 1' and 1= 'Gate 2'
pending	Track state
308.2427	Mount azimuth angle (if mount is connected)
-3.0602	Mount elevation angle (if mount is connected)
-155.00	Raw pixel track error (X)
-263.00	Raw line track error (Y)
-158.09	Filter pixel track error (X)
-268.25	Filter line track error (Y)
right	Track mode
23	Target width in pixels (X)
6	Target height in lines (Y)
378	Top/Left most target pixel (X)
773	Top/Left most target line (Y)
92	Target pixel count
0	Track status (bit field)
0.00	Slant range to target in meters (if known)
0x0000	Tracker digital I/O bits (if enabled) as a hexadecimal word

C3.7.8 Log Data in Binary Format

When this check box is selected, the log data is logged in binary format. The log file is raw binary in Intel byte order. Each record in the file is formatted as follows:

32-bit unsigned integer	HeaderID (0x00C0FFEE)
32-bit unsigned integer	ByteCount
SYSTEMTIME structure	SystemTime
STATUS_MSG	StatusMessage
64-bit IEEE floating point	Range
16-bit unsigned integer	DIO

The following is a description for each parameter of the record.

C3.7.8.1 HeaderID

HeaderID is equal to 0x00C0FFEE.

C3.7.8.2 ByteCount

ByteCount is the total number of bytes in the record excluding the HeaderID and the ByteCount itself. This allows for future expansion to the end of the record while allowing older software to ignore addition fields of data.

C3.7.8.3 SystemTime

SystemTime is the standard C SYSTEMTIME structure used to timestamp the record. All time is UTC.

```
typedef struct _SYSTEMTIME {
        WORD wYear;
        WORD wMonth;
        WORD wDayOfWeek; // NOT USED
        WORD wDay;
        WORD wHour;
        WORD wMinute;
        WORD wSecond;
        WORD wMilliseconds;
} SYSTEMTIME;
```

C3.7.8.4 StatusMessage

StatusMessage is the standard 36-byte tracker status message (type 255) as defined in ***Appendix B, section B2.1 Status Message.***

C3.7.8.5 Range

Range contains the last measured laser rangefinder's reading in meters or the last user supplied range value.

C3.7.8.6 DIO

DIO is the value of the video tracker's 16-bit digital I/O port.

C3.7.9 Start/Stop and Close File Buttons

Clicking on the ***Start*** button will open a log file with the name listed in the File Name input box and begin the data logging process. Pressing the ***Stop*** button will temporarily suspend data logging.

When the desired amount of data has been collected, click on the ***Close*** button to indicate logging is complete and the file is to be closed and saved.

C3.8 Lens Button

The ***Lens Parameters*** screen contains five tabs, one for each video input to the tracker. Initially, the lens type is set to none for all five video inputs. The display will be updated when a lens type is selected and the ***Apply*** (or ***OK***) button is pressed. The screen displayed will depend on the type of lens selected. Note that the ***Lens Parameters*** screen may contain fields that are used by other lenses of this type but not used by this specific model lens (will be grayed-out). Note that a lens can be on any/all of the five video inputs. Contact E-O Imaging if your application requires support for a lens not listed below.

C3.8.1 Optimum Optical Systems TFOV Lens Configuration Screen

The ***Optimum Optical Systems (OOS) Tri-Field of View (TFOV)*** lens configuration screen (Figure C3.43) provides the basic level of functionality to adjust the field of view, focus, and line of sight offsets for this lens.

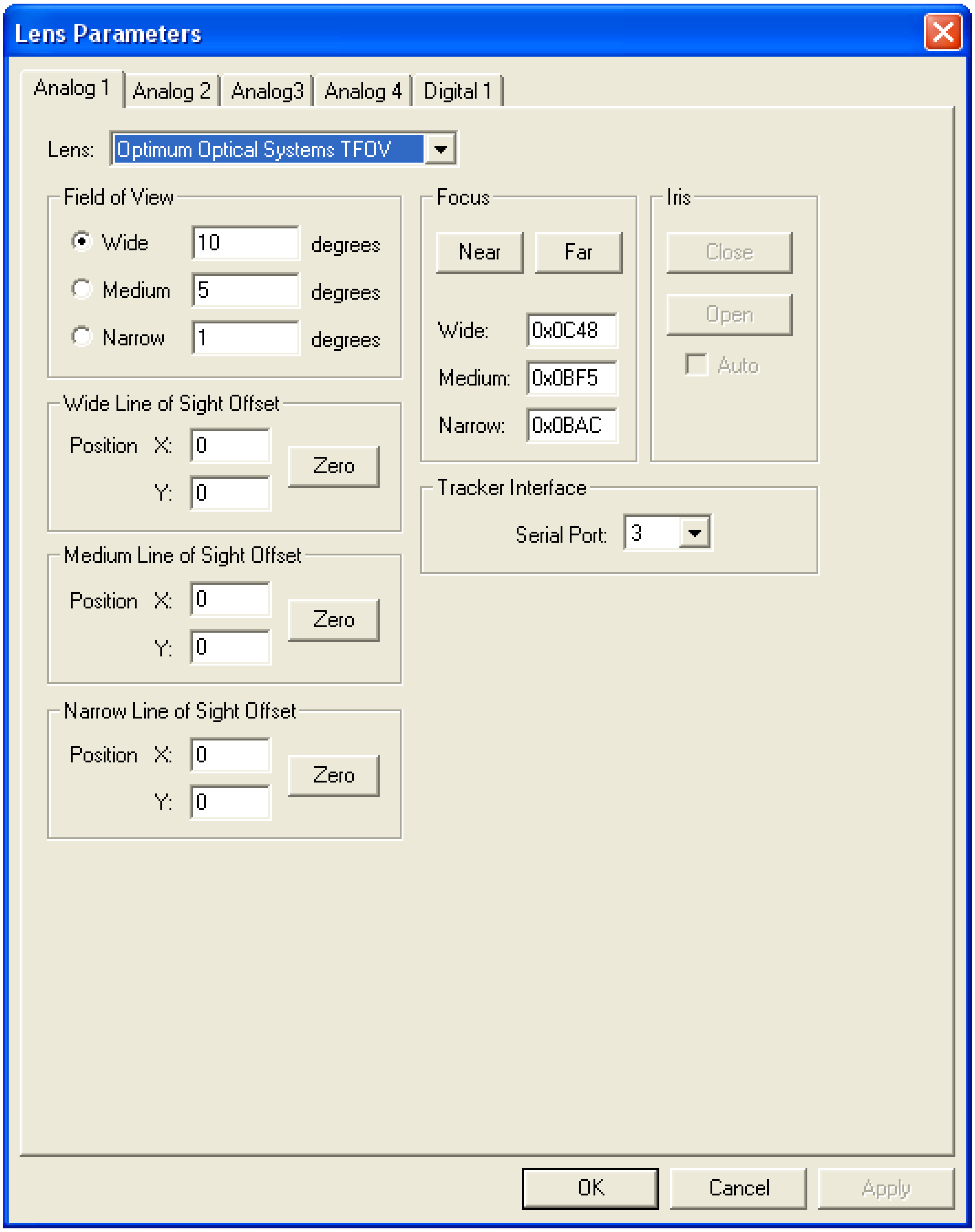

Figure C3.43. Optimum Optical Systems TFOV Lens Configuration Screen

C3.8.1.1 Field Of View

The ***Field of View*** radio buttons determine the current FOV for the lens, with three options of ***Wide***, ***Medium***, or ***Narrow***. The tracker will then set the focus to the last setting for this FOV input by the user from the GUI or the 702 Controller. Note that the focus setting is stored in FLASH memory when the tracker configuration is saved to FLASH.

C3.8.1.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

Current ***Focus*** position data is displayed for the ***Wide***, ***Medium***, and ***Narrow*** FOV options.

C3.8.1.3 Iris

There is currently no iris control for this model lens.

C3.8.1.4 Wide Line Of Sight Offset

The ***Wide Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Wide FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.1.5 Medium Line Of Sight Offset

The ***Medium Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Medium FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.1.6 Narrow Line Of Sight Offset

The ***Narrow Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Narrow FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.1.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

C3.8.2 Sophie Thermal Binoculars Lens Configuration Screen

The ***Sophie Thermal Binoculars*** lens configuration screen (Figure C3.44) provides the basic level of functionality to adjust the field of view, focus, and line of sight offsets for the thermal binoculars. Overall thermal imaging sensor gain may be adjusted here.

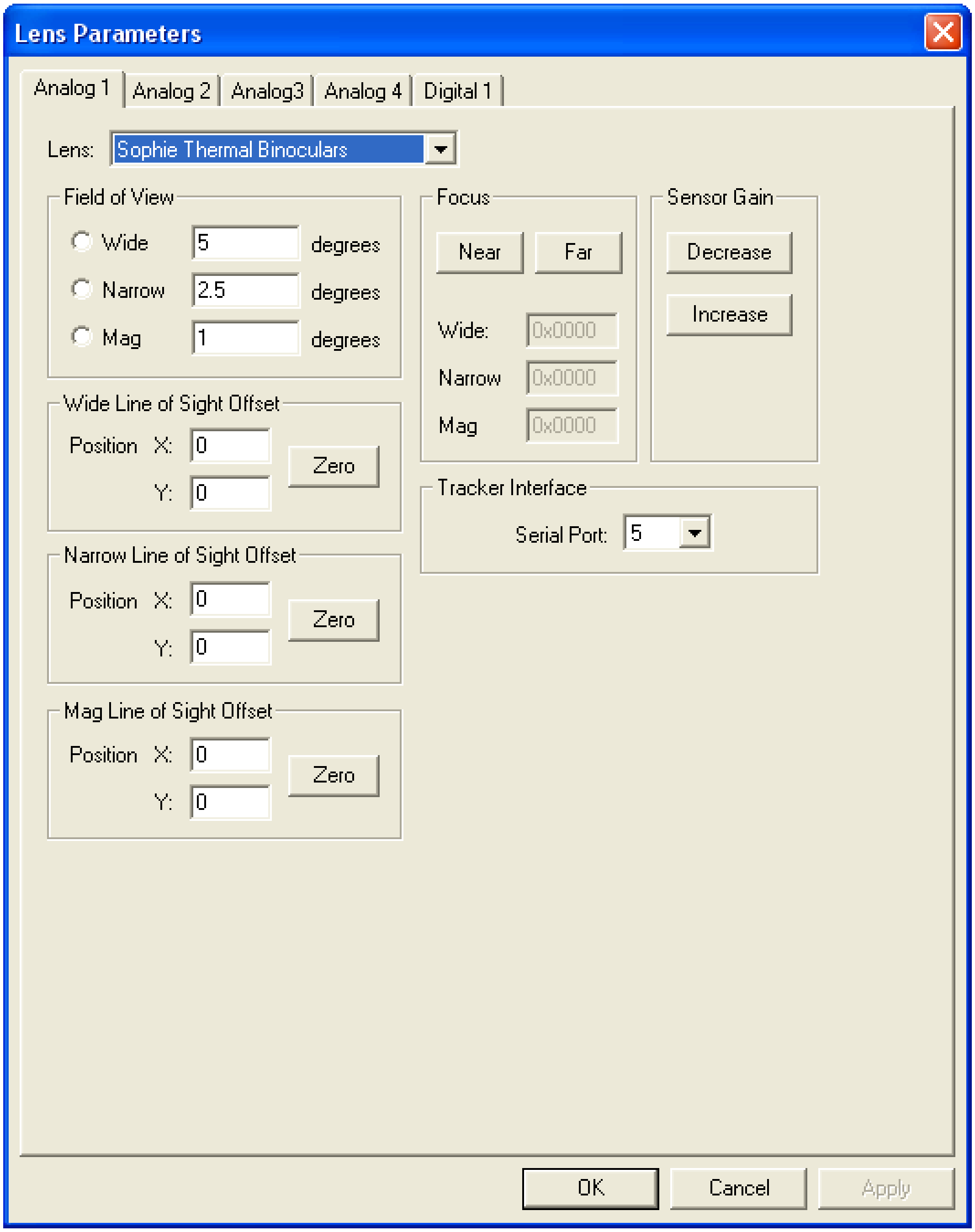

Figure C3.44. Sophie Thermal Binoculars Lens Configuration Screen

C3.8.2.1 Field Of View

The ***Field of View*** radio buttons determine the current FOV for the lens, with three options of ***Wide***, ***Medium***, or ***Narrow***. The tracker will then set the focus to the last setting for this FOV input by the user from the GUI or the 702 Controller. Note that the focus setting is stored in FLASH memory when the tracker configuration is saved to FLASH.

C3.8.2.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

Current ***Focus*** position data is not available for this model lens.

C3.8.2.3 Sensor Gain

The ***Sensor Gain*** determines the overall gain of the thermal imaging sensor. Clicking the ***Increase*** button will increase the overall gain, and clicking the ***Decrease*** button will decrease the overall gain.

C3.8.2.4 Wide Line Of Sight Offset

The ***Wide Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Wide FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.2.5 Medium Line Of Sight Offset

The ***Medium Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Medium FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.2.6 Narrow Line Of Sight Offset

The ***Narrow Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Narrow FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.2.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

C3.8.3 Generic Lens Configuration Screen

The ***Generic*** Lens configuration screen (Figure C3.45) provides a mount gain scale factor or sets the field-of-view for the lens in degrees. This setting is used to scale the mount movement when the corresponding video source is selected.

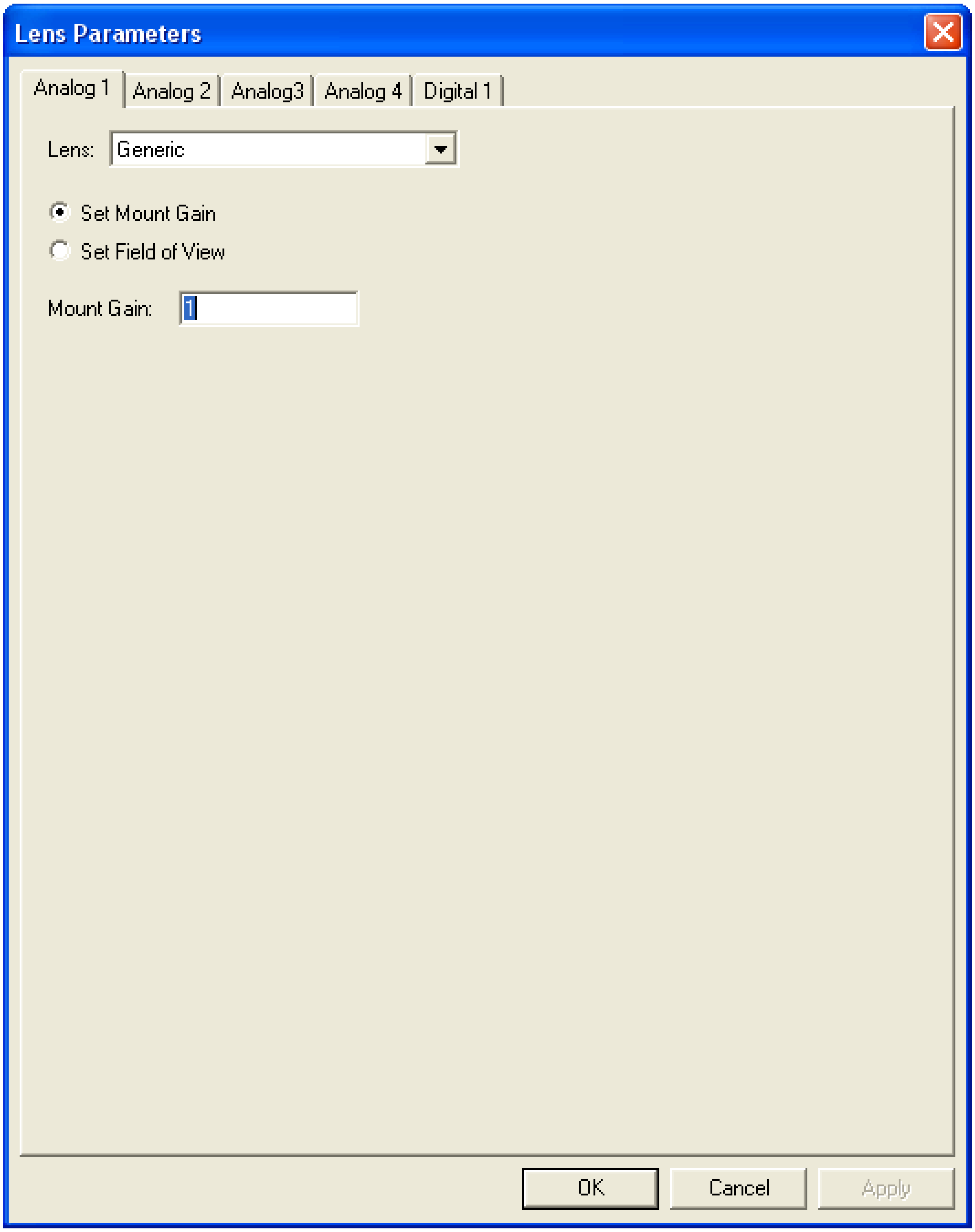

Figure C3.45. Generic Lens Configuration Screen

C3.8.3.1 Set Mount Gain

Mount movement commands are scaled based on the current field-of-view divided by the largest field-of-view in the system. The ***Set Mount Gain*** radio button allows the user to enter a decimal value ranging between zero and one. The default value is 1 (unity gain).

C3.8.3.2 Set Field of View

The ***Set Field of View*** radio button allows the user to set the current field-of-view for the lens. The tracker will handle setting the appropriate scale factor. The default value is 1 degree.

C3.8.4 Western Video / ITS 6125DF Lens Configuration Screen

The ***Western Video / ITS 6125DF*** Lens configuration screen (Figure C3.46) provides the basic level of functionality for adjusting the field of view, focus, zoom, and line of sight offsets for this lens.

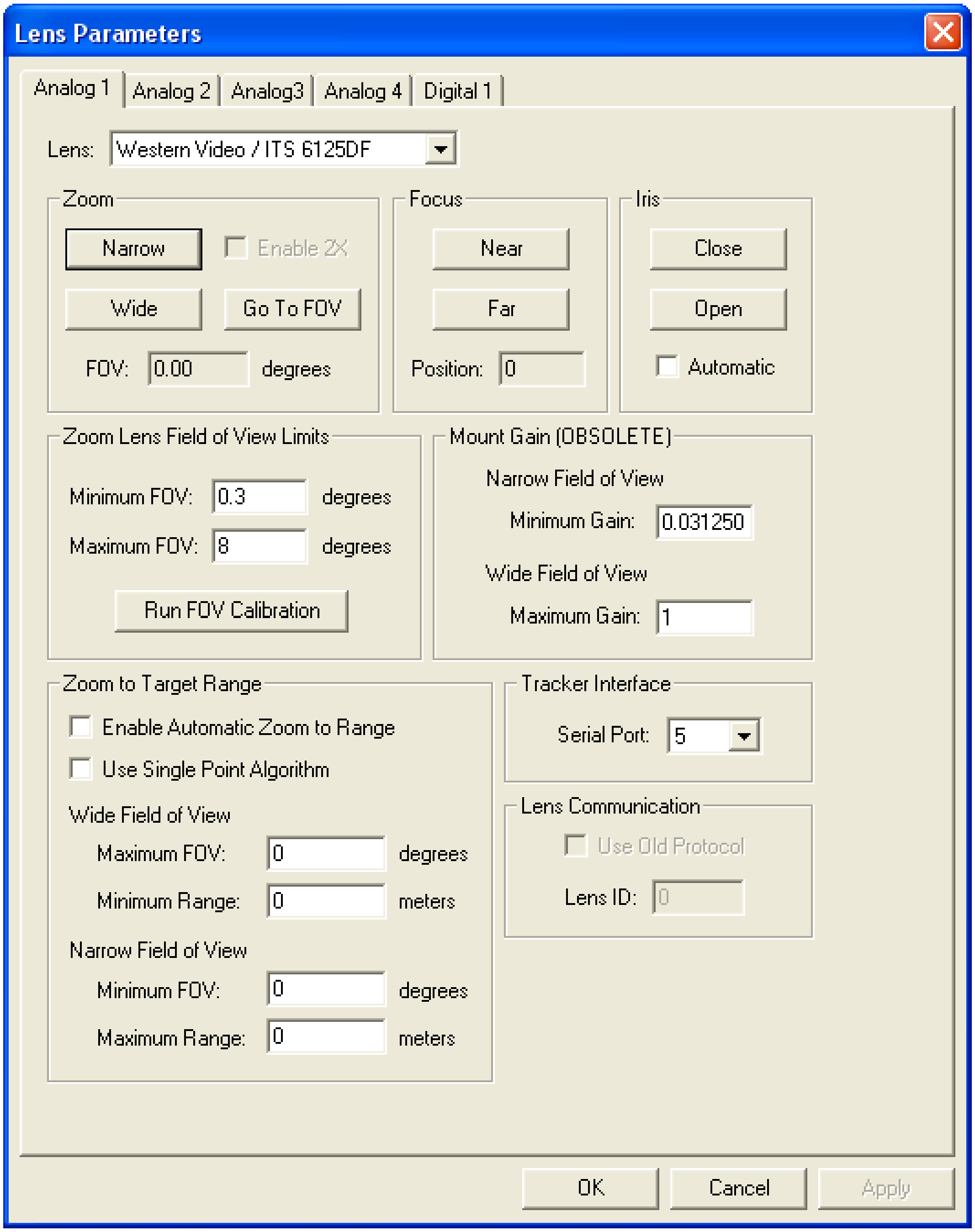

Figure C3.46. Western Video / ITS 6125DF Lens Configuration Screen

C3.8.4.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.4.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Position*** box provides feedback on the current focus position.

C3.8.4.3 Iris

Press the ***Close*** button to close down the iris.

Press the ***Open*** button to open up the iris.

Checking the ***Automatic*** checkbox will enable the auto iris feature of the lens. Note that the **Automatic** checkbox must be unchecked for the ***Close*** and ***Open*** buttons to have any effect.

C3.8.4.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Minimum FOV*** and ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.4.5 Mount Gain (OBSOLETE)

C3.8.4.6 Zoom To Target Range

If a laser rangefinder is installed or range data messages are sent to the tracker, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.4.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 5.

C3.8.4.8 Lens Communication

Not available with this model lens.

C3.8.5 DiOP / Senspex FieldPro 5X Lens Configuration Screen

The ***DiOP / Senspex FieldPro 5X*** Lens configuration screen (Figure C3.47) provides the basic level of functionality to adjust the field of view, focus, zoom, and line of sight offsets for the FieldPro 5X lens. Several sensor options may be adjusted, including gain control, a non-uniformity correction factor, and image polarity.

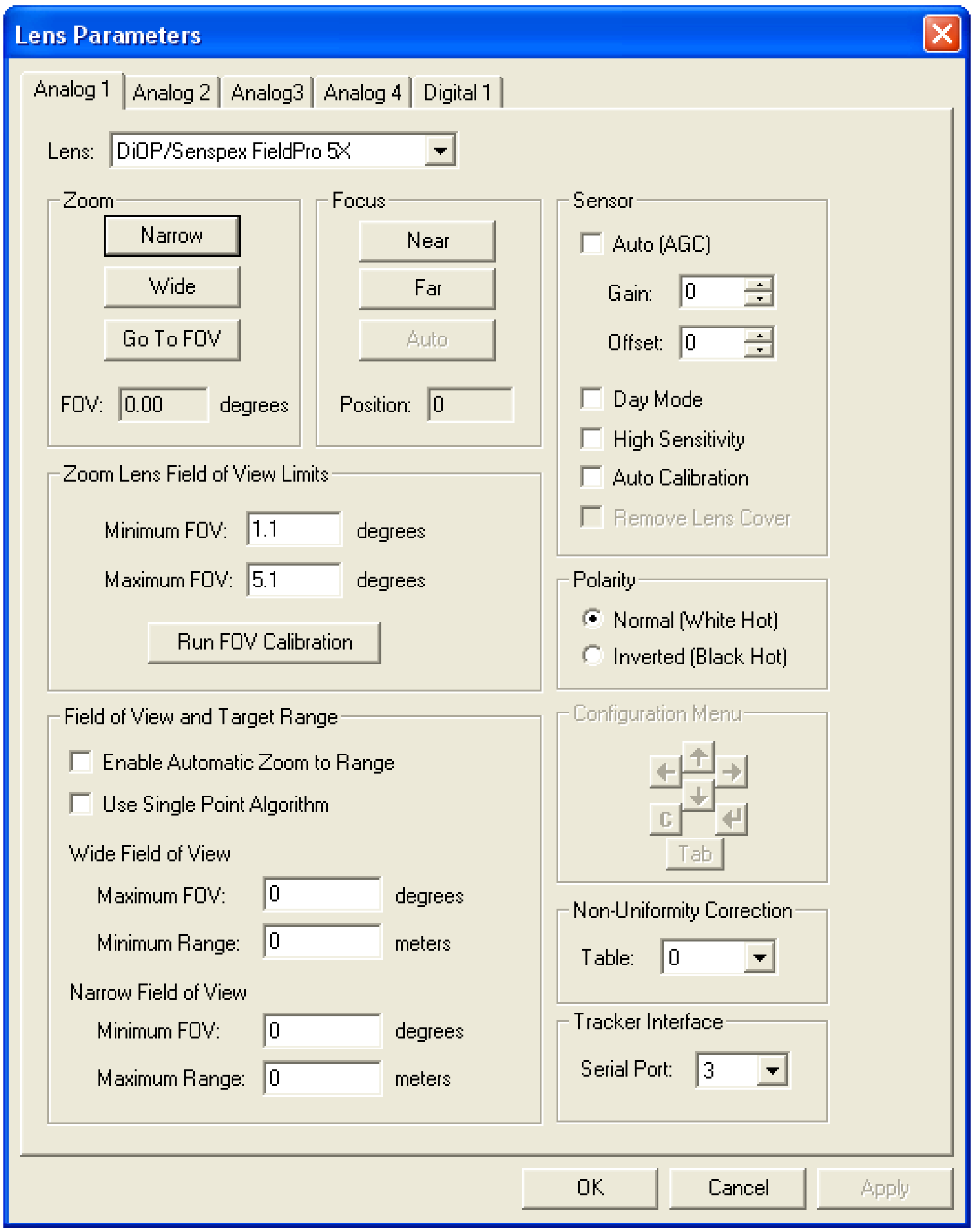

Figure C3.47. DiOP / Senspex FieldPro 5X Lens Configuration Screen

C3.8.5.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV.

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.5.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Auto Focus*** feature is not available with this model lens.

The ***Position*** box provides feedback on the current focus position.

C3.8.5.3 Sensor

Checking the ***Auto (AGC)*** checkbox will enable the lens' automatic gain control. When this checkbox is unchecked, the lens' ***Gain*** and ***Offset*** may be set directly by the user.

Several options may be enabled on the lens by checking the appropriate checkbox, including ***Day Mode***, ***High Sensitivity***, and ***Auto Calibration***. For more information on these features, reference the lens manuals.

The ***Remove Lens Cover*** feature is not available with this model lens.

C3.8.5.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Minimum FOV*** and ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.5.5 Polarity

Select ***Normal (White Hot)*** to display hotter objects whiter and cooler objects blacker.

Select ***Inverted (Black Hot)*** to display hotter objects blacker, and cooler objects whiter.

C3.8.5.6 Field of View and Target Range

If a laser rangefinder is installed, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.5.7 Configuration Menu

The ***Configuration Menu*** feature is not available with this model lens.

C3.8.5.8 Non-Uniformity Correction

The ***Non-Uniformity Correction Table*** dropdown box allows the user to select one of several user-defined pixel gain correction tables.

C3.8.5.9 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

C3.8.6 Graflex 27X (Serial) Lens Configuration Screen

The ***Graflex 27X (Serial)*** Lens configuration screen (Figure C3.48) allows the user to adjust the focus and zoom of a Graflex 27X zoom lens. It also provides scaling limits, which are applied to mount movements during track based on real time zoom position feedback.

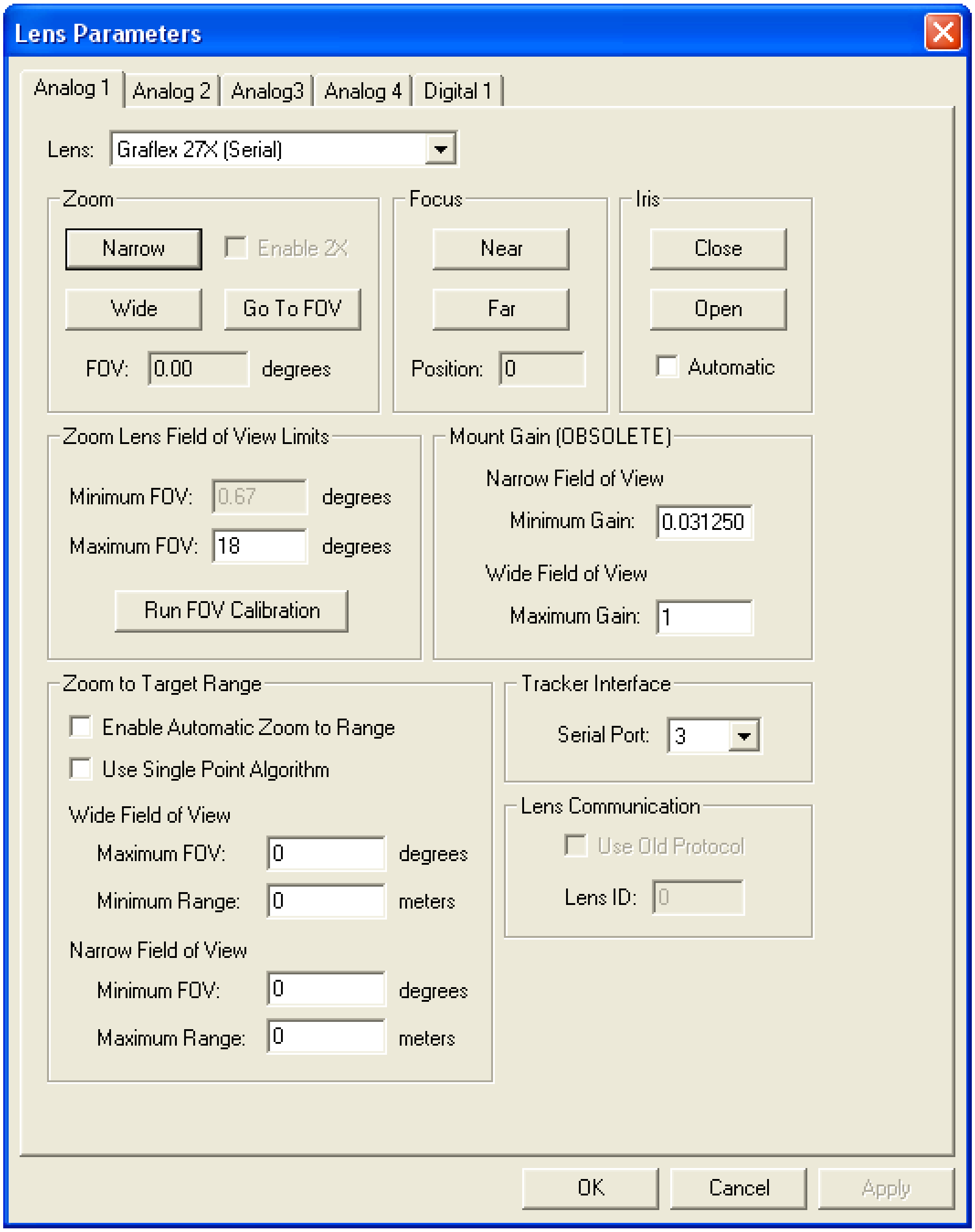

Figure C3.48. Graflex 27X (Serial) Lens Configuration Screen

C3.8.6.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.6.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Position*** box provides feedback on the current focus position.

C3.8.6.3 Iris

Press the ***Close*** button to close down the iris.

Press the ***Open*** button to open up the iris.

Checking the ***Automatic*** checkbox will enable the auto iris feature of the lens. Note that the **Automatic** checkbox must be unchecked for the ***Close*** and ***Open*** buttons to have any effect.

C3.8.6.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.6.5 Mount Gain (OBSOLETE)

C3.8.6.6 Zoom To Target Range

If a laser rangefinder is installed or range data messages are sent to the tracker, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.6.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 5.

C3.8.6.8 Lens Communication

Not available with this model lens.

C3.8.7 Graflex 27X (Vinten) Lens Configuration Screen

The ***Graflex 27X (Vinten)*** Lens Configuration Screen (Figure C3.49) allows the user to adjust the focus and zoom of a Graflex 27X zoom lens integrated with a Vinten HS105P or HS-2010ME mount.

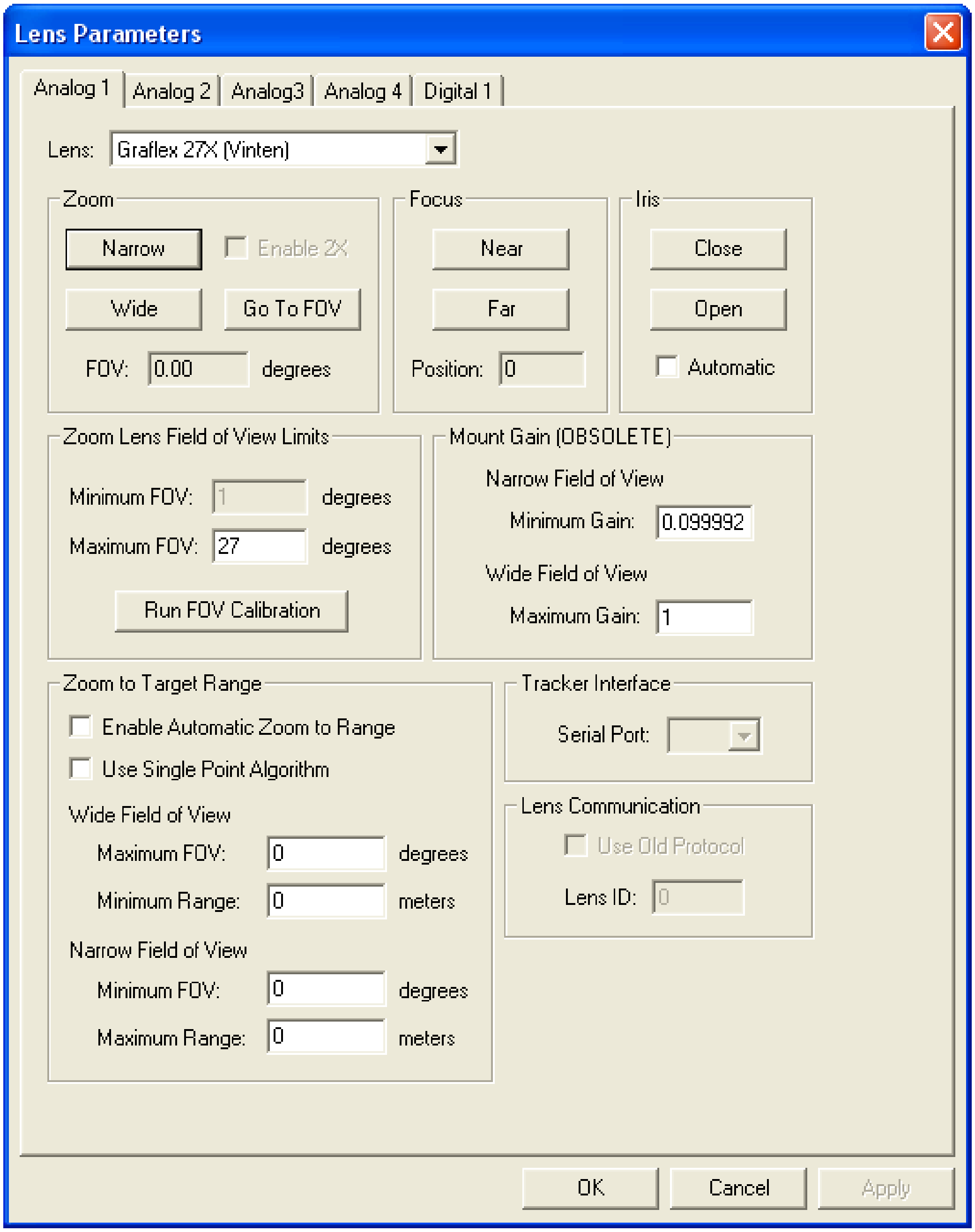

Figure C3.49. Graflex 27X (Vinten) Lens Configuration Screen

C3.8.7.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.7.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Position*** box provides feedback on the current focus position.

C3.8.7.3 Iris

Press the ***Close*** button to close down the iris.

Press the ***Open*** button to open up the iris.

Checking the ***Automatic*** checkbox will enable the auto iris feature of the lens. Note that the **Automatic** checkbox must be unchecked for the ***Close*** and ***Open*** buttons to have any effect.

C3.8.7.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.7.5 Mount Gain (OBSOLETE)

C3.8.7.6 Zoom To Target Range

If a laser rangefinder is installed or range data messages are sent to the tracker, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.7.7 Tracker Interface

The ***Tracker Interface*** dropdown box is disabled as all lens messages are transmitted through the tracker serial communications port for the mount.

C3.8.7.8 Lens Communication

Not available with this model lens.

C3.8.8 Generic Analog Zoom Lens Configuration Screen

The ***Generic Analog Zoom*** Lens configuration screen (Figure C3.50) allows the user to adjust the focus and zoom of a generic analog zoom lens.

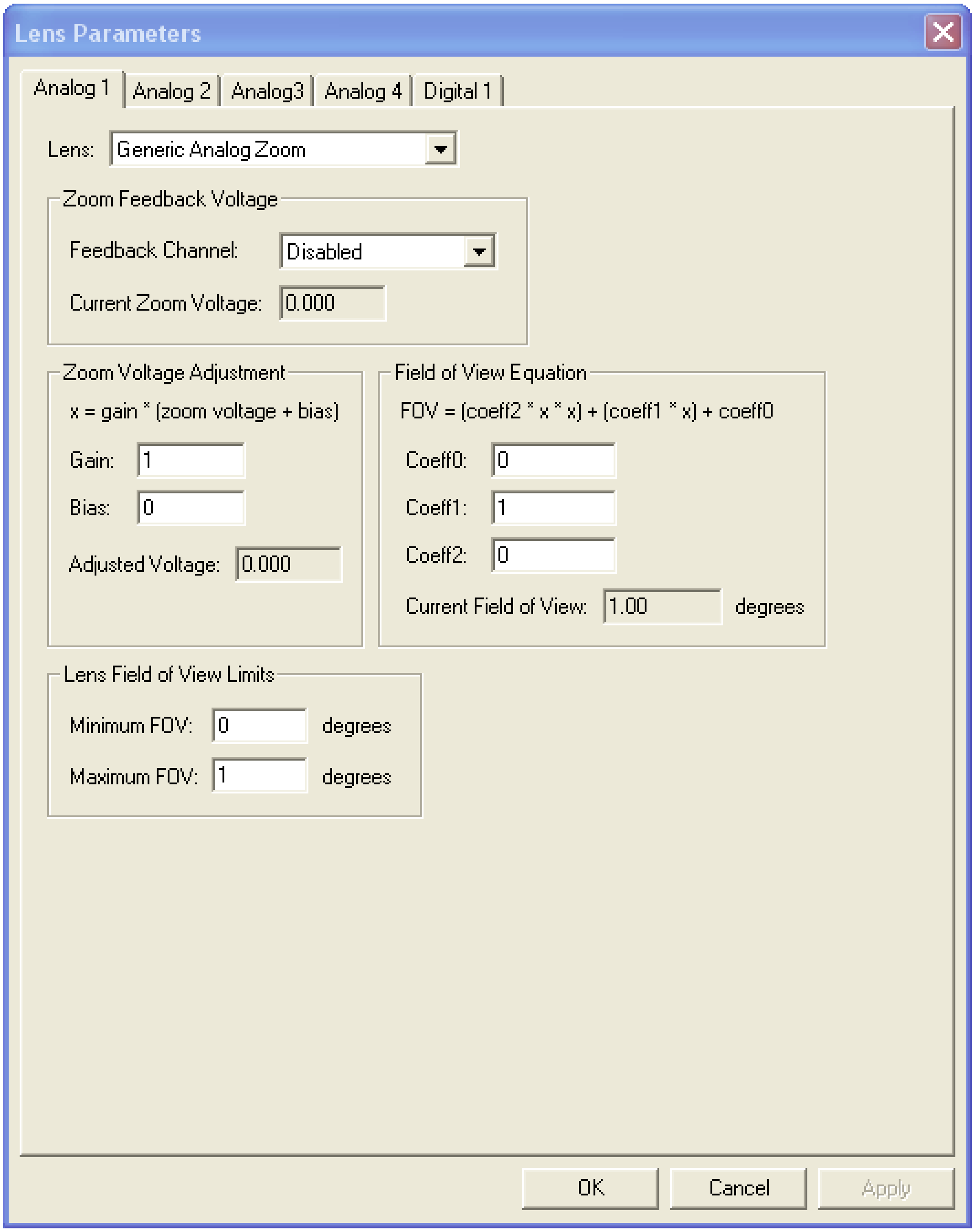

Figure C3.50. Generic Analog Zoom Lens Configuration Screen

C3.8.8.1 Zoom Feedback Voltage

For the ***Zoom Feedback Voltage***, the user may select between one of eight (8) tracker analog inputs, or one of two (2) zoom feedback channels from a Model 702 Controller using the ***Feedback Channel*** dropdown box. The ***Current Zoom Voltage*** is displayed.

C3.8.8.2 Zoom Voltage Adjustment

The ***Zoom Voltage Adjustment*** allows the user to normalize any ***Gain*** and remove any ***Bias*** in the lens' FOV feedback. The ***Adjusted Voltage*** is displayed for verification.

C3.8.8.3 Field Of View Equation

The ***Field of View Equation*** implements a 2^{nd}-order polynomial for the zoom feedback channel data, with ***Coeff0***, ***Coeff1***, and ***Coeff2*** as user-defined coefficients. The ***Current Field of View*** textbox provides user feedback as to the current FOV.

C3.8.8.4 Lens Field Of View Limits

The ***Lens Field of View Limits*** set the ***Minimum FOV*** and ***Maximum FOV*** to user-defined limits, in degrees.

C3.8.9 Cohu MPC Protocol Lens Configuration Screen

The ***Cohu MPC Protocol*** Lens configuration screen (Figure C3.51) allows the user to adjust the focus and zoom of a Cohu MPC Protocol zoom lens.

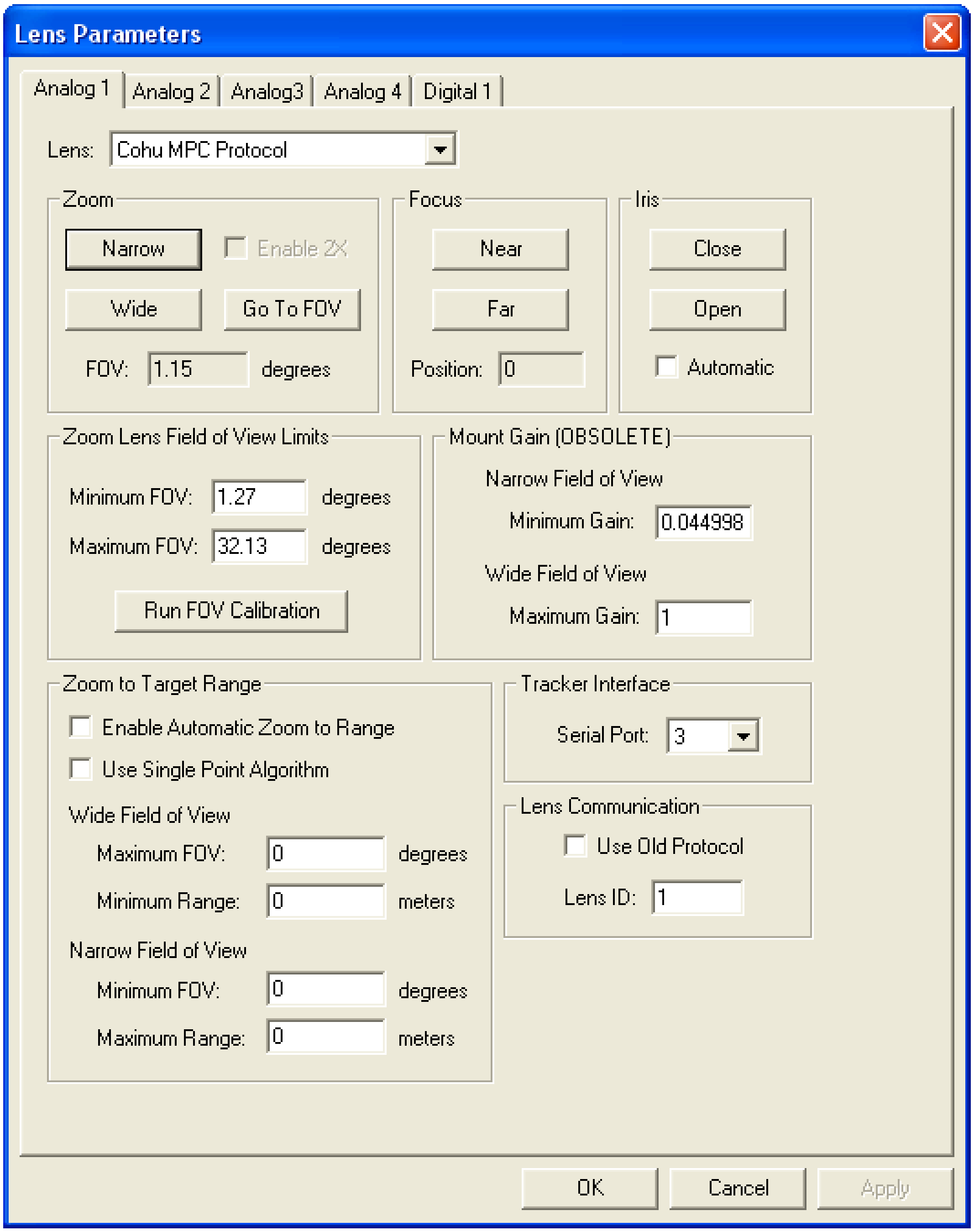

Figure C3.51. Cohu MPC Protocol Lens Configuration Screen

C3.8.9.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.9.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Position*** box provides feedback on the current focus position.

C3.8.9.3 Iris

Press the ***Close*** button to close down the iris.

Press the ***Open*** button to open up the iris.

Checking the ***Automatic*** checkbox will enable the auto iris feature of the lens. Note that the **Automatic** checkbox must be unchecked for the ***Close*** and ***Open*** buttons to have any effect.

C3.8.9.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Minimum FOV*** and ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.9.5 Mount Gain (OBSOLETE)

C3.8.9.6 Zoom To Target Range

If a laser rangefinder is installed or range data messages are sent to the tracker, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.9.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 5.

C3.8.9.8 Lens Communication

Check ***Use Old Protocol*** to operate very old lenses. This protocol is obsolete.

The lens protocol supports multiple lenses and requires a ***Lens ID*** to be included in each command. The Lens ID can be obtained from the camera (on a label or via a local control interface).

C3.8.10 Janos Asio DFOV Lens Configuration Screen

The ***Janos Asio Dual-Field of View (DFOV)*** Lens configuration screen (Figure C3.52) provides the basic level of functionality to adjust the field of view, focus, and line of sight offsets for the Janos Asio DFOV lens.

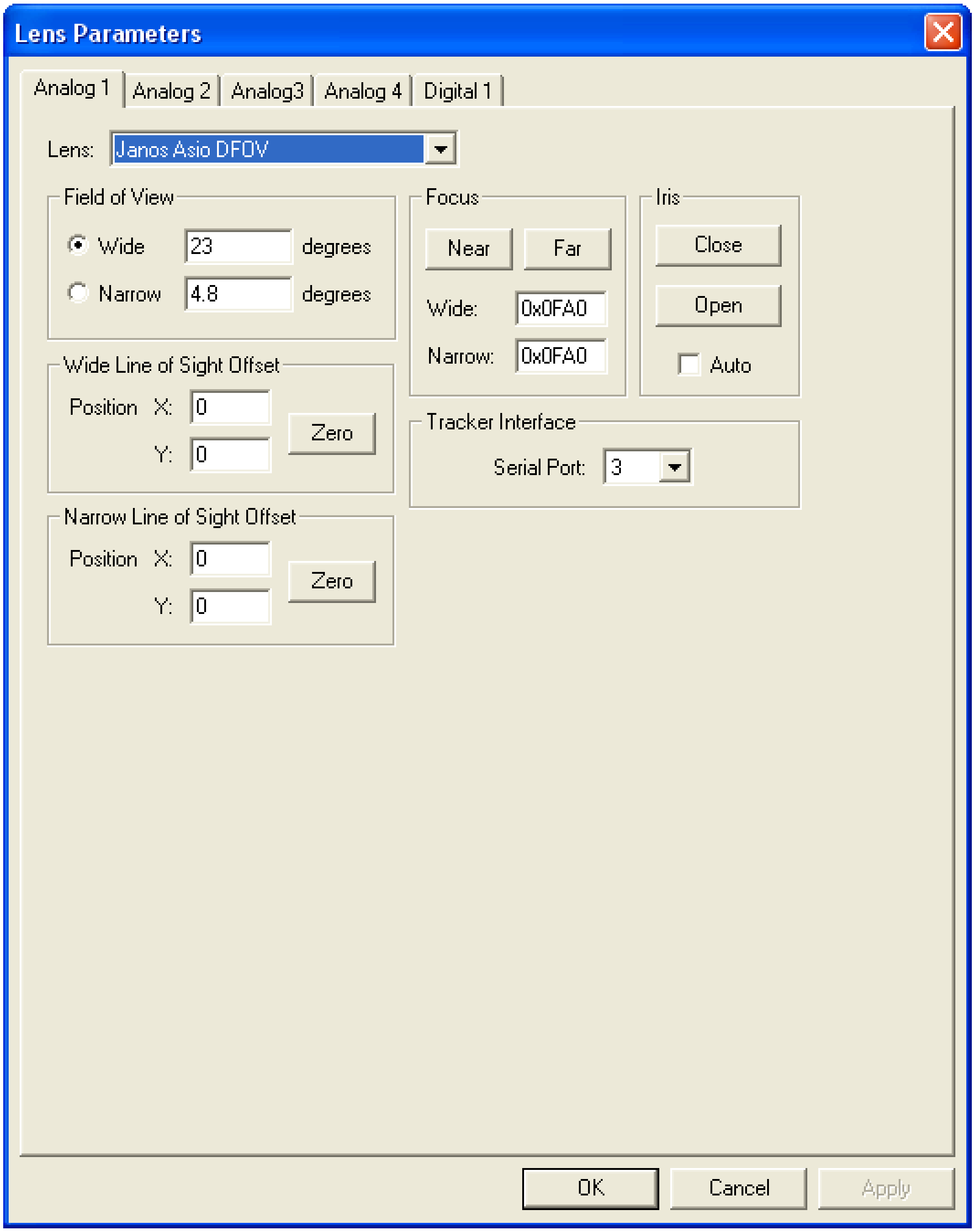

Figure C3.52. Janos Asio DFOV Lens Configuration Screen

C3.8.10.1 Field Of View

The ***Field of View*** radio buttons determine the current FOV for the lens, with two options of ***Wide*** or ***Narrow***. The tracker will then set the focus to the last setting for this FOV input by the user from the GUI or the 702 Controller. Note that the focus setting is stored in FLASH memory when the tracker configuration is saved to FLASH.

C3.8.10.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Wide*** and ***Narrow*** boxes provide feedback on the current focus position for each FOV.

C3.8.10.3 Iris

Press the ***Close*** button to close down the iris.

Press the ***Open*** button to open up the iris.

Check the ***Auto*** check box to have the lens automatically adjust the iris.

C3.8.10.4 Wide Line Of Sight Offset

The ***Wide Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Wide FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.10.5 Narrow Line Of Sight Offset

The ***Narrow Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Narrow FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.10.6 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

C3.8.11 Janos Alba TFOV Lens Configuration Screen

The ***Janos Alba Tri-Field of View (TFOV)*** Lens configuration screen (Figure C3.53) provides the basic level of functionality to adjust the field of view, focus, and line of sight offsets for the Janos Alba TFOV lens.

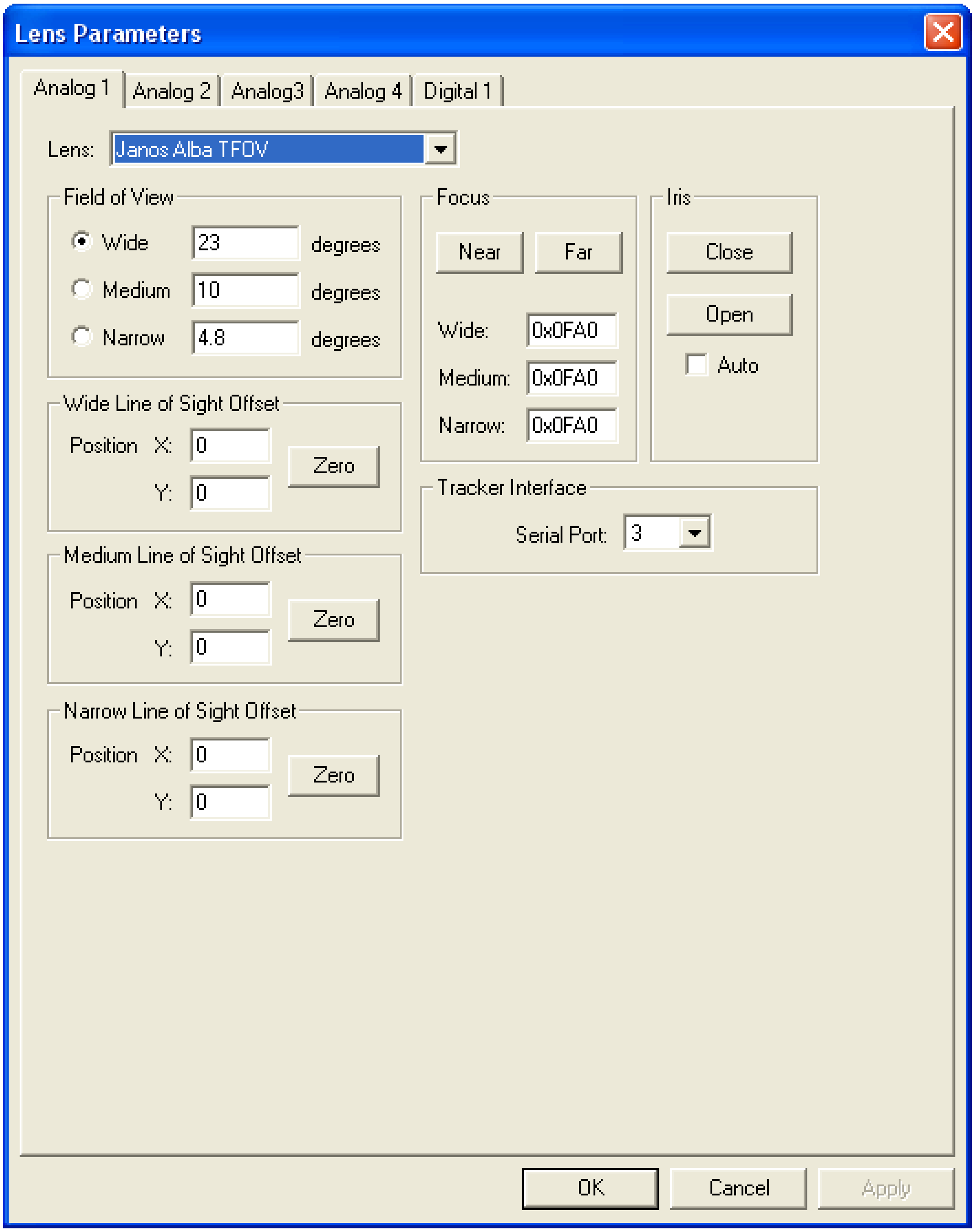

Figure C3.53. Janos Alba TFOV Lens Configuration Screen

C3.8.11.1 Field Of View

The ***Field of View*** radio buttons determine the current FOV for the lens, with three options of ***Wide, Medium,*** or ***Narrow***. The tracker will then set the focus to the last setting for this FOV input by the user from the GUI or the 702 Controller. Note that the focus setting is stored in FLASH memory when the tracker configuration is saved to FLASH.

C3.8.11.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Wide, Medium*** and ***Narrow*** boxes provide feedback on the current focus position for each FOV.

C3.8.11.3 Iris

Press the ***Close*** button to close down the iris.

Press the ***Open*** button to open up the iris.

Check the ***Auto*** check box to have the lens automatically adjust the iris.

C3.8.11.4 Wide Line Of Sight Offset

The ***Wide Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Wide FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.11.5 Medium Line Of Sight Offset

The ***Medium Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Medium FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.11.6 Narrow Line Of Sight Offset

The ***Narrow Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Narrow FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.11.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

C3.8.12 OOS Multiband Telescope Lens Configuration Screen

The ***OOS Multiband Telescope*** Lens configuration screen (Figure C3.54) provides the basic level of functionality to adjust the field of view and focus for the lens.

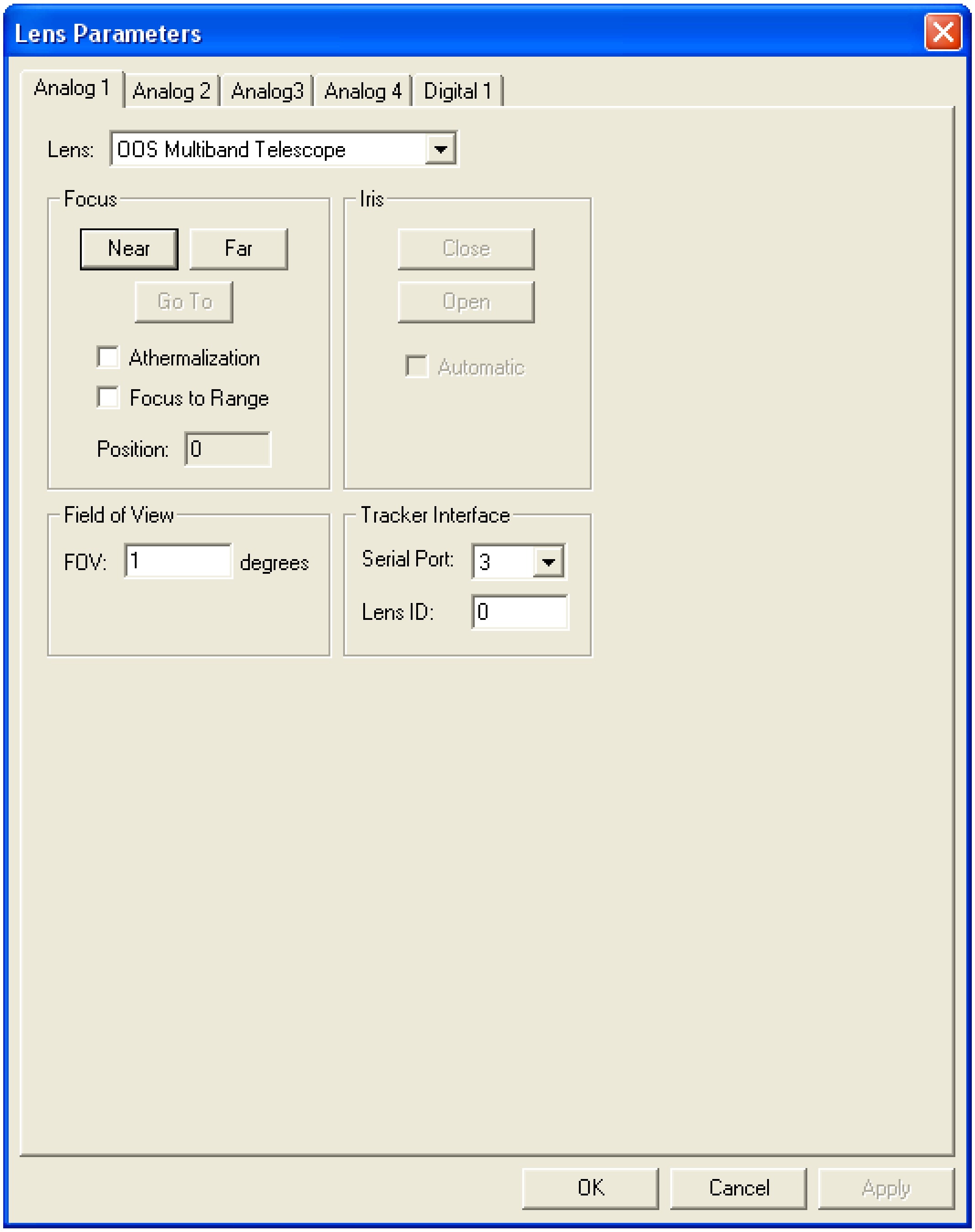

Figure C3.54. OOS Multiband Telescope Lens Configuration Screen

C3.8.12.1 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

Check the ***Athermalization*** checkbox to enable athermalization in the lens. This enables the lens to normalize focus with respect to temperature changes.

Check the ***Focus To Range*** checkbox to enable this feature of the lens (if supported).

The ***Position*** box provides feedback on the current focus position.

C3.8.12.2 Iris

Control of the Iris is not available with this model lens. ***Close***, ***Open*** and ***Automatic*** will be grayed-out .

C3.8.12.3 Field Of View

The ***Field of View*** field sets the field of view of the lens.

C3.8.12.4 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

The lens protocol supports multiple lenses and requires a ***Lens ID*** to be included in each command. The Lens ID can be obtained from the camera (on a label or via a local control interface).

C3.8.13 FLIR MilCAM DFOV Lens Configuration Screen (UNSUPPORTED)

The ***FLIR MilCAM Dual Field-of-View (DFOV)*** Lens is unsupported and the configuration screen is unavailable.

C3.8.14 Fujinon D60 Lens Configuration Screen

The ***Fujinon D60*** Lens configuration screen (Figure C3.55) provides the basic level of functionality to adjust the field-of-view, focus and iris of the lens.

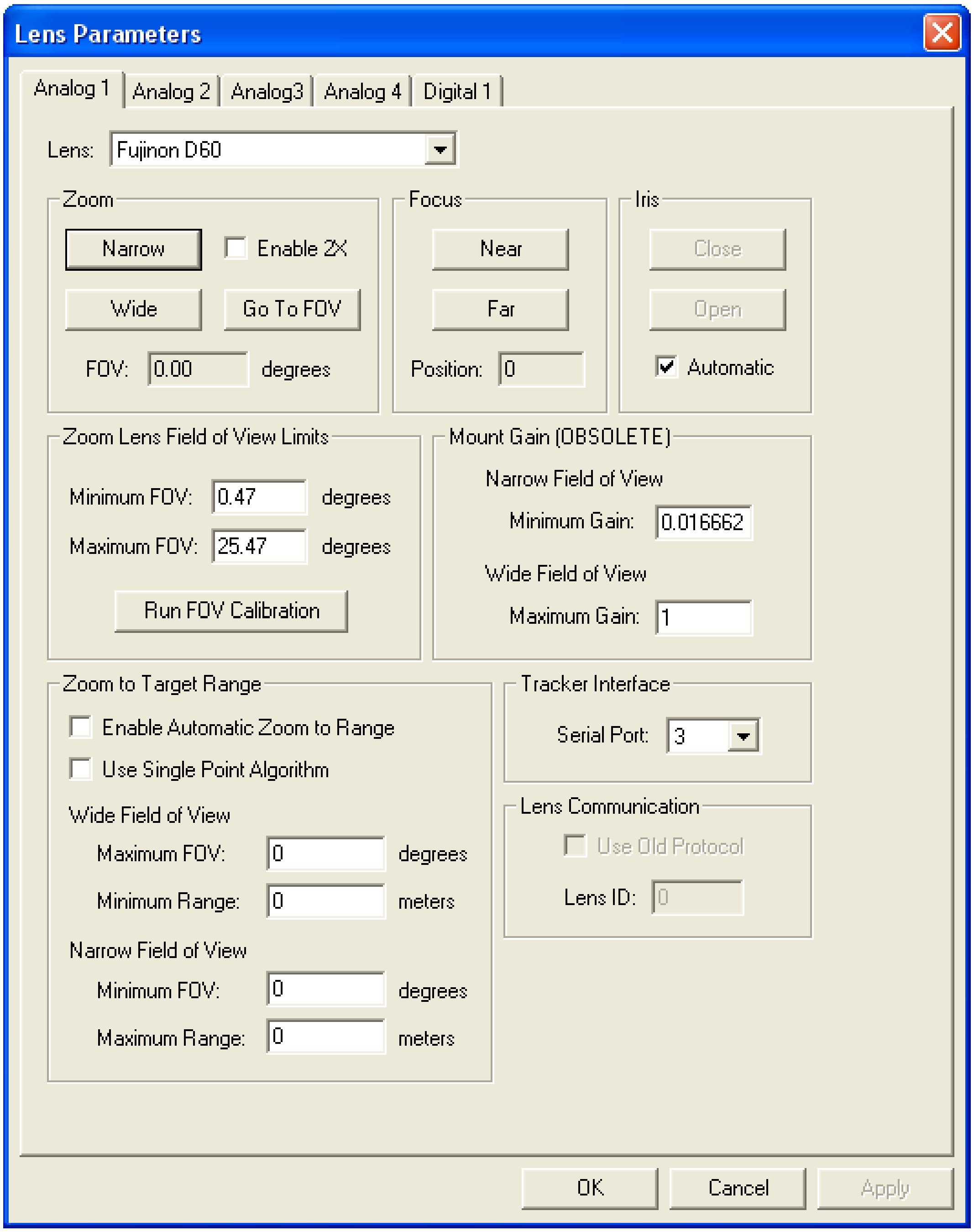

Figure C3.55. Fujinon D60 Lens Configuration Screen

C3.8.14.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Check ***Enable 2X*** checkbox to engage the 2X optical extender feature of the lens.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.14.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Position*** box provides feedback on the current focus position.

C3.8.14.3 Iris

Manual control of the Iris is not available with this model lens. ***Close*** and ***Open*** will be grayed-out and ***Automatic*** will be checked.

C3.8.14.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Minimum FOV*** and ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.14.5 Mount Gain (OBSOLETE)

C3.8.14.6 Zoom To Target Range

If a laser rangefinder is installed or range data messages are sent to the tracker, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.14.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 5.

C3.8.14.8 Lens Communication

Not available with this model lens.

C3.8.15 Graflex 35X Lens Configuration Screen

The ***Graflex 35X*** Lens configuration screen (Figure C3.56) provides the basic level of functionality to adjust the field-of-view, focus, and iris of the lens.

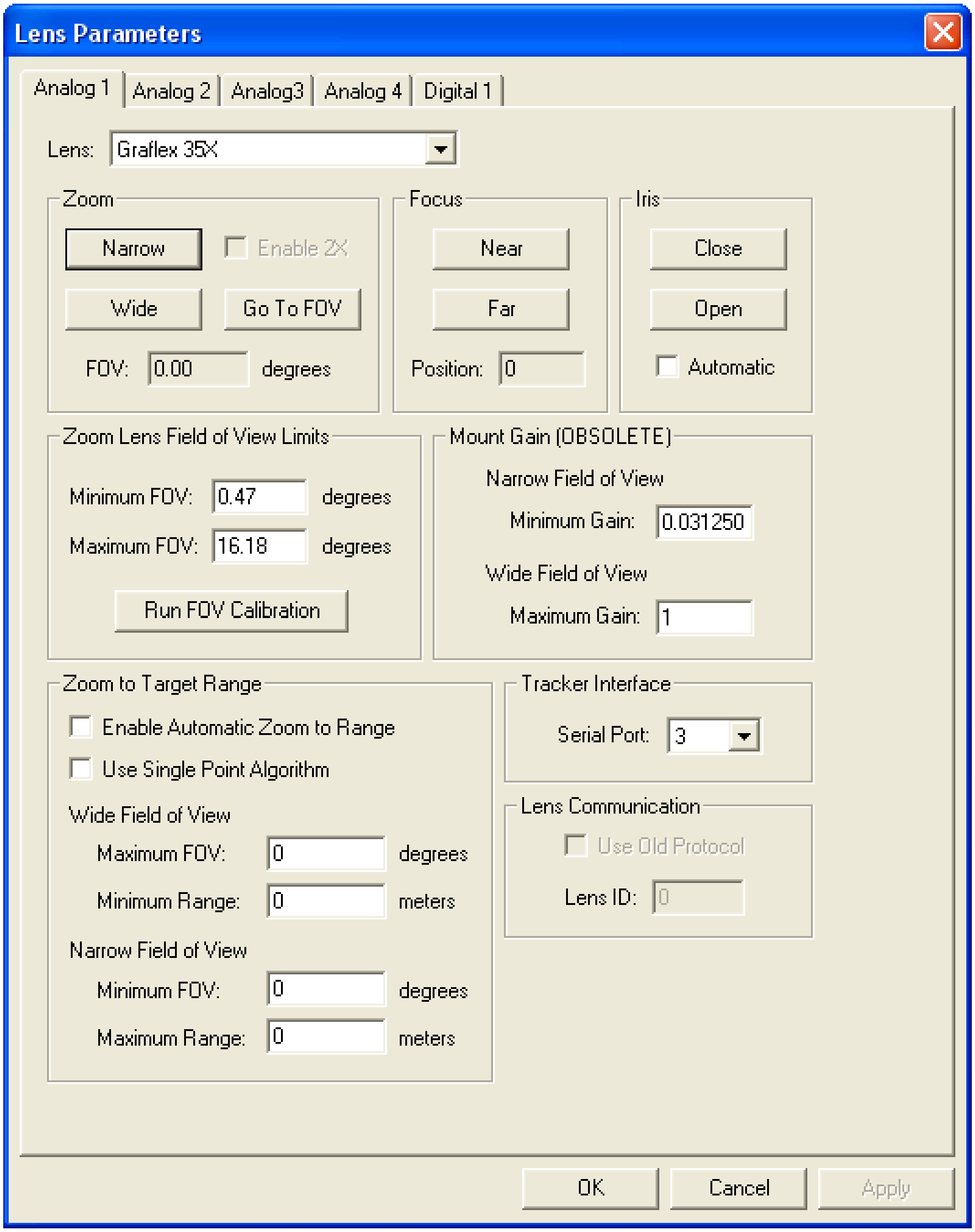

Figure C3.56. Graflex 35X Lens Configuration Screen

C3.8.15.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.15.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Position*** box provides feedback on the current focus position.

C3.8.15.3 Iris

Press the ***Close*** button to close down the iris.

Press the ***Open*** button to open up the iris.

Checking the ***Automatic*** checkbox will enable the auto iris feature of the lens. Note that the **Automatic** checkbox must be unchecked for the ***Close*** and ***Open*** buttons to have any effect.

C3.8.15.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Minimum FOV*** and ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.15.5 Mount Gain (OBSOLETE)

C3.8.15.6 Zoom To Target Range

If a laser rangefinder is installed or range data messages are sent to the tracker, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.15.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 5.

C3.8.15.8 Lens Communication

Not available with this model lens.

C3.8.16 FLIR Ranger HRC Lens Configuration Screen

The ***FLIR Ranger HRC*** Lens configuration screen (Figure C3.57) provides the basic level of functionality to adjust the field-of-view and focus of the lens. Controls to access and manipulate the lenses on-screen Configuration Menu are also provided.

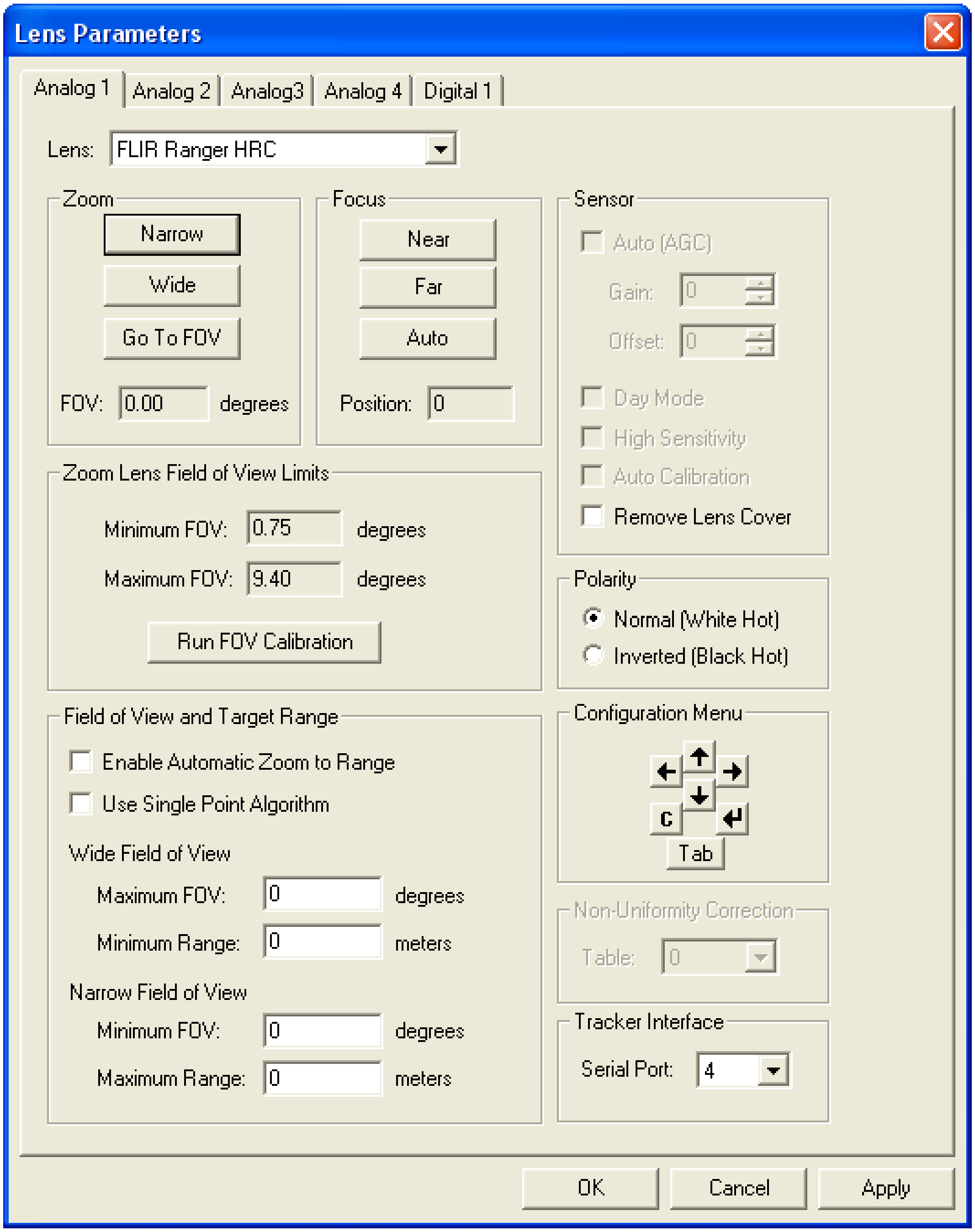

Figure C3.57. FLIR Ranger HRC Lens Configuration Screen

C3.8.16.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV.

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.16.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

Press the ***Auto*** button to set the focus to auto focus.

The ***Position*** box provides feedback on the current focus position.

C3.8.16.3 Sensor

The ***AGC, Day Mode***, ***High Sensitivity*** and ***Auto Calibration*** features are not available for this model lens.

Check the ***Remove Lens Cover*** to enable the automatic lens cover removal feature (if supported).

C3.8.16.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Minimum FOV*** and ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.16.5 Polarity

Select ***Normal (White Hot)*** to display hotter objects whiter and cooler objects blacker.

Select ***Inverted (Black Hot)*** to display hotter objects blacker, and cooler objects whiter.

C3.8.16.6 Field of View and Target Range

If a laser rangefinder is installed, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

The ***Current Field of View*** box provides feedback on the current field of view.

C3.8.16.7 Configuration Menu

The Configuration Menu buttons provide access to the internal FLIR Ranger HRC video overlay configuration menu. The purpose of the buttons is as follows:

- Pressing the Enter button will turn on the configuration menu, or select a highlighted item.
- Pressing the Arrow buttons provide for up/down and left/right movement through the menu items.
- Pressing the Clear button will back up through the menu tree, eventually exiting the configuration menu.
- Pressing the Tab button will advance selected menu values.

C3.8.16.8 Non-Uniformity Correction

The ***Non-Uniformity Correction Table*** feature is not available with this model lens.

C3.8.16.9 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

C3.8.17 Fujinon C22x23R2D-ZP1Lens Configuration Screen

The ***Fujinon C22x23R2D-ZP1*** Lens configuration screen (Figure C3.58) provides the basic level of functionality to adjust the field of view, focus and iris of the lens.

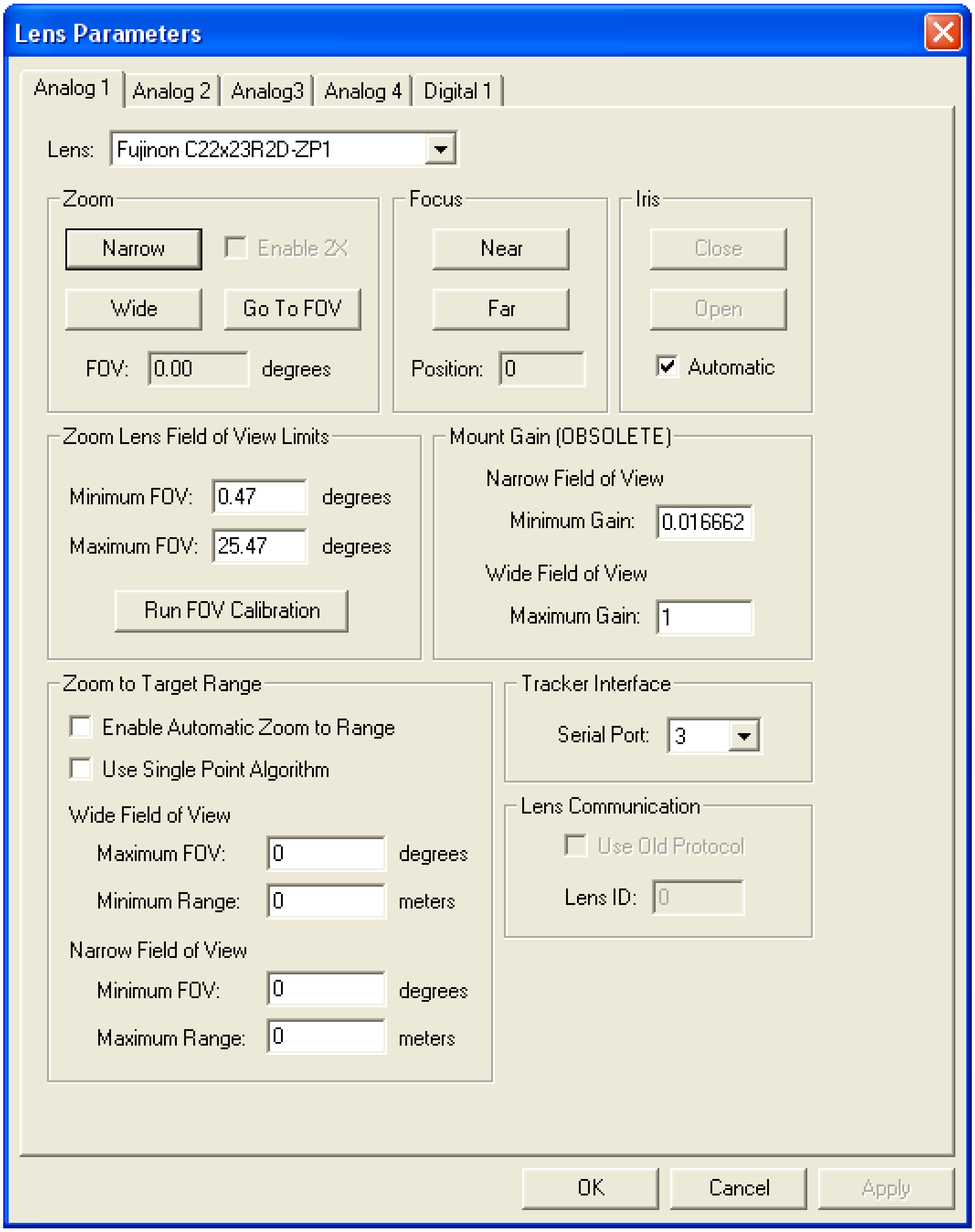

Figure C3.58. Fujinon C22x23R2D-ZP1 Lens Configuration Screen

C3.8.17.1 Zoom

Press the ***Narrow*** button to increase the zoom from wide to narrow.

Press the ***Wide*** button to decrease the zoom from narrow to wide.

Press the ***Go To FOV*** button to focus the lens to a specific FOV. When pressed, a dialog box will be displayed, which will allow the user to enter the desired FOV

The ***FOV*** (Field of View) box provides feedback on the current field of view.

C3.8.17.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Position*** box provides feedback on the current focus position.

C3.8.17.3 Iris

Manual control of the Iris is not available with this model lens. ***Close*** and ***Open*** will be grayed-out and ***Automatic*** will be checked.

C3.8.17.4 Zoom Lens Field Of View Limits

Input boxes allow the user to set the ***Minimum FOV*** and ***Maximum FOV***, in degrees.

Press the ***Run FOV Calibration*** button to automatically calibrate the lens' field of view.

C3.8.17.5 Mount Gain (OBSOLETE)

C3.8.17.6 Zoom To Target Range

If a laser rangefinder is installed or range data messages are sent to the tracker, checking the ***Enable Automatic Zoom to Range*** checkbox will enable automatic zooming of the camera based upon target range. The ***Minimum Range*** and ***Maximum Range***, defined in meters, determine the range of distances a target must fall within to be considered valid. The ***Maximum FOV*** and ***Minimum FOV***, defined in degrees, determine the FOV range the camera may zoom to while tracking the target.

The ***Use Single Point Algorithm*** checkbox, also controls automatic zooming of the camera, based on target range. Alternately, it uses ***Maximum FOV*** and ***Minimum Range*** fields to specify a desired field-of-view (***Maximum FOV***) at a specified range (***Minimum Range)***. Using these two parameters, the tracker linearly scales the FOV (automatic zoom).

C3.8.17.7 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 5.

C3.8.17.8 Lens Communication

Not available with this model lens.

C3.8.18 Graflex Fixed FOV Lens Configuration Screen

The ***Graflex Fixed FOV*** Lens configuration screen (Figure C3.59) provides the basic level of functionality to set the field of view and adjust the focus and iris of the lens.

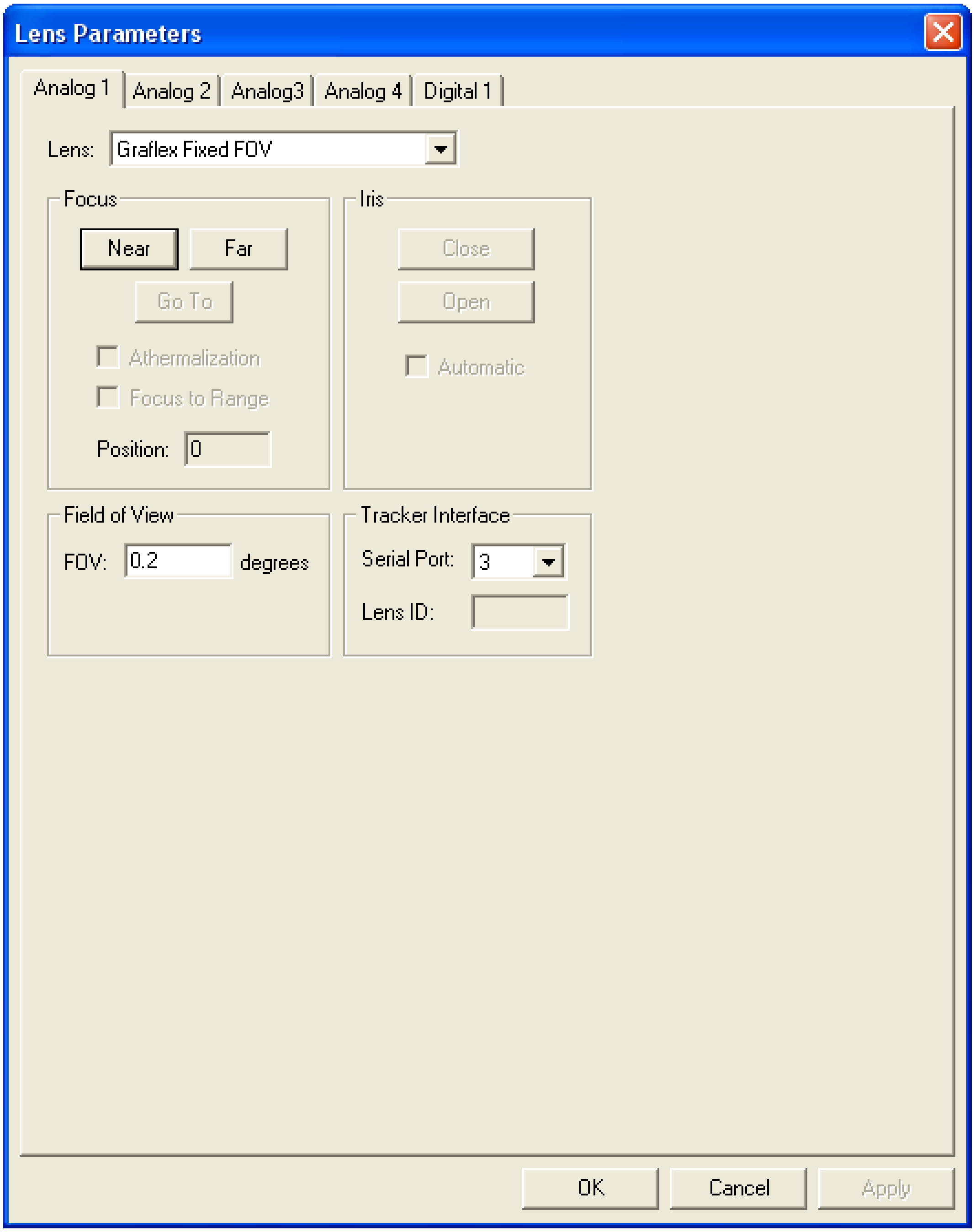

Figure C3.59. Graflex Fixed FOV Lens Configuration Screen

C3.8.18.1 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

The ***Go To FOV*** feature is not available for this lens type.

The ***Athermalization*** feature is not available for this lens type.

The ***Focus To Range*** feature is not available for this lens type.

The ***Position*** box provides feedback on the current focus position.

C3.8.18.2 Iris

Control of the Iris is not available for this lens type. ***Close***, ***Open*** and ***Automatic*** will be grayed-out.

C3.8.18.3 Field Of View

The ***Field of View*** field allows the user to sets the measured field of view for the lens.

C3.8.18.4 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

The ***Lens ID*** feature is not applicable for this lens type.

C3.8.19 FLIR RS6700 DFOV Lens Configuration Screen

The ***FLIR RS6700 DFOV*** Lens configuration screen (Figure C3.60) provides a basic level of functionality to set the field of view and adjust the focus and iris of the lens.

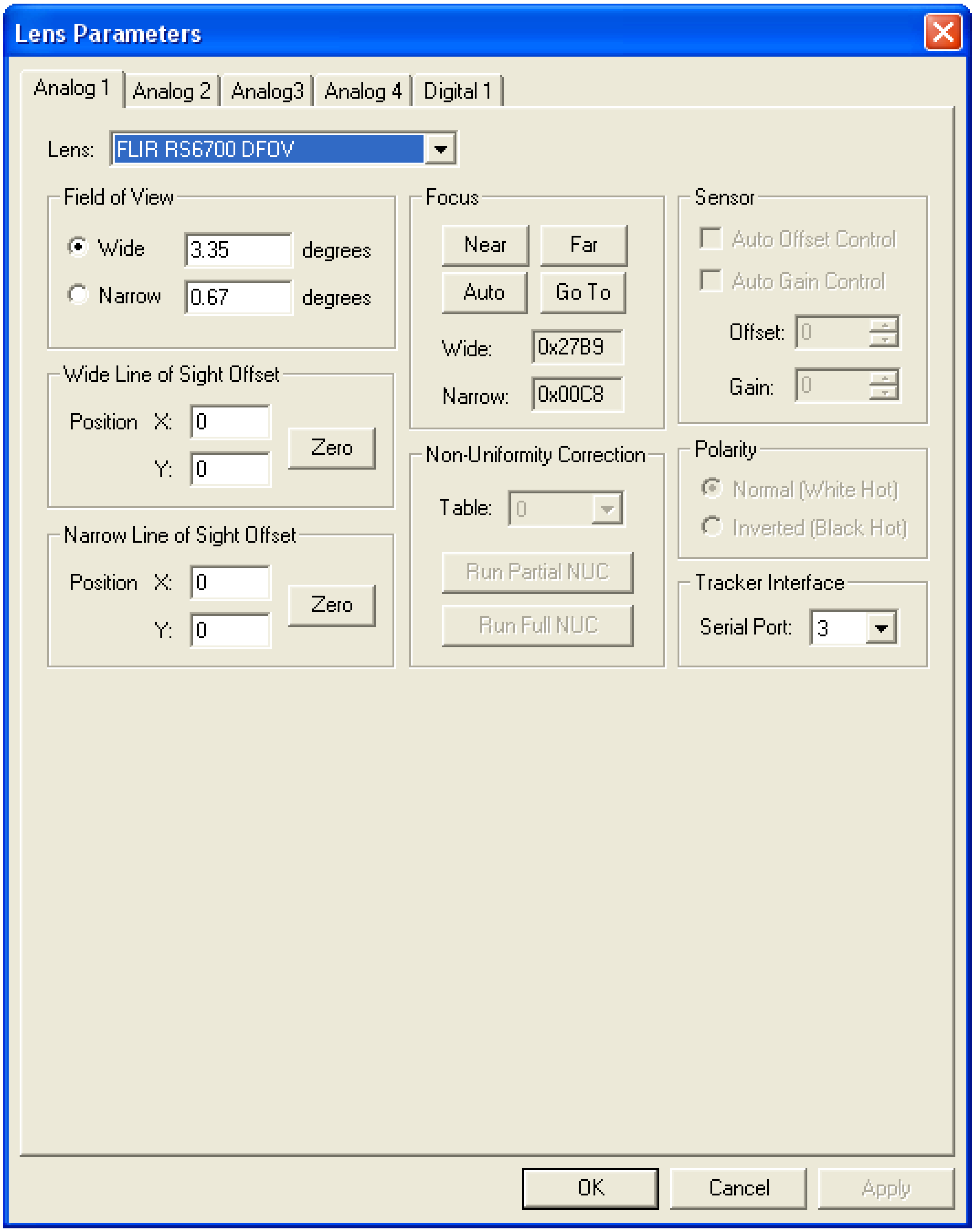

Figure C3.60. FLIR RS6700 DFOV Lens Configuration Screen

C3.8.19.1 Field Of View

The ***Field of View*** radio buttons select and report the current FOV for the lens of either ***Wide*** or ***Narrow***. The tracker will also set the focus to the last setting for this FOV. Note that the focus settings are stored in FLASH memory when the tracker configuration is saved to FLASH.

C3.8.19.2 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

Press the ***Auto*** button to set the focus to auto focus.

Press the ***Go To*** button to focus the lens to a specific position. When pressed, a dialog box will be displayed, to allow the user to enter a desired focus position.

The ***Wide*** and ***Narrow*** boxes provide feedback on the current focus position for each FOV.

C3.8.19.3 Sensor

The ***Auto/Manual Offset*** and ***Auto/Manual Gain*** features are not available with this model lens.

C3.8.19.4 Wide Line Of Sight Offset

The ***Wide Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Wide FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.19.5 Narrow Line Of Sight Offset

The ***Narrow Line of Sight Offset*** defines the ***X Position*** and ***Y Position*** for the Narrow FOV-specific LOS offset. The X and Y positions may be zeroed by clicking on the ***Zero*** button.

C3.8.19.6 Non-Uniformity Correction

The ***Non-Uniformity Correction Table*** feature is not available for this lens type.

C3.8.19.7 Polarity

The ***Polarity*** feature is not available for this lens type.

C3.8.19.8 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

C3.8.20 Optec Telescope Focuser Lens Configuration Screen

The ***Optec Telescope Focuser*** Lens configuration screen (Figure C3.61) provides a basic level of functionality to set the field of view and adjust the focus of the lens.

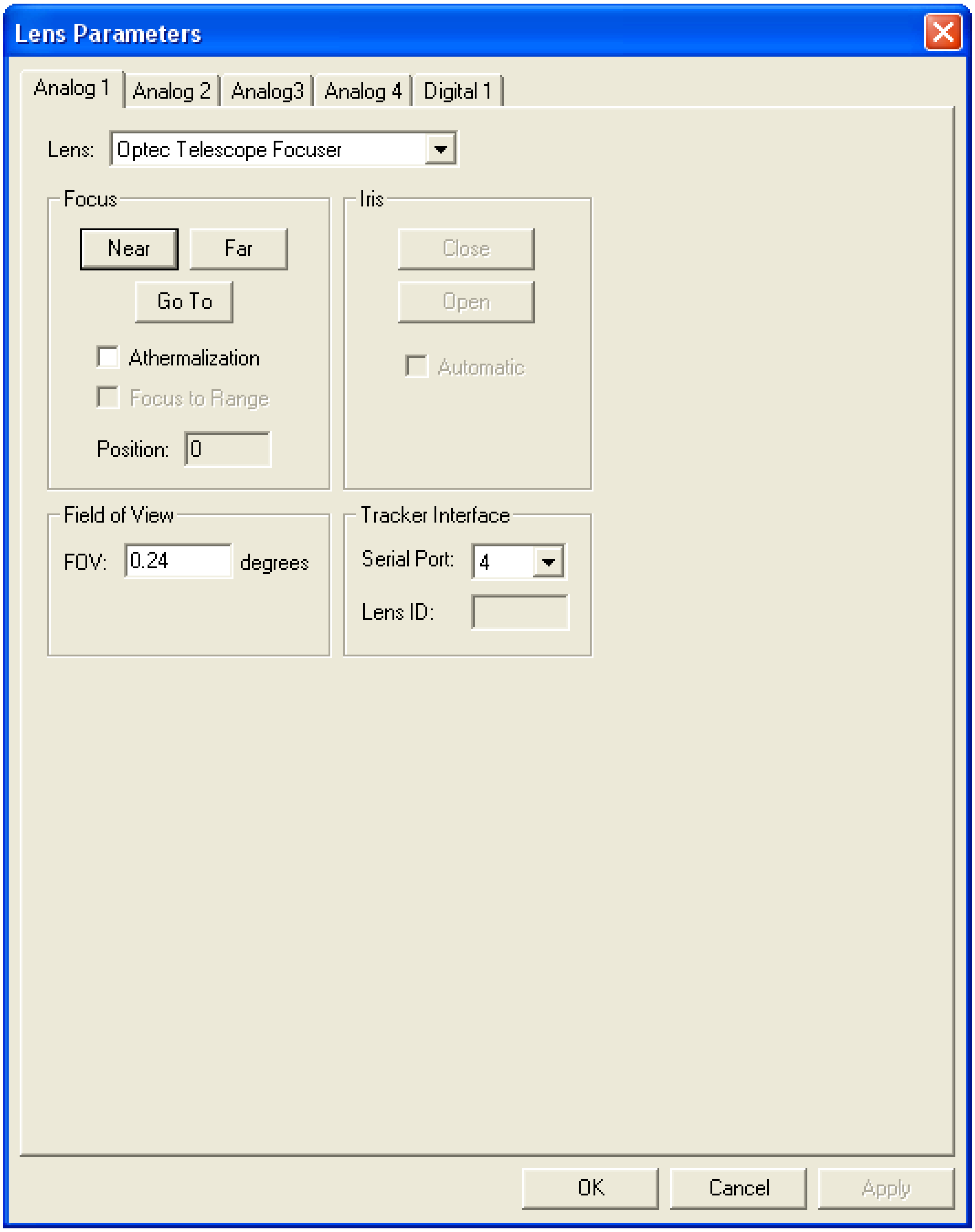

Figure C3.61. Optec Telescope Focuser Lens Configuration Screen

C3.8.20.1 Focus

Press the ***Near*** button to change the focus from far to near.

Press the ***Far*** button changes the focus from near to far.

Press the ***Go To*** button to set the lens to a specific focus position. When pressed, a dialog box will be displayed, which will allow the user to enter a desired focus position.

Check the Athermalization box to enable athermalization in the lens. This enables the lens to normalize focus with respect to temperature changes.

The ***Focus To Range*** feature is not available for this lens type.

The ***Position*** box provides feedback on the current focus position.

C3.8.20.2 Iris

Control of the Iris is not available for this lens type. The ***Close***, ***Open*** and ***Automatic*** controls will be grayed-out .

C3.8.20.3 Field Of View

The ***Field of View*** field sets the measured field of view of the lens.

C3.8.20.4 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 3.

The ***Lens ID*** feature is not applicable for this lens type.

C3.9 Camera Button (DEPRECATED)

The ***Camera Button*** control screen (Figure C3.62) contains five tabs, one for each video input to the tracker. Initially, the Camera type is set to none for all four video inputs. The display will be updated when a Camera type is selected and the ***Apply*** button is pressed. The screen displayed will depend on the type of camera selected. Contact E-O Imaging if your application requires support for a camera not listed below.

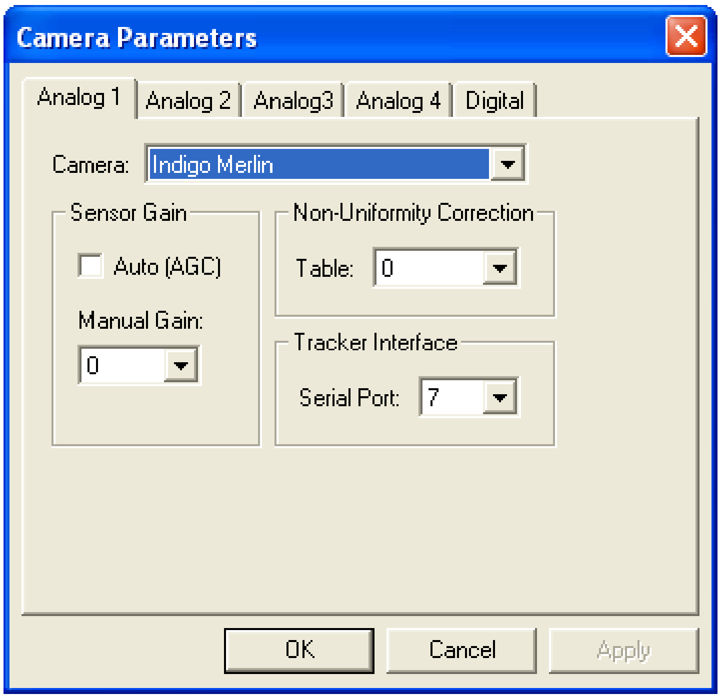

Figure C3.62. Camera Configuration Screen

C3.9.1 Camera

Currently the ***Indigo Merlin*** is the only camera supported.

C3.9.1.1 Sensor Gain

Check the ***Sensor Gain Auto (AGC)*** checkbox to enable automatic gain control.

A ***Manual Gain*** of 0-3 may also be applied by selecting the gain from the dropdown box.

C3.9.1.2 Non-Uniformity Correction

The ***Non-Uniformity Correction Table*** dropdown box allows the user to select one of several user-defined pixel gain correction tables.

C3.9.1.3 Tracker Interface

The ***Tracker Interface*** dropdown box allows the user to select a tracker serial communications port between 3 and 7 for the lens. The default tracker serial port is 7.

C4 Main Menu Bar

The ***Main Menu Bar*** provides the standard Windows functions of this program.

C4.1 File Menu

The ***File*** menu (Figure C4.1) contains GUI system-level operations.

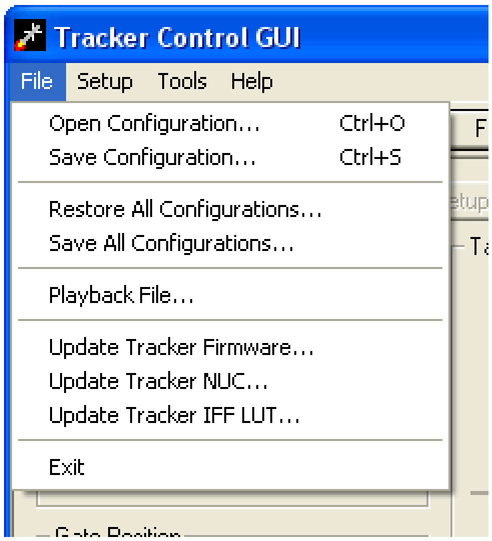

Figure C4.1. File Menu

C4.1.1 Open Configuration

The user can open a tracker configuration (.xml) file. This file will be used by the GUI to send configuration messages to the tracker.

C4.1.2 Save Configuration

The user can save a tracker configuration file. The GUI will query the tracker for the current settings, and save them to the selected .xml file.

C4.1.3 Restore All Configurations

The user can restore all ten saved tracker configurations by using the "Restore All Configurations…" file menu. The user will select the first in a sequence of saved .xml files. The GUI will then load each of ten configurations, and save the configuration in the tracker FLASH.

C4.1.4 Save All Configurations

The user can save all tracker configurations by using the "Save All Configurations…" menu item. The tracker will load each of ten configurations from FLASH and send the config to the GUI. The GUI will store the configuration for each FLASH bank as an xml file with the base of the filename as entered in the dialog. Subsequent filenames will be created using {base filename+0-9}.xml.

C4.1.5 Playback File

The file playback feature allows the user to playback a set of mount positions through the tracker. The tracker will command the mount at video rate using the positions in the file.

C4.1.6 Update Tracker Firmware

The ***Update Tracker Firmware*** menu option allows the user to download updated DSP and FPGA firmware to the tracker without sending the unit back to E-O Imaging for service. Instructions will be provided with each firmware update issued. When applying firmware updates, make sure the tracker has a reliable power source such as a UPS. Loss of power during a firmware update may result in an inoperable unit that must be returned to E-O Imaging for service.

C4.1.7 Update Tracker NUC

The ***Update Tracker NUC*** menu option allows the user to download camera non-uniformity correction and bad pixel replacement tables to the tracker. This is a custom feature and requires specific firmware.

C4.1.8 Update Tracker IFF LUT

The ***Update Tracker IFF LUT*** menu option allows the user to download a look-up table for the Identification Friend or Foe (IFF) tracking function. This is a custom feature and requires specific hardware. Reference Section C4.3.13.

C4.1.9 Exit

Select the ***Exit*** menu option to close the tracker control program. The ✕ button in the upper right corner of the window will also close the program. There are no advantages to using one method over the other with this program.

C4.2 Setup Menu

The ***Setup*** menu (Figure C4.2) contains entries that provide GUI configuration functions. These settings determine how the PC running the GUI will communicate with the tracker and other attached devices.

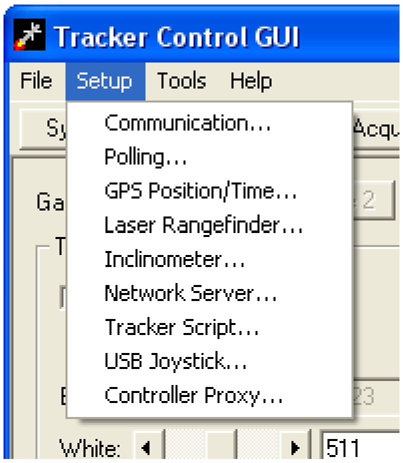

Figure C4.2. Setup Menu

C4.2.1 Setup Communication Screen

The ***Communication*** screen (Figure C4.3) allows the user to select which method the GUI should use to communicate with the tracker.

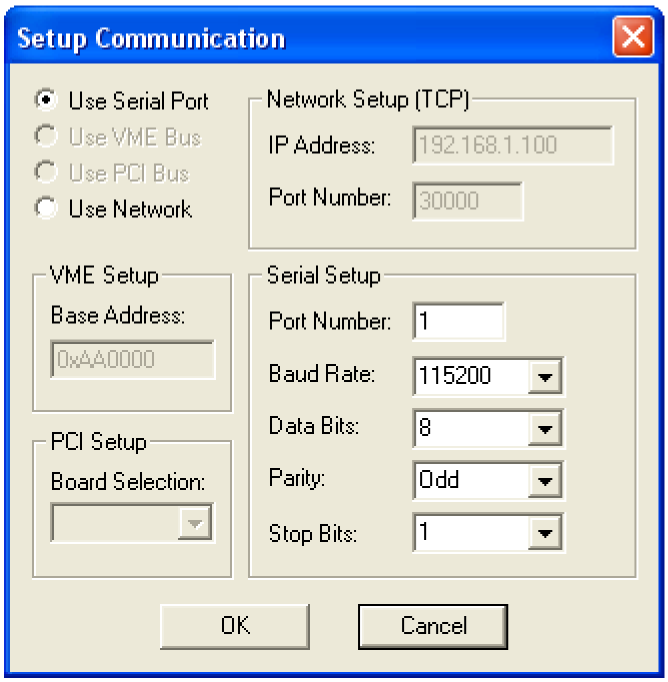

Figure C4.3. Setup Communication Screen

C4.2.1.1 Serial Setup

The ***Port Number*** entry refers to the PC's serial COM port when ***Use Serial Port*** is selected. This selection must correspond to the connector on the PC where the serial cable is attached. The other setting options in this window default to the values expected by the tracker. These values should not be modified for tracker communications. The ***Baud Rate*** should be set to 115200, ***Data Bits*** should be set to 8, ***Parity*** should be set to Odd, and ***Stop Bits*** should be set to 1.

C4.2.1.2 VME Setup

Use VME Bus can only be selected when the GUI is running on a XYCOM VME-based PC. Also, the XYCOM Windows VME drivers must also be installed for the GUI to function. The ***Base Address*** should be set according to the switch selection on the tracker board. ***Reference Appendix B, Section B1.2 Bus Communication Protocol.***

C4.2.1.3 PCI Setup

Use PCI Bus can only be selected when the GUI is running on a PCI-based computer. A dropdown box for ***Board Selection*** is provided to select between multiple boards installed in the same system.

C4.2.1.4 Network Setup

Use Network can be selected if the tracker's gigabit Ethernet port is connected directly to the computer or to a network which the computer is a member. Enter the ***IP Address*** of the tracker to control. The tracker can be configured to use a fixed IP address. By default, the tracker will use DHCP to automatically obtain an IP address. First use serial communications with the tracker to change these settings. In rare cases, the ***Port Number*** can also be changed from the default value of 30,000.

C4.2.2 Setup Tracker Polling Screen

When the tracker is set for Command Triggered Output at the System control panel, the tracker will only send out status and track error information in response to a message. To provide data for the Real Time Data display on the Run-Time Control screen, the GUI sends a ping message to the tracker at a configurable interval. These parameters are defined using the ***Tracker Polling*** screen (Figure C4.4). The tracker responds to the ping message with data for the display update. The ***Real-Time Data Update*** value is the time interval, in milliseconds, between these ping messages. If no ping messages are desired, a zero should be entered in this field. If Field Rate (50/60 Hz) output is selected in the System control panel, messages triggered by the value in this parameter will be sent in addition to the field rate data.

The ***Comm Activity Update*** value defines the interval between updates of the colored status lights on the Run Time Control screen's Real Time Data Display that indicates communication activity to and from the tracker.

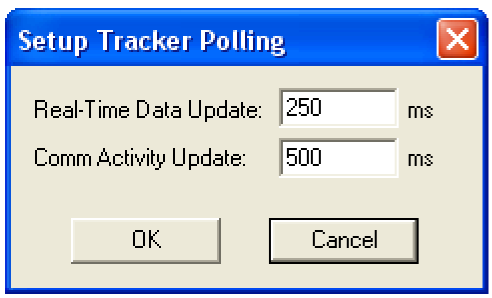

Figure C4.4. Tracker Polling Setup Screen

C4.2.3 Setup GPS Position and Time Screen

The ***GPS Position and Time*** screen (Figure C4.5) allows the user to enable GPS position and IRIG clocks, as well as define the data's annotation. Check the ***Use Brandywine VME SyncClock*** box if you are running the GUI on a supported Xycom or VMIC/GEFanuc VMEbus PC and have a Brandywine VME SyncClock installing in the same VME chassis. Set the ***VME Base Address*** to the base address of the board. This will allow the GUI to communicate with the Brandywine board to get the current GPS position and time. Brandywine PCI SyncClock boards will automatically be detected if installed. The GPS position and time information will be logged to disk along with the tracker data.

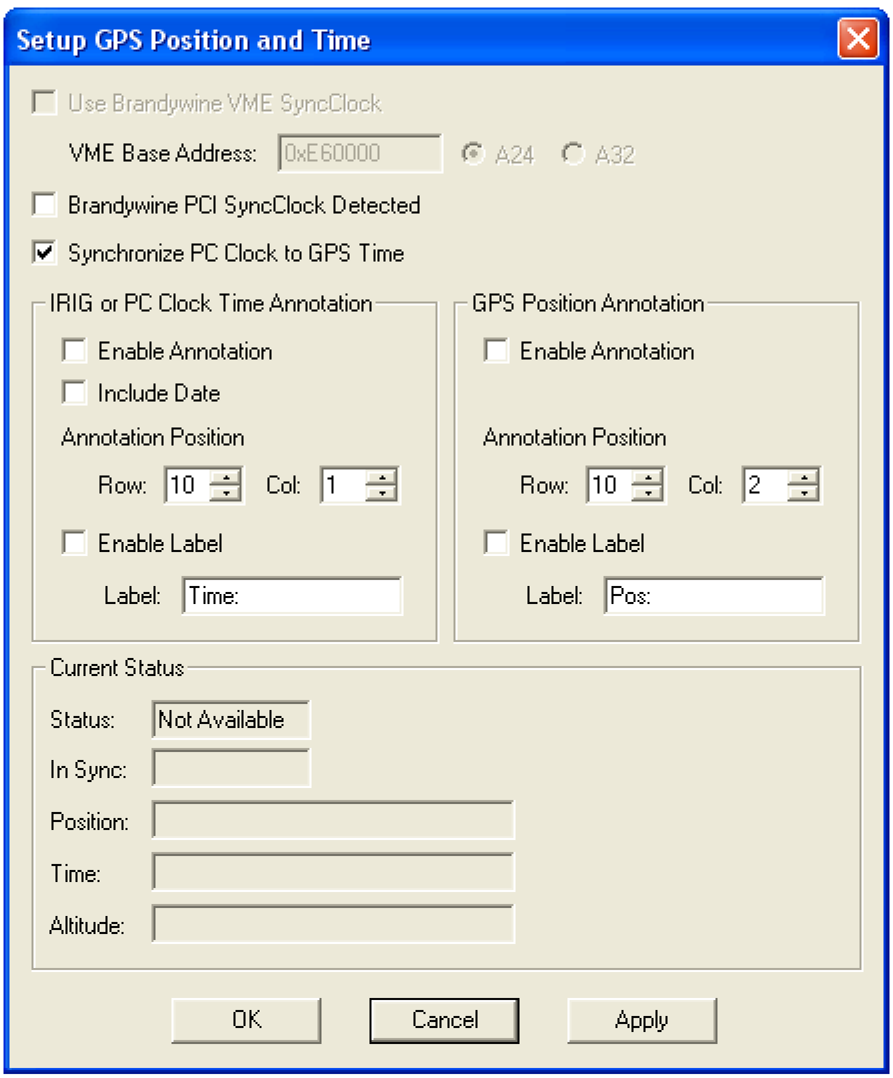

Figure C4.5. Setup GPS Position and Time Screen

C4.2.3.1 Brandywine PCI SyncClock Detected

The ***Brandywine PCI SyncClock Detected*** checkbox is checked when the GUI detects a PCI or PCIe SyncClock board on the PCI or PCIe bus.

C4.2.3.2 Synchronize PC Clock to GPS Time

When checked, use the IRIG time to set the computer's internal clock.

C4.2.3.3 IRIG Time Annotation Enable

When checked, the ***Enable Annotation*** checkbox inserts an IRIG time annotation into the video signal at the position chosen in the ***Row*** and ***Column*** input boxes.

When checked, the ***Include Date*** checkbox inserts the date in the GPS annotation.

When checked, the ***Enable Label*** checkbox inserts a user-defined label directly before the IRIG time annotation.

C4.2.3.4 GPS Position Annotation Enable

When checked, the ***Enable Annotation*** checkbox inserts a GPS Position annotation into the video signal at the position chosen in the ***Row*** and ***Column*** input boxes.

When checked, the ***Enable Label*** checkbox inserts a user-defined label directly before the GPS position annotation.

C4.2.4 Setup Laser Rangefinder Screen (OBSOLETE)

The ***Laser Rangefinder*** screen (Figure C4.6) controls an Advanced Laser Systems Technology (ALST) laser rangefinder connected to a serial port of the computer running the GUI. Check the ***Enabled*** box to start periodically firing the laser and collecting range data. The last range measured will be logged to disk along with the tracker data.

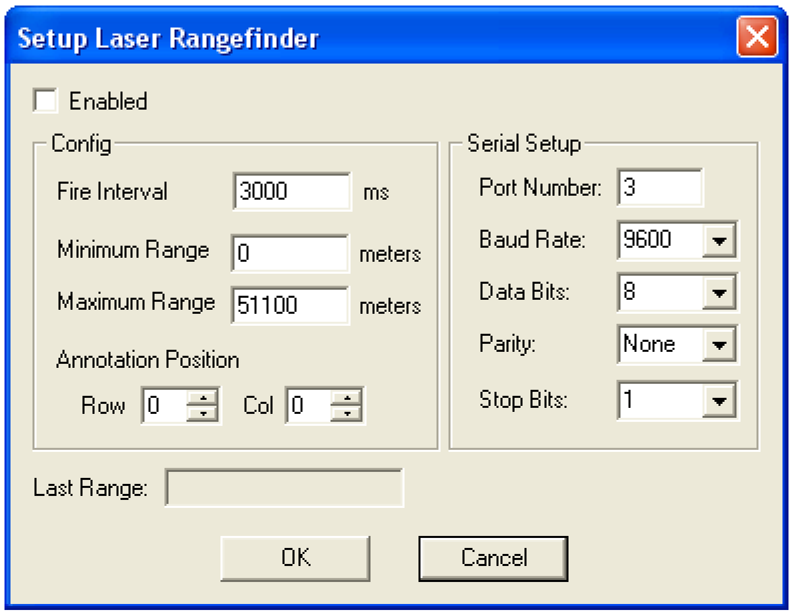

Figure C4.6. Setup Laser Rangefinder Screen

C4.2.4.1 Configuration

The ***Fire Interval*** defines the time, in milliseconds, between successive firings.

The window for a valid target, in meters, may be defined using the ***Minimum Range*** and ***Maximum Range*** fields.

The range to target distance will be displayed on the screen at the user-defined location defined by the ***Row*** and ***Column*** fields.

C4.2.4.2 Serial Setup

The ***Port Number*** entry refers to the tracker's serial COM port used to communicate with the rangefinder. Default communications settings are ***Port Number*** 3, a ***Baud Rate*** of 9600, ***Data Bits*** should be set to 8, ***Parity*** should be set to None, and ***Stop Bits*** should be set to 1.

C4.2.4.3 Feedback

The range to the last target captured is shown in the ***Last Range*** field.

C4.2.5 Setup Inclinometer

The ***Setup Inclinometer*** screen (Figure C4.7) communicates with an Applied Geomechanics or Jewell Instruments MD900 series inclinometer connected to a serial port of the computer running the GUI.

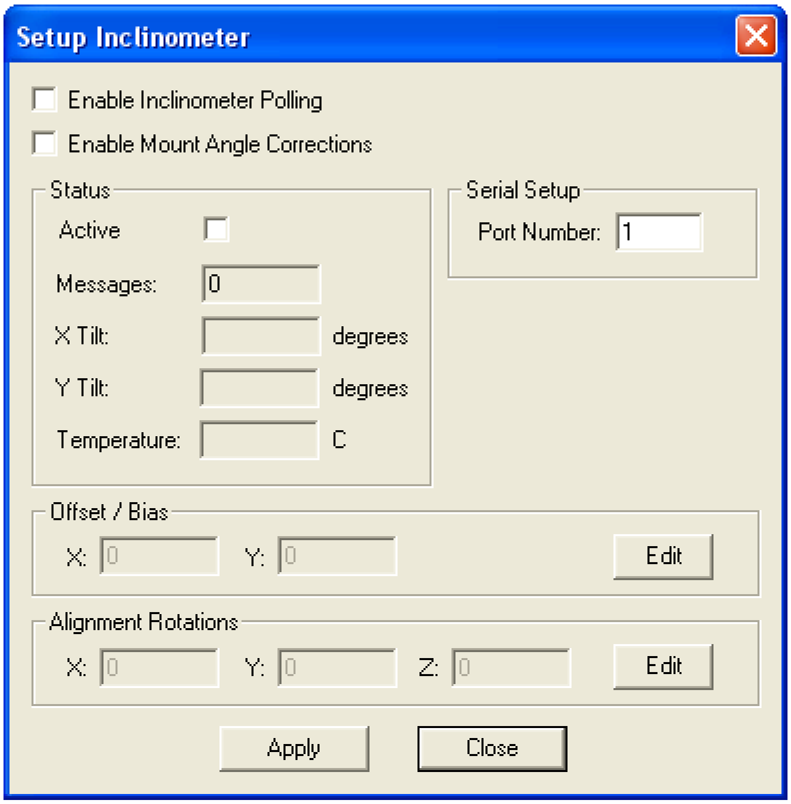

Figure C4.7. Setup Inclinometer Screen

C4.2.5.1 Enables

Checking the ***Enable Inclinometer Polling*** checkbox opens the computer's serial port and attempts to establish communications with the inclinometer. Once communication is established, the inclinometer is polled periodically to update the tilt angles and status information. Once a stable reading is obtained, this checkbox can be unchecked to disable updates and use a fixed set of tilt values for operation.

Checking the ***Enable Mount Angle Corrections*** checkbox will apply inclinometer corrections to the mount pointing angle data in order to correct for mislevel errors. Corrections are applied to both incoming (position and position tracking) angles and outgoing (logs and status) angles.

C4.2.5.2 Serial Setup

Set the ***Port Number*** field to the computer's serial COM port used to communicate with the inclinometer.

C4.2.5.3 Status

The ***Active*** checkbox will be checked when the GUI is actively communicating with the inclinometer and the ***Messages*** field should be incrementing as each message from the inclinometer is received.

The last ***X Tilt***, ***Y Tilt*** and ***Temperature*** data received from the inclinometer is displayed.

C4.2.5.4 Offset / Bias

If necessary, a user calibrated ***X Offset*** and ***Y Offset*** can be entered which will be subtracted from the inclinometer's reported tilt angles before they are reported in the status fields and before the mislevel corrections are calculated. Press the ***Edit*** button to allow these fields to be updated.

C4.2.5.5 Alignment Rotations

If necessary, a user calibrated set of ***X, Y, Z*** alignment rotations can be entered which will be used during the mislevel error calculations. Press the ***Edit*** button to allow these fields to be updated.

C4.2.6 Setup Network Server

The ***Setup Network Server*** screen (Figure C4.8) sets up the GUI network server, which allows TCP/IP control of the GUI and access to the data log.

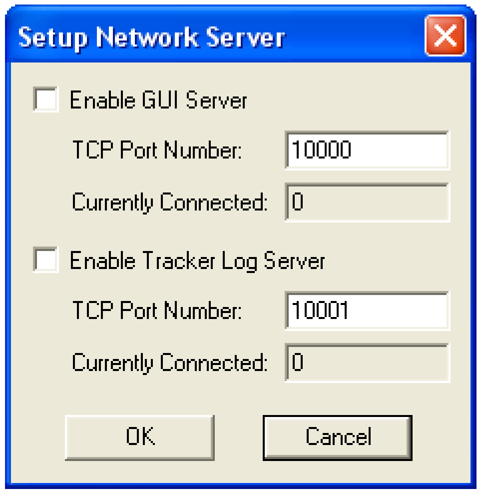

Figure C4.8. Setup Network Server Screen

C4.2.6.1 GUI Server

Checking the ***Enable GUI Server*** enables the GUI server. This will allow network control of the GUI.

The ***TCP Port Number*** field specifies the TCP port on which the GUI server will respond to connections.

The ***Currently Connected*** field indicates the number of clients connected to the server.

All commands and responses are carriage return with line feed (<CR><LF>) terminated ASCII strings. Commands are not case sensitive. All commands will receive a response in the format of either OK or Error:<reason>. Responses to queries are in the same format as the command.

C4.2.6.1.1 Commands

Log:File:<filename>

Sets the log file name.

Log:File:?

Returns the current log file name.

Log:Desc:<description string>

Sets the log file description string.

Log:Desc:?

Returns the current log file description string.

Log:Open

Opens the current log file. This will erase any data current in the file and start a new file.

Log:Close

Closes and flushes the log file disk.

Log:?

Returns the current status of the log file ("Log:Open" or "Log:Closed")

Log:Enable:On

Enable logging to disk. You must set the successful open the log file before this command.

Log:Enable:Off

Disable logging to disk. This does not close the log file, it just suspends data logging.

Log:Enable:?

Returns the on/off status of logging ("Log:Enable:On" or "Log:Enable:Off")

Mount:Pos:<azimuth> <elevation> <azimuth velocity> <elevation velocity>

Drives the mount to the specified azimuth and elevation position in degrees at the specified maximum velocity in degress per second (example: "Mount:Pos:-10.234 170.122 10.000 8.000")

Mount:PosTrk:<azimuth> <elevation> <azimuth velocity> <elevation velocity>

Drives the mount at a given rate (position mode tracking) to the specified azimuth and elevation position in degrees. Some mounts also support a velocity in degress per second which can be a rate limit or similar. Some mounts require the velocities to be set to zero.

(example: "Mount:PosTrk:-10.234 170.122 0 0")

Mount:Pos:?

Returns the current mount azimuth and elevation position in degrees and target range in meters (if valid)

(example: "Mount:Pos:-10.234 170.122" or "Mount:Pos:-10.234 170.122 100.50")

AutoTrack:On

Enable auto-track.

AutoTrack:Off

Disable auto-track.

AutoTrack:?

Returns the current state of the auto-track function ("AutoTrack:On" or "AutoTrack:Off")

Range:<range>

Sets the current range to the target in meters (example: "Range:1205.54")

Range:?

Returns the last measured range (example: "Range:1205.54" or "Range:Unknown")

GPS:?

Returns the current position with altitude, date and time of the attached IRIG/GPS unit.

The output is in the format "GPS:<sync status>:<latitude> <longitude> <altitude>:<date>:<time>"

where the parameters are defined as follows:

<sync status> can be N (not synced) or S (synced)

<latitude> is in degrees, minutes and seconds with milliseconds

<longitude> is in degrees, minutes and seconds with milliseconds

<altitude> is in meters above geoid

<date> is in the format year-month-day

<time> is in the format hour.minute.second.milliseconds UTC

(example: "GPS:S:N035 49'01.645" W117 35'34.812" 762.29m:2012-07-06:14.09.43.697")

Quit or Exit

Disconnects from the GUI.

C4.2.7 Tracker Script

The ***Tracker Script screen*** can be used to map changes in tracker status or a digital input bit (triggers) to a desired action. The available actions are currently limited to setting or clearing of a tracker's digital output bit. This is a custom function and not intended for general customer use.

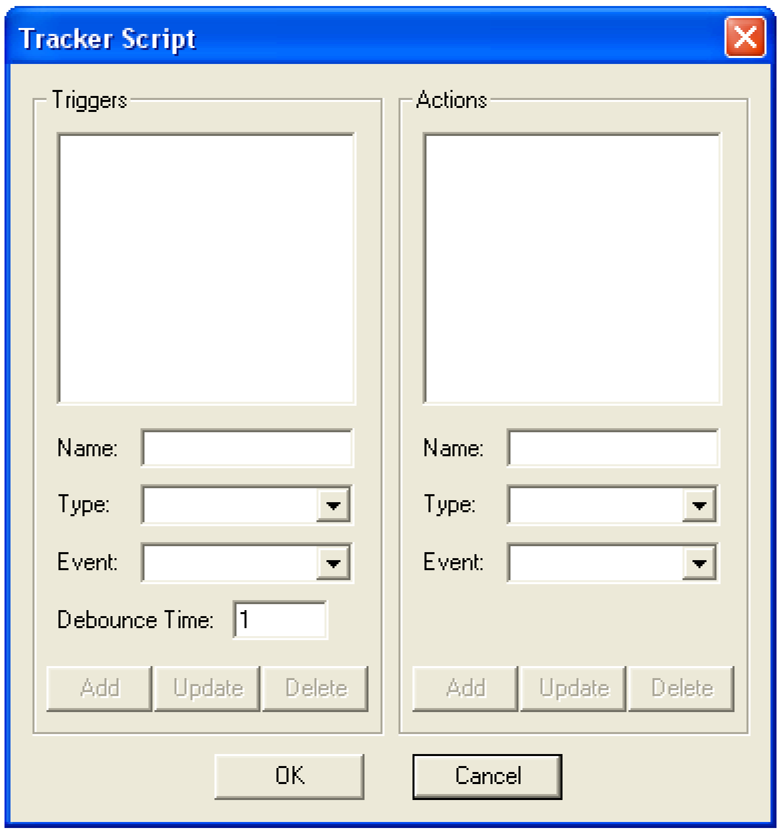

Figure C4.9. Tracker Script Screen

C4.2.8 Setup USB Joystick

The ***USB Joystick*** screen (Figure C4.10) allows the user to enable and configure a USB joystick connected to the host computer running the GUI.

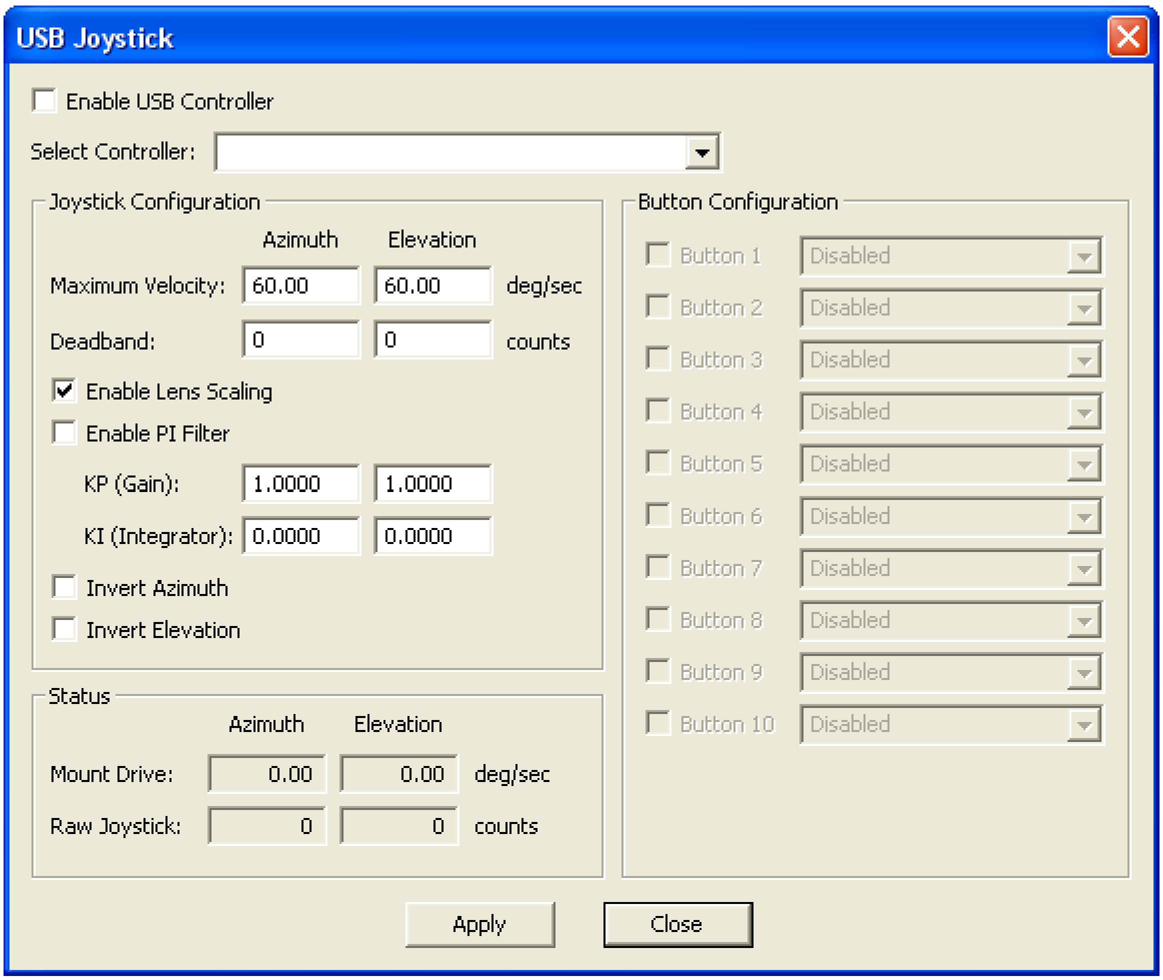

Figure C4.10. USB Joystick Screen

C4.2.8.1 Enable USB Controller

Check the ***Enable USB Controller*** checkbox to enable the USB joystick operation.

C4.2.8.2 Select Controller

Select an available Controller from the ***Select Controller*** drop down list to enable the proper joystick (protocol) operation.

C4.2.8.3 Joystick Configuration

C4.2.8.3.1 Maximum Velocity

This sets the maximum velocity sent to the mount for joystick movement.

C4.2.8.3.2 Deadband

This setting controls the amount of movement near the resting position of the joystick (center of movement) that will be ignored. This can be used to eliminate drift due to mechanical issues when the joystick does not properly return to the exact center position.

C4.2.8.3.3 Enable Lens Scaling

Checking the ***Enable Lens Scaling*** checkbox will scale the mount movement commands from the joystick based upon the current camera/lens zoom position. This means that the mount will move less when the camera is at a narrow FOV for a given joystick input versus when at a wide FOV. This scaling as a function of zoom can be disabled, if desired. The default value is enabled.

C4.2.8.3.4 Enable PI Filter

Checking this box will enable a software PI (proportion and integral) filter when will be applied to the joystick. This function is typically used to provide an operational mode where joystick movement adjusts the current slew rate of the mount. ***Reference Section C3.4*** for details on the PI Filter and the parameters Proportion (Kp), and Integral (Ki).

C4.2.8.3.5 Invert Azimuth / Elevation

Check the Invert Azimuth (Elevation) to reverse the direction of rotation that the mount will advance when the Joystick is pushed left/right or up/down. The default azimuth is not inverted (push right for clockwise rotation) and the default elevation is not inverted (push up to lower the elevation).

C4.2.8.4 Joystick Status

C4.2.8.5 Button Configuration

The ***Button Configuration*** options allow tracker functions to be assigned to the joystick buttons. Check the checkbox associated with a joystick button to enable the button functionality selected from the adjacent dropdown list. The following nine functions are supported:

- Disabled
- Enable Mount
- Zero Drive
- Track / Acquire
- Gain Override
- Focus Far
- Focus Near
- Zoom Narrow
- Zoom Wide

C4.2.9 Setup Controller Proxy

The ***Setup Controller Proxy*** screen (Figure C4.11) is used to setup a connection between the GUI on the host computer and a Model 702 Controller connected serially to the host computer. The Controller messaging is handled by the GUI and proxied through the host computer to the tracker over the currently selected tracker communication interface (***Reference Section C4.2.1***). This can be useful when the distance between the GUI host computer and the tracker hardware is large and it is desired that the Controller be physically located near the GUI host computer.

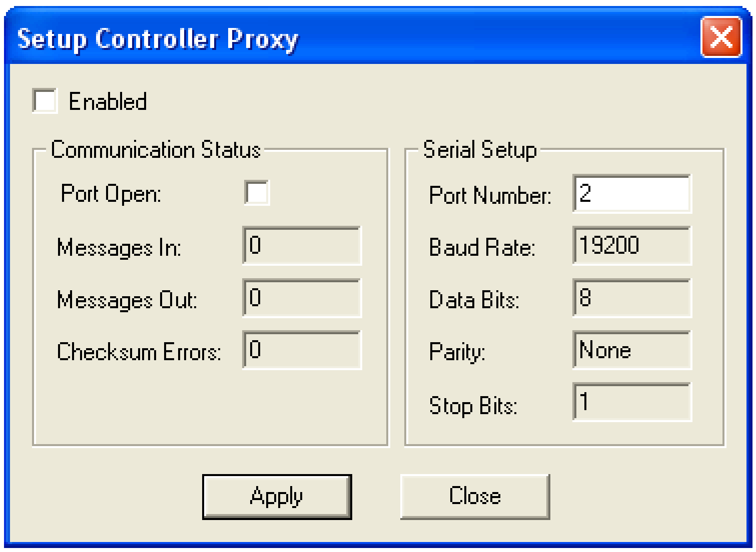

Figure C4.11. Setup Controller Proxy Screen

C4.2.9.1 Setup Controller Proxy Enable

Check the ***Enabled*** checkbox to open the selected serial port and start the controller proxy.

C4.2.9.2 Communication Status

The Communication Status data provides real-time statistics for messages flowing to and from the Controller. This screen can be useful when trouble shooting the hardware interface to the Controller (COM port, serial cable).

C4.2.9.3 Serial Setup

The ***Port Number*** entry refers to the host computer's serial COM port used to communicate with the Controller. Default for the serial port setting is ***Port Number*** 1 while the other serial parameters are shown but fixed to the Controller's communication specifications. Press the ***Apply*** button to activate any changes in the setup.

C4.3 Tools Menu

The ***Tools*** menu (Figure C4.12) contains entries that provide tracker configuration functions, useful tools, and tracker feedback.

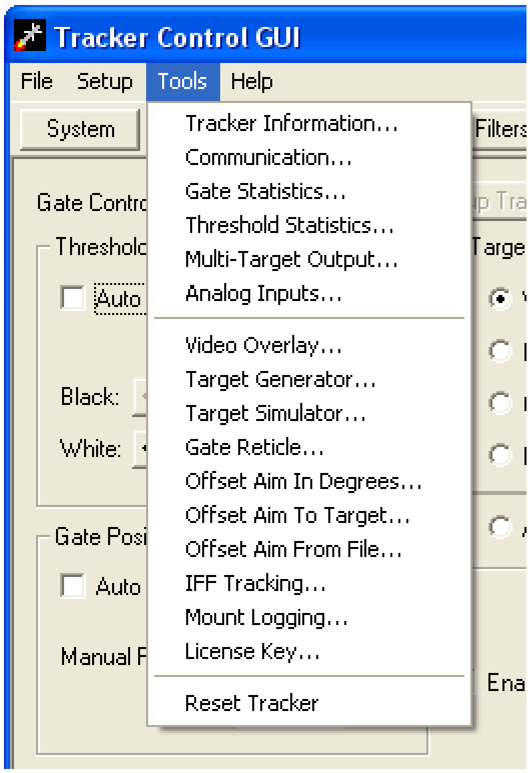

Figure C4.12. Tools Menu

C4.3.1 Tracker Information

The Tracker Information screen (Figure C4.13) shows various data about the tracker. This includes model number, serial number, tracker capabilities and firmware versions.

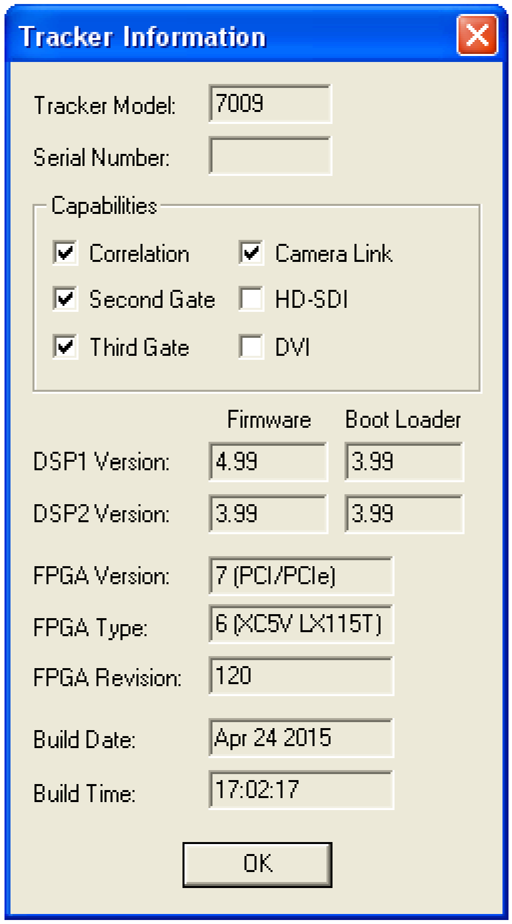

Figure C4.13. Tracker Information Screen

C4.3.2 Communication Statistics Screen

The ***Communication Statistics*** screen (Figure C4.14) provides real-time statistics for messages flowing to and from the tracker. This screen can be useful when trouble shooting the hardware interface to the tracker (serial cable, VME/PCI bus or Ethernet).

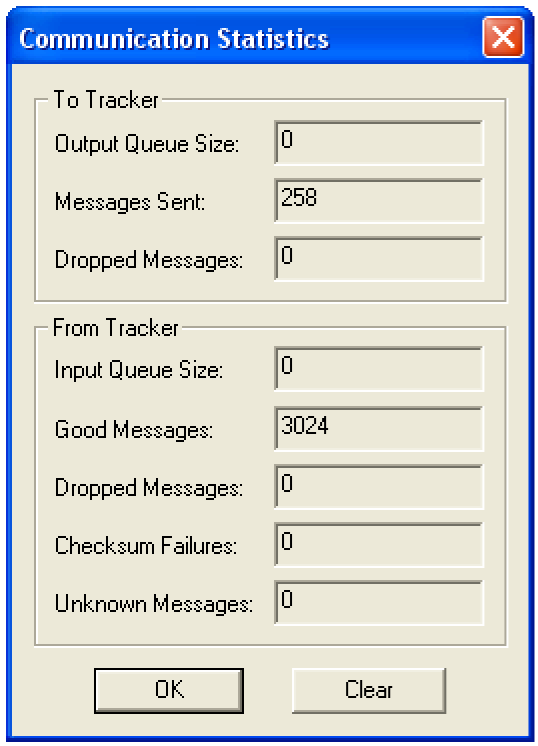

Figure C4.14. Communications Statistics Screen

C4.3.3 Gate Statistics

Gate statistics (Figure C4.15) shows gate histogram statistics. When the second gate is not enabled, the second gate data provides statistics on the entire field-of-view.

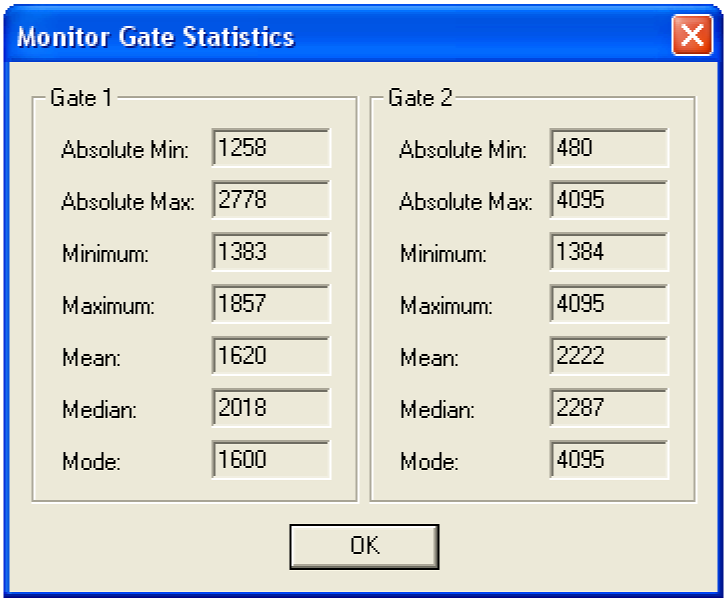

Figure C4.15. Monitor Gate Statistics Screen

C4.3.4 Threshold Statistics Screen

The ***Monitor Threshold Statistics*** screen (Figure C4.16) shows threshold statistics for Gate 1 and Gate 2.

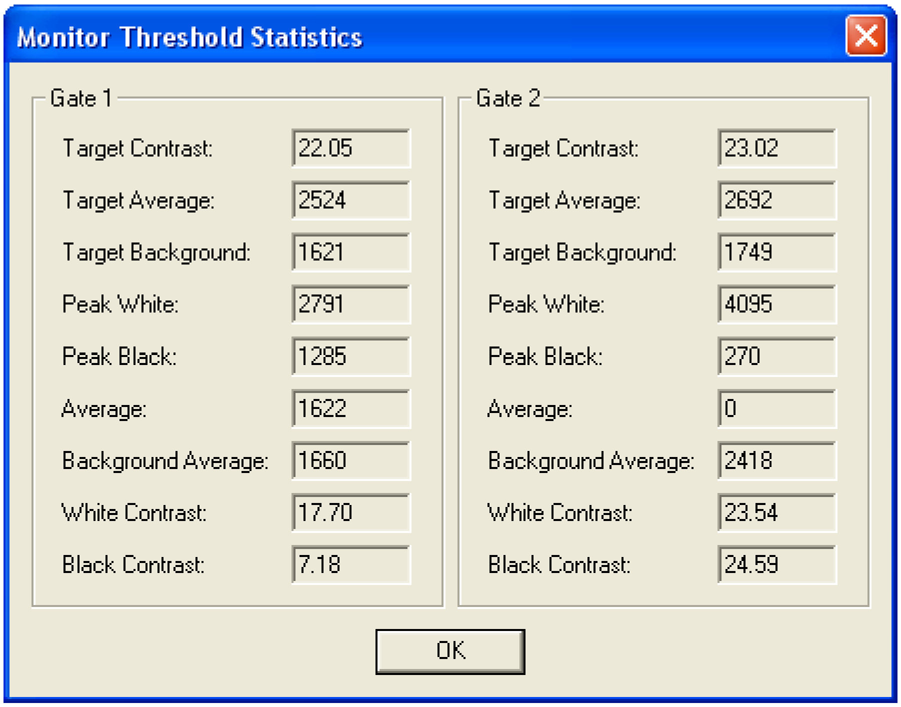

Figure C4.16. Monitor Threshold Statistics Screen

C4.3.5 Multi-Target Output Screen

The *Multi-Target Output* screen (Figure C4.17) displays a sorted list of the best five (5) targets detected along with their corresponding target data. The targets are sorted according to the current multi-target acquisition criteria with the best target at the top of the list. There may be more detected targets than can be shown on this screen.

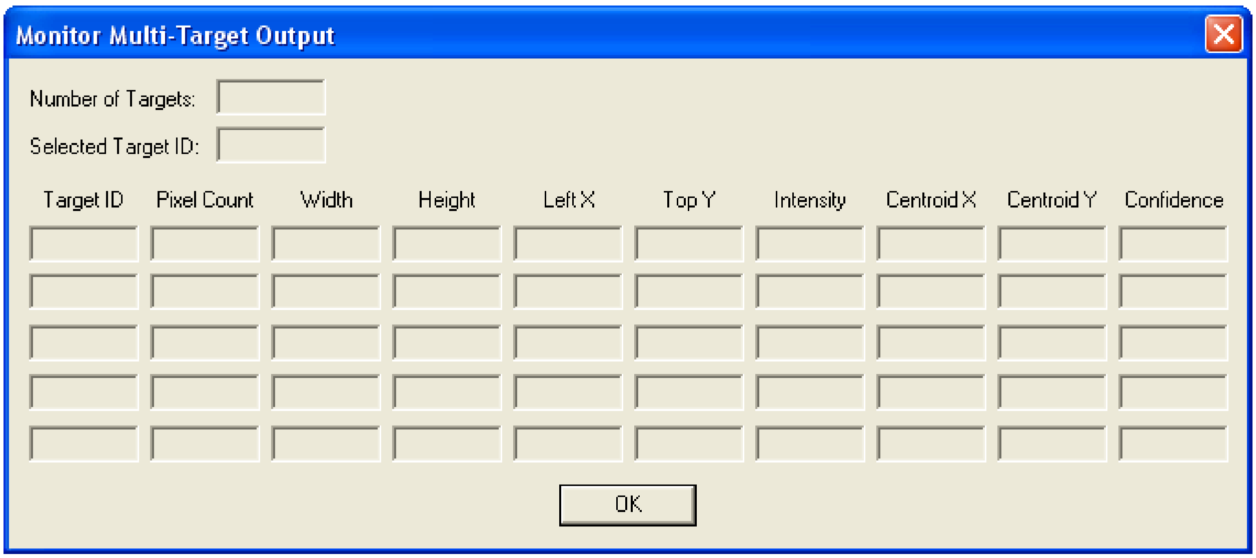

Figure C4.17. Monitor Multi-Target Output Screen

C4.3.5.1 Number of Targets

This field shows the total number of targets detected and can be a higher number than the number of targets displayed.

C4.3.5.2 Selected Target ID

This field shows the ID of the currently selected target. When in acquire mode, this is the target which will be tracked if track mode is engaged.

C4.3.6 Analog Inputs Screen

The ***Analog Inputs*** screen (Figure C4.18) provides real time statistics for the analog inputs from the tracker. This screen can be useful when troubleshooting the joystick interface to the tracker.

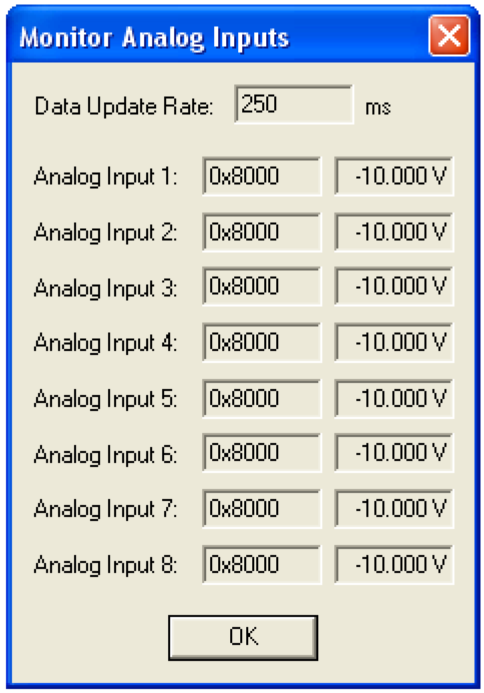

Figure C4.18. Monitor Analog Inputs Screen

C4.3.7 Video Overlay

The Overlay screen (Figure C4.19) allows for the configuration of the video overlay and sprites on tracker Models that support them.

The video overlay is supported on the Models 7005, 7015, 7007 and 7010. There are two (2) overlay planes, one that is currently displayed (*display plane*) and one that is hidden and available for editing (*edit plane*). The user can toggle the planes to display the newly edited plane and edit the formerly displayed plane. This can be used to provide a simple (slow) form of animation; however the sprites should be used whenever quick graphic movement is desired.

The video sprites are supported on all tracker Models except the 7410. There are four (4) sprites, which are 128 pixels by 128 lines each.

Note: This window is supplied for functional demonstration only.

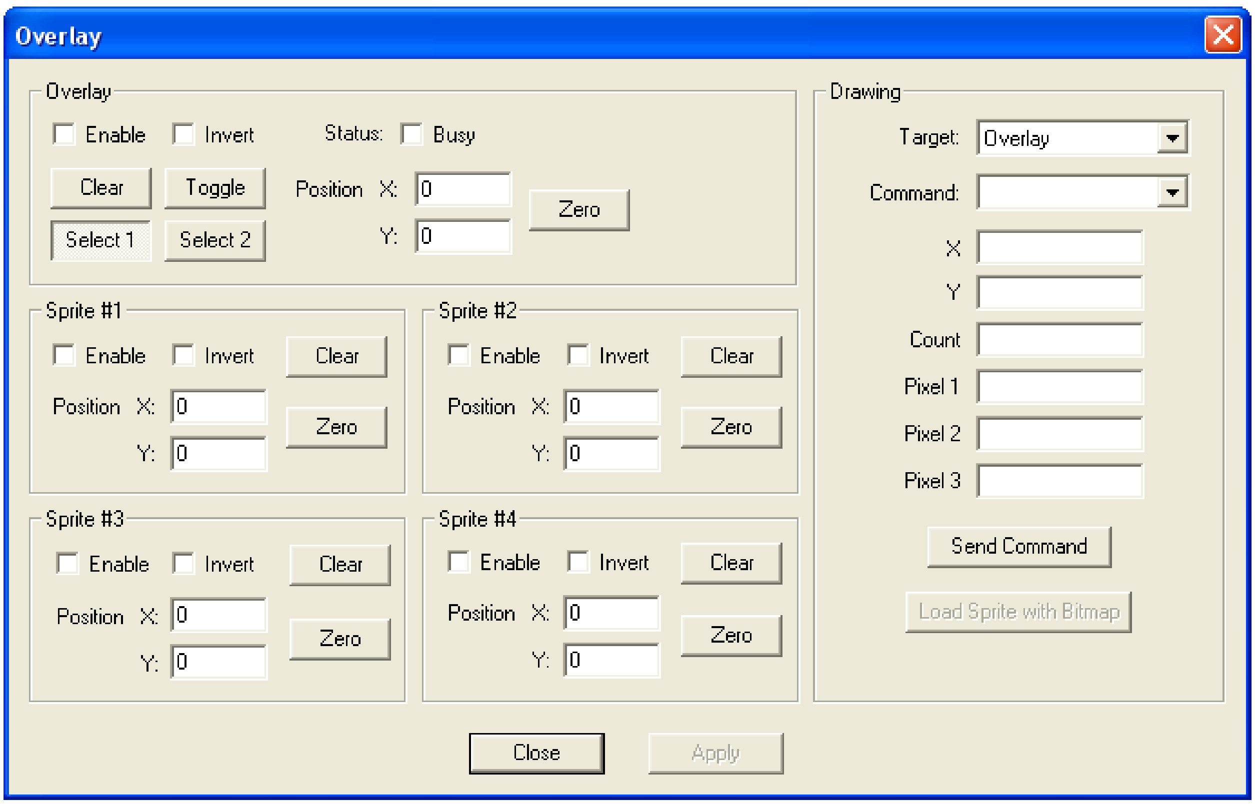

Figure C4.19. Overlay Screen

C4.3.7.1 Overlay

This box contains the controls for the video overlay planes and the ***Busy*** status indicator for the overlay/sprite engine.

C4.3.7.1.1 Enable

When checked, the overlay ***Enable*** checkbox enables the display of the video overlay. If overlays are not supported this box will be grayed-out.

C4.3.7.1.2 Invert

Check the ***Invert*** checkbox to display the inverted the color (gray-scale value) of any/all graphics drawn to the overlay.

C4.3.7.1.3 Status: Busy

The ***Busy*** checkbox is an overlay/sprite engine status indicator, providing feedback as to when the overlay engine is busy drawing or clearing the overlay or one of the sprites. Overlay drawing commands should be throttled using this indicator.

C4.3.7.1.4 Clear

The ***Clear*** button erases the overlay *edit plane* (sets all pixels to transparent). Clearing the 'edit' overlay can take up to 500 milliseconds to complete. During this time, the ***Busy*** checkbox will be checked. The overlay *display plane* will not be affected.

C4.3.7.1.5 Toggle

Pressing the ***Toggle*** button will switch between ***Select 1*** and ***Select 2***.

C4.3.7.1.6 Overlay Select

The ***Select 1*** and ***Select 2*** buttons, when pressed, determine which overlay plane is to be set as the display plane. Note that the plane not selected is then the target of any overlay drawing commands sent to the tracker.

Note that the overlay planes are switched during vertical sync and only when the overlay engine is not ***Busy***. This prevents artifacts of partially complete drawing functions from showing on the screen.

C4.3.7.1.7 Position

This can be used to manually set the ***screen position*** of the upper, left corner of the overlay. A position of 0, 0 corresponds with the upper, left corner of the screen. The position can contain large and/or negative coordinates, in which case some, or all, of the overlay may be drawn off-screen.

In addition, the user may place the mouse cursor inside the Overlay box (on a clear area) and then hold down the right mouse button while moving the mouse to change the Overlay position.

C4.3.7.1.8 Zero

The ***Zero*** button clears the position coordinates to 0, 0.

C4.3.7.2 Sprites #1 through #4

These boxes contain the controls for the four (4) sprites. If sprites are not supported these boxes will be grayed-out.

C4.3.7.2.1 Enable

When checked, the ***Enable*** checkbox enables the ***display*** of this video sprite. Sprites can be erased and drawn while the ***Enable*** checkbox is unchecked.

C4.3.7.2.2 Invert

Check the ***Invert*** checkbox to display the inverted the color (gray-scale value) of any/all graphics drawn to the sprite.

C4.3.7.2.3 Clear

The ***Clear*** button erases the sprite (sets all pixels to transparent).

C4.3.7.2.4 Position

This can be used to manually set the ***screen position*** of the upper, left corner of the sprite. Note that the sprite is quite often bigger (128 x 128 pixels) than the visible shapes drawn within. A position of 0, 0 corresponds with the upper, left corner of the screen. The position can contain large and/or negative coordinates, in which case some, or all, of the sprite may be drawn off-screen.

In addition, the user may place the mouse cursor inside the Sprite box (on a clear area) and then hold down the right mouse button while moving the mouse to change the Sprite position.

C4.3.7.2.5 Zero

The ***Zero*** button clears the position coordinates to 0, 0.

C4.3.7.3 Drawing

Graphical points, lines, and shapes can be drawn on the overlay *edit plane* and any of the four (4) Sprites. There is no difference in the command structure or parameter limits between the overlay and the sprites.

C4.3.7.3.1 Target

The Target dropdown list allows the user to select the drawing ***target***, either the overlay *edit plane* or one of the four (4) sprites.

C4.3.7.3.2 Command

The ***Command*** dropdown list allows the user to choose from the following drawing symbology. All of the commands allow for the specification of the Pixel Value (color or gray-scale).

- Points – draws up to 3 points (pixels), starting at *X*, *Y*. If there is more than one point, the *X*-coordinate is incremented automatically.
- Line – draws a line from *X1*, *Y1* to *X2*, *Y2*
- Rectangle – draws an unfilled rectangle, upper left-hand corner at *X*, *Y*, of *X Length* pixels and *Y Length* lines.
- Square – draws an unfilled square, upper left-hand corner at *X*, *Y*, of *X Length* (for both dimensions).
- Triangle – draws an unfilled triangle, upper left-hand corner ***of the bounding rectangle*** at *X*, *Y*, of base width *X Length* and height *Y Length*. The Direction can be 0 (up), 1 (right), 2 (down), or 3 (left).

- Ellipse – draws an unfilled ellipse, center point at *X, Y*, of *X Radius* and *Y Radius*.
- Circle – draws an unfilled circle, center point at *X, Y*, of *X Radius*.
- Arc – draws an arc, center point at X, Y, of *X Radius*, starting at *Start* degrees and ending at *Stop* degrees.
- Diamond – draws an unfilled diamond of four (4) segments, upper left-hand corner of the bounding box at *X, Y,* of (bounding box) *X Length* and *Y Length*. Segments (one of the four lines that make up the diamond) can be individually enabled using the *Segment Map* as follows: 1=lower right, 2=lower left, 4=upper right, 8=upper left. Multiple segments can be enabled by adding the segment numbers together. Example: 12 = up-arrow (upper left & upper right)
- Color Bar – draws a color bar (gray-scale bar), upper left-hand corner at *X, Y* of *X Length* pixels and *Y Length* lines (Overlay only).
- Graticule – draws a graticule (circular set of angle marks), center point at *X, Y* of *X Radius* (Overlay only)
- String – draws an ASCII character *String* similar to the standard tracker annotation, upper left-hand corner of the first character's bounding box at *X,Y* with selected *background* and *foreground* colors.

C4.3.7.3.3 Send Command

After the ***Target*** and ***Command*** parameters are entered, pressing the ***Send Command*** button will send the overlay command message to the tracker.

C4.3.7.3.4 Load Sprite with Bitmap

The ***Load Sprite with Bitmap*** allows the user to select a bitmap file to load into the selected sprite. The file must be a Windows bitmap (.bmp) file, no more that 128 x 128 in size. The color black (0) maps to overlay/sprite *transparent* and the remaining colors are converted into gray-scale before being sent to the tracker. The data may be divided into multiple tracker commands due to command size limits.

C4.3.8 Target Generator

The ***Target Generator*** screen (Figure C4.20) provides access to the tracker's built-in target generator. The target generator can be used to inject synthetic targets into the video stream and test the operational capability of the tracker. Up to two targets may be defined on a colored background.

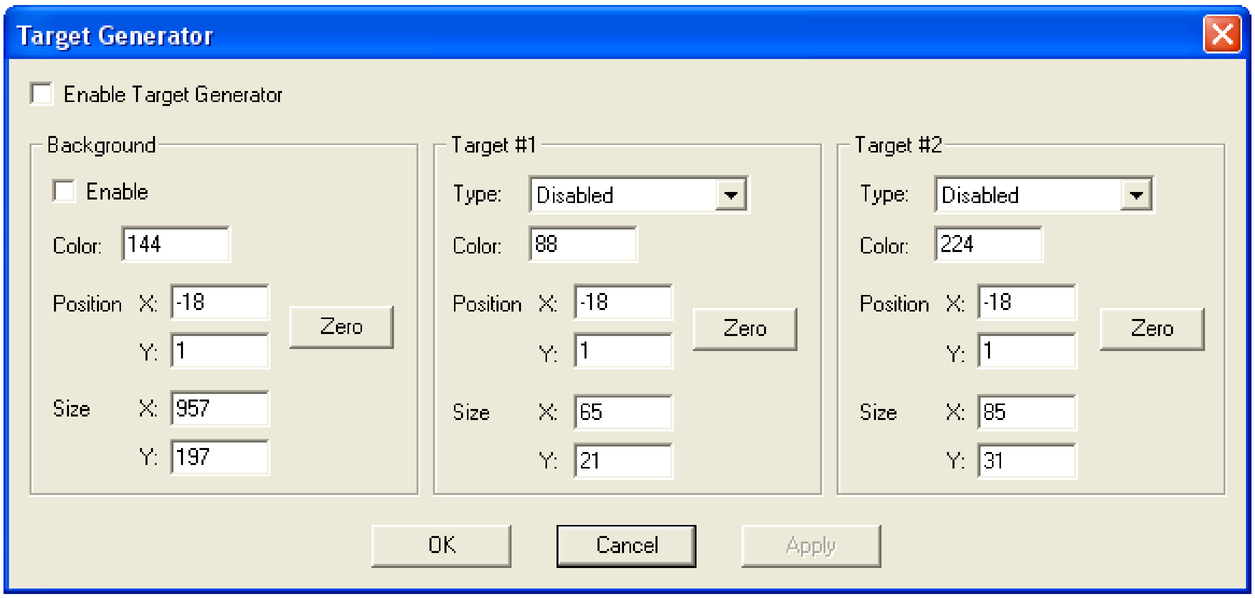

Figure C4.20. Target Generator Screen

C4.3.8.1 Enable Target Generator

The tracker's Target Generator may be enabled by checking the ***Enable Target Generator*** checkbox.

C4.3.8.2 Background

When the ***Enable*** checkbox is checked, a portion of the live video background is replaced by a monochrome background whose color is defined by the ***Color*** field. The X and Y ***Position*** and ***Size*** can also be defined by the entering their values in the proper fields. The background's position may be set to (0,0) by clicking the ***Zero*** button.

C4.3.8.3 Target #1

The Target #1 Type dropdown box offers three possible target types: ***Rectangle***, ***Diamond***, and ***Color Bars***. The default target type is ***Disabled***. The target's color is defined by the ***Color*** field.

The target's X and Y ***Position*** and ***Size*** can also be defined by the entering their values in the proper fields. The position may be set to (0,0) by clicking the ***Zero*** button.

C4.3.8.4 Target #2

The Target #2 Type dropdown box offers three possible target types: ***Rectangle***, ***Diamond***, and ***Single Pixel***. The default target type is ***Disabled***. The target's color is defined by the ***Color*** field.

The target's X and Y ***Position*** and ***Size*** can also be defined by the entering their values in the proper fields. The position may be set to (0,0) by clicking the ***Zero*** button.

C4.3.9 Target Simulator

The Target Simulator screen (Figure C4.21) is for company internal use only and is not a customer supported feature.

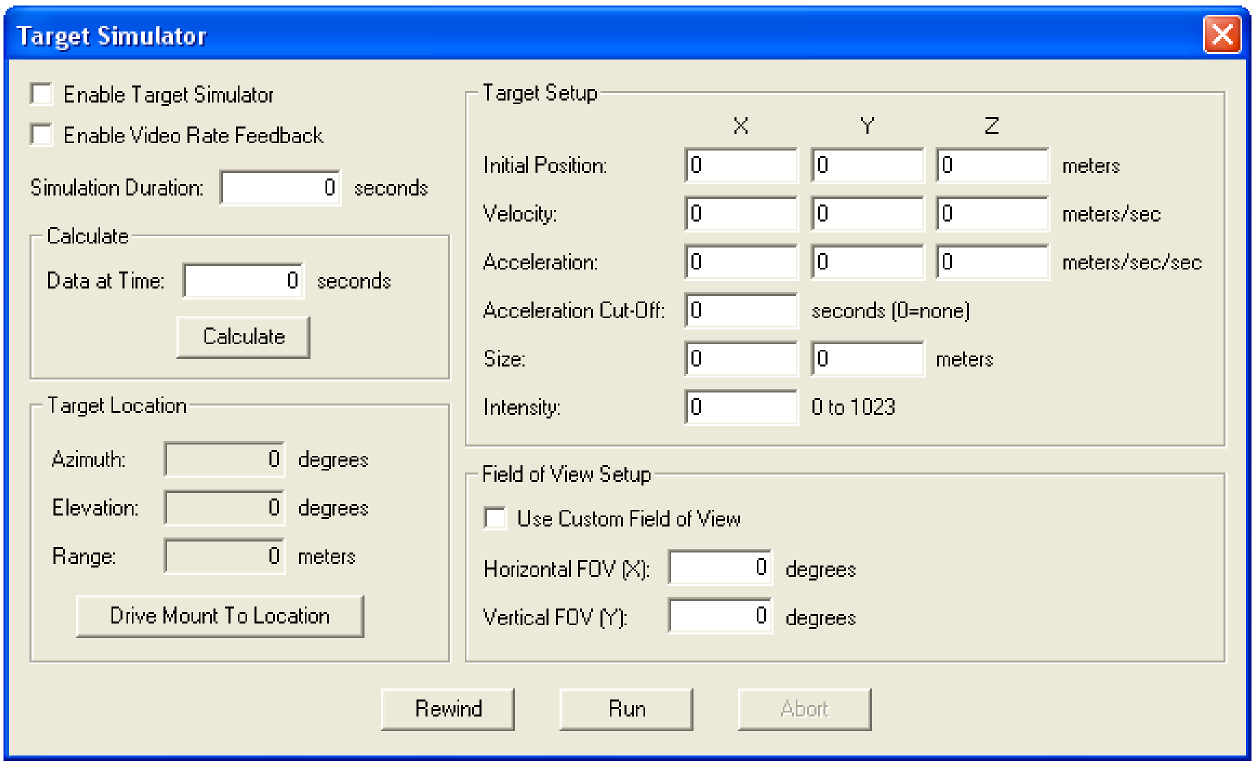

Figure C4.21. Target Simulator Screen

C4.3.10 Gate Reticle Control

The Gate Reticle Control screen (Figure C4.22) allows the second gate symbology to be used as a reticle when dual gate functionally is disabled.

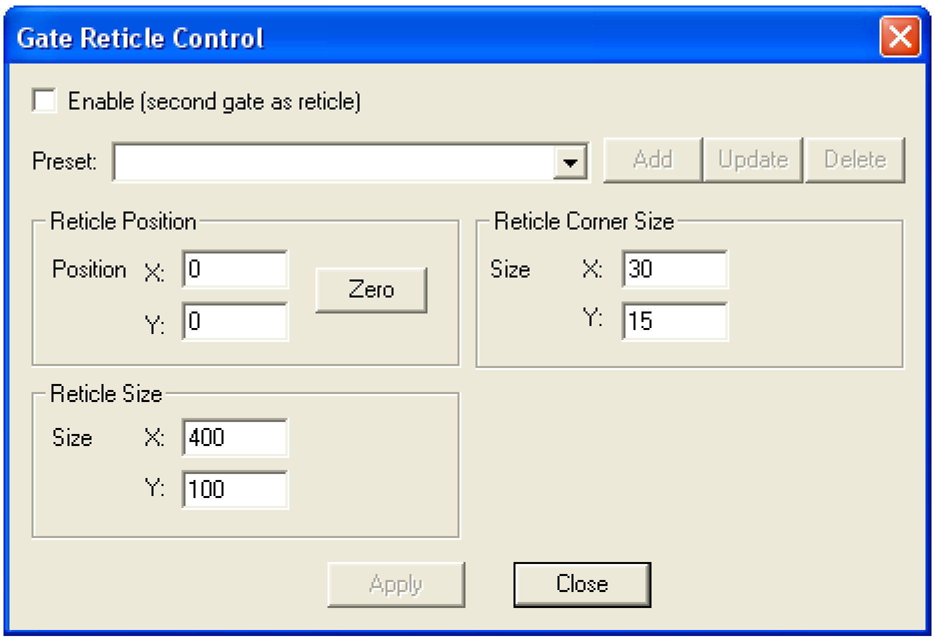

Figure C4.22. Gate Reticle Control Screen

C4.3.10.1 Enable (second gate as reticle)

The tracker's second gate may be used as a reticle by checking the ***Enable (second gate as reticle)*** checkbox.

C4.3.10.2 Preset

Gate reticle settings may be stored as presets and restored. All presets are stored on the GUI computer. To add a preset, set up the gate reticle, type a preset name in the preset field and click ***Add***. To select a preset, choose a stored preset from the drop down list, and click ***Update.*** To delete a preset, choose a stored preset from the drop down list, and click ***Delete.***

C4.3.10.3 Reticle Position

Reticle Position is relative to boresite and can be set by entering values for ***X*** and ***Y***. Alternately the position can be set by dragging the mouse, while keeping the right button pressed. To zero the position, press the ***Zero*** button.

C4.3.10.4 Reticle Size

Reticle Size can be set by entering values for ***X*** and ***Y***. Alternately the size can be set by dragging the mouse, while keeping the right button pressed.

C4.3.10.5 Reticle Corner Size

Reticle Corner Size can be set by entering values for ***X*** and ***Y***. Alternately the size can be set by dragging the mouse, while keeping the right button pressed.

C4.3.11 Offset Aim In Degrees

The ***Offset Aim in Degrees*** screen (Figure C4.23) is a custom feature for a customer specific application and is not generally supported.

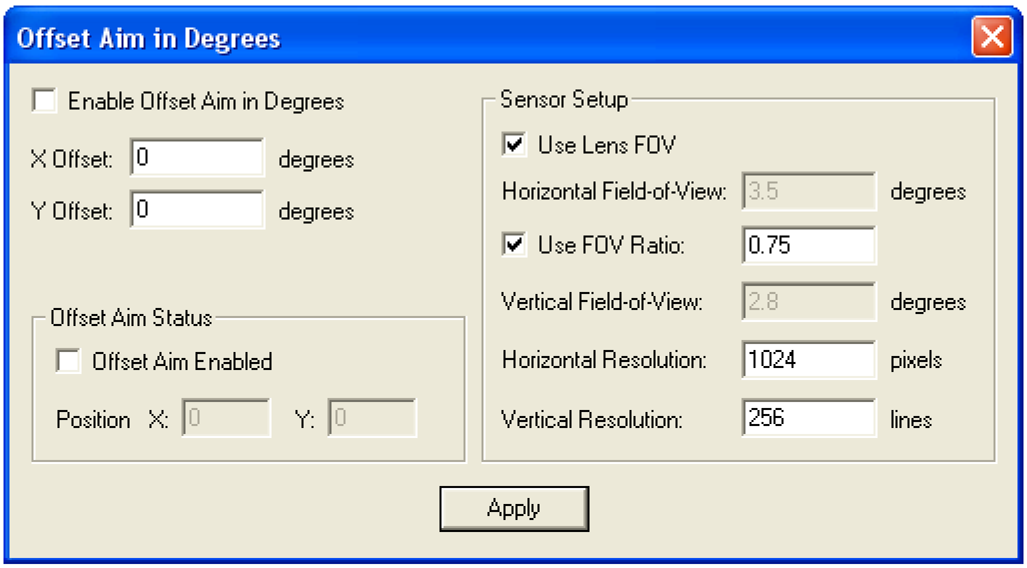

Figure C4.23. Offset Aim in Degrees Screen

C4.3.12 Offset Aim To Target

The ***Offset Aim To Target*** screen (Figure C4.24) is a custom feature for a customer specific application and is not generally supported.

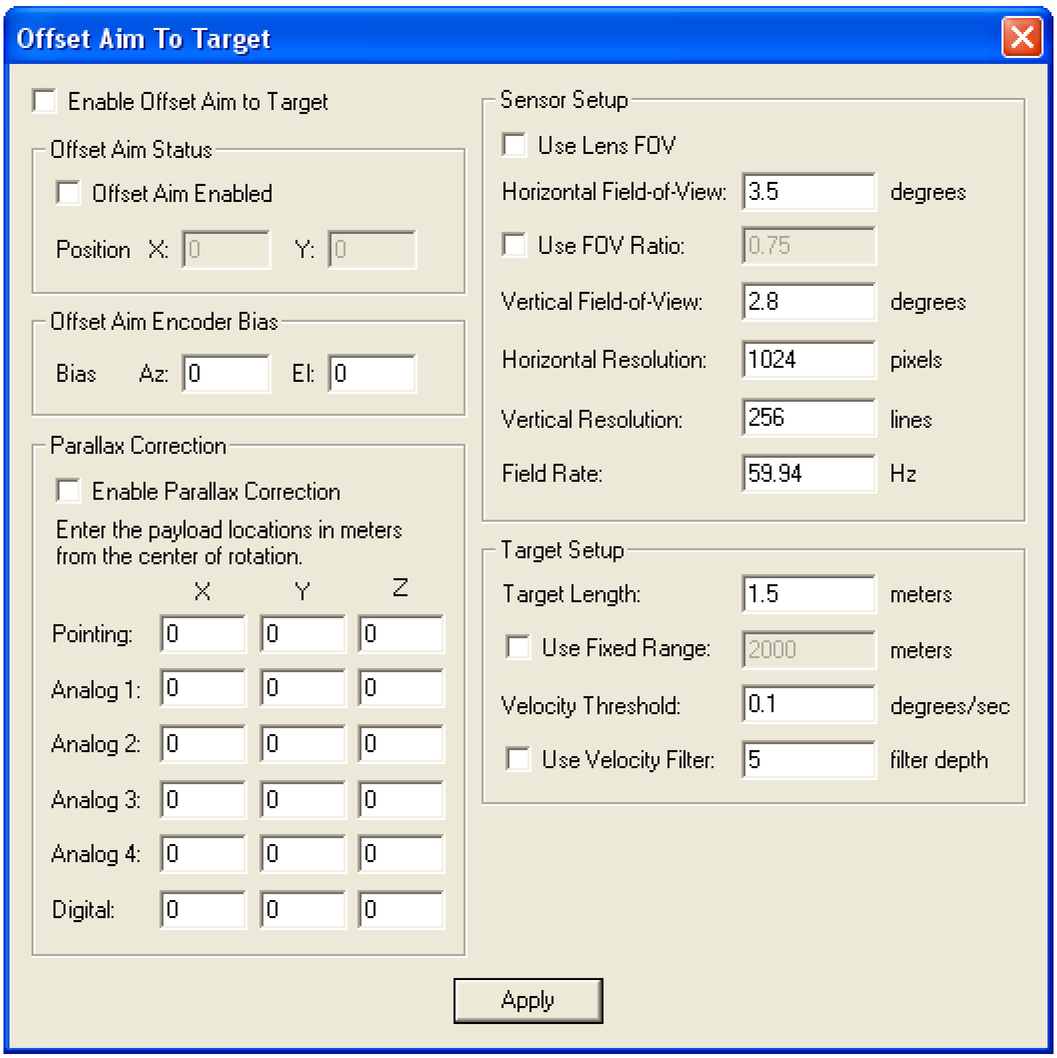

Figure C4.24. Offset Aim To Target Screen

C4.3.13 Offset Aim From File

The ***Offset Aim From File*** screen (Figure C4.25) is a custom feature for a customer specific application and is not generally supported.

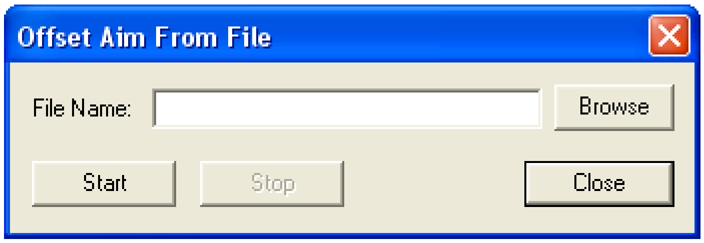

Figure C4.25. Offset Aim From File Screen

C4.3.14 IFF Tracking

The ***IFF Tracking*** screen (Figure C4.26) is a custom feature for a customer specific application and is not generally supported.

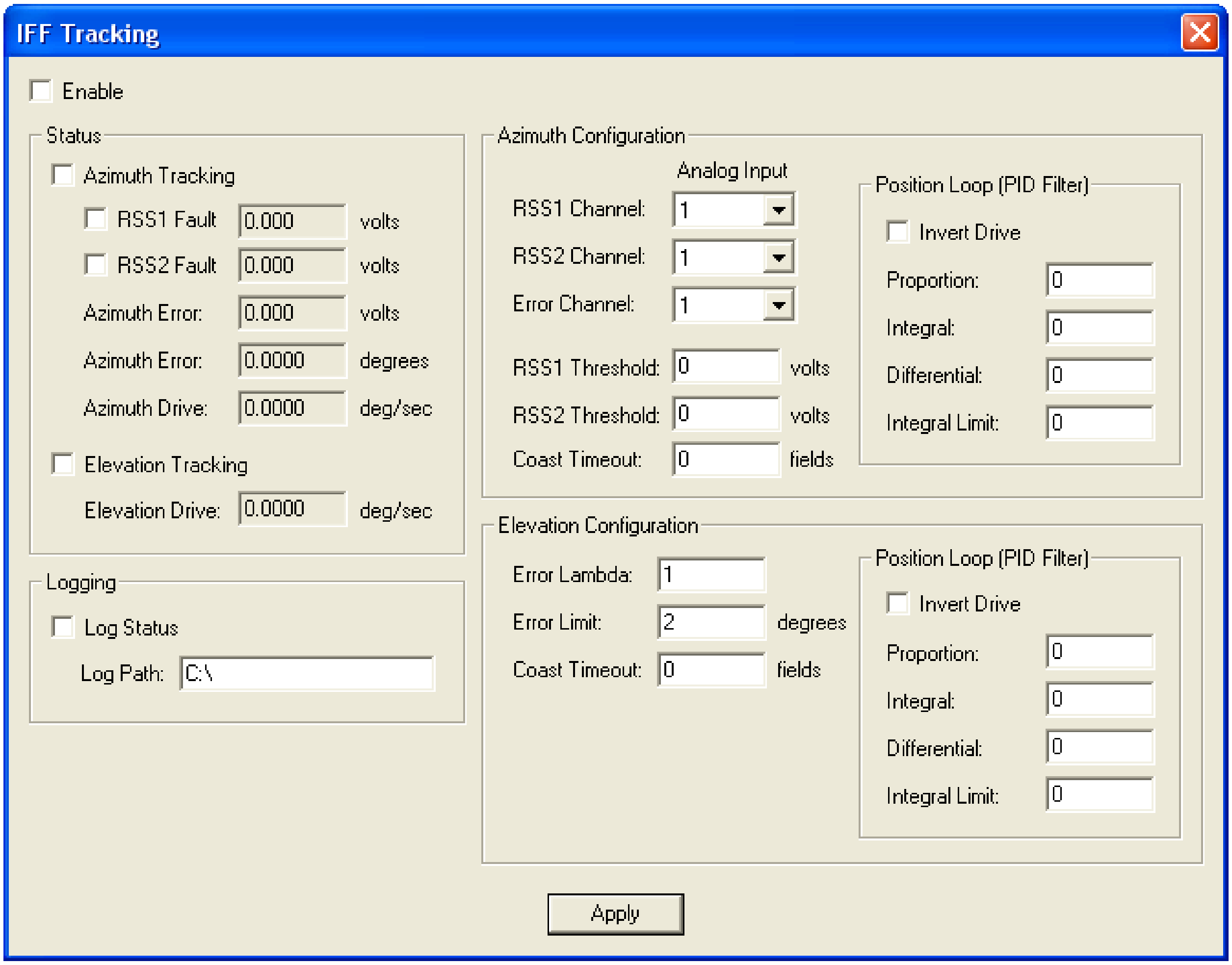

Figure C4.26. IFF Tracking Screen

C4.3.15 Mount Logging (DEPRECATED)

Mount Data Logging (Figure C4.27) can be used to log detailed, real-time track and mount data for analysis and tuning. Mount logging is only functional over the tracker's VME or PCI bus interface for serially connected mounts, because of the low latency required to capture real-time position and velocity data.

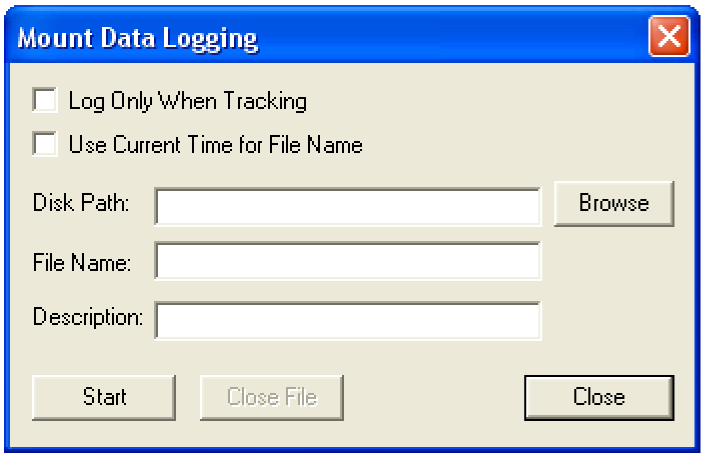

Figure C4.27. Mount Data Logging Screen

C4.3.15.1 Log Only When Tracking

When the ***Log Only When Tracking*** checkbox is checked, and the ***Start*** button is pressed, the GUI will only log data when the tracker is actively tracking a target. When unchecked the GUI will start logging when the ***Start*** button is pressed.

C4.3.15.2 Use Current Time for File Name

When the ***Use Current Time for File Name*** checkbox is checked, the log file will be saved with the current time as the file name.

C4.3.15.3 Disk Path

The ***Disk Path*** is the location of the log file to be stored. The location may be either typed in directly or browsed to by clicking the ***Browse*** button. The default location is "C:".

C4.3.15.4 File Name

The ***File Name*** is the file name to use for the log file. Typical filenames end in a ".txt" or ".log" extension.

C4.3.15.5 Description

The ***Description*** is a user-defined description stored within the log file.

C4.3.16 Data Format

Data is logged to disk in standard ASCII text format. Lines are carriage return and line feed terminated (CRLF) and fields within each line are tab delimited. This format is easy to import into a spreadsheet application. Any line beginning with a pound character (#) is a comment or part of the header information. Below is a sample of the first few lines of a typical log file.

```
# 2015-06-03 14.54.12
#
#
#
# X PID    Gain=1.000          P=1.000   I=0.000   D=0.000   IntClip=0.0          Vff=0.000 Aff=0.000
# Y PID    Gain=1.000          P=1.000   I=0.000   D=0.000   IntClip=0.0          Vff=0.000 Aff=0.000
#
# Sequence          Time       X-DeltaPos          X-Pos     X-Vel     X-AveVel  X-AveAccel          X-Error   X-DriveCmd
           X-P      X-I        X-D       X-PIDOut  X-Vff     Y-DeltaPos          Y-Pos     Y-Vel     Y-AveVel  Y-AveAccel
           Y-Error  Y-DriveCmd           Y-P       Y-I       Y-D       Y-PIDOut  Y-Vff
```

The first seven lines consist of header information and read as follows:

Header Line	Description
# 2015-06-03 14:54:12	The date and time the file was created in the format 'year-month-day hh:mm:ss'.
# X PID	The configured PID filter settings for the X-Axis (Azimuth)
# Y PID	The configured PID filter settings for the Y-Axis (Elevation)

C4.3.17 License Key

The ***License Key*** screen (Figure C4.28) allows entry of the tracker license key. The license key enables specific levels of functionality for the tracker.

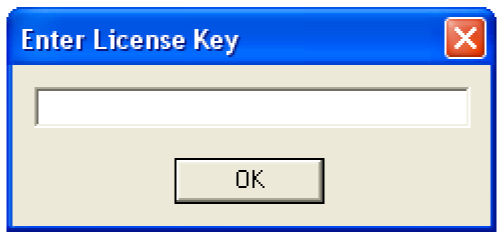

Figure C4.28. Enter License Key Screen

C4.3.18 Reset Tracker

The ***Reset Tracker*** menu selection sends the required sequence of three commands to the tracker causing a software reset of the system.

C4.4 Help Menu

The ***Help*** menu (Figure C4.29) contains the ***About*** selection (Figure C4.30). The About screen contains part number, copyright and version information of the GUI control program.

Figure C4.29. Help Menu

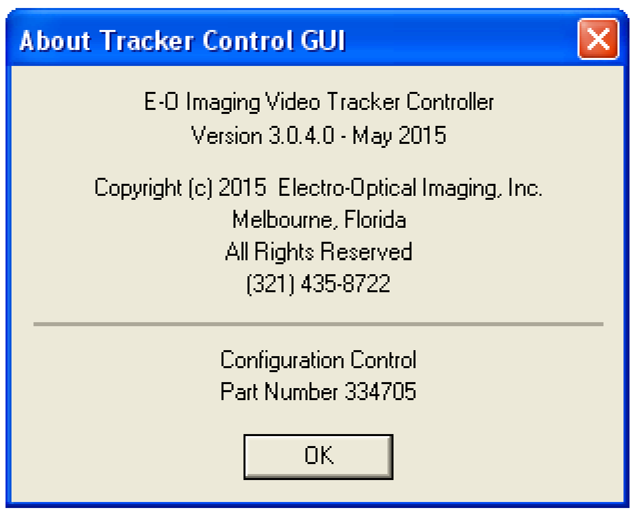

Figure C4.30. About Screen

Appendix D

Series 7000 Chassis Rear Panel Interface Control Document

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D1 Rear Panel Interface - A/N 335547 Rev B

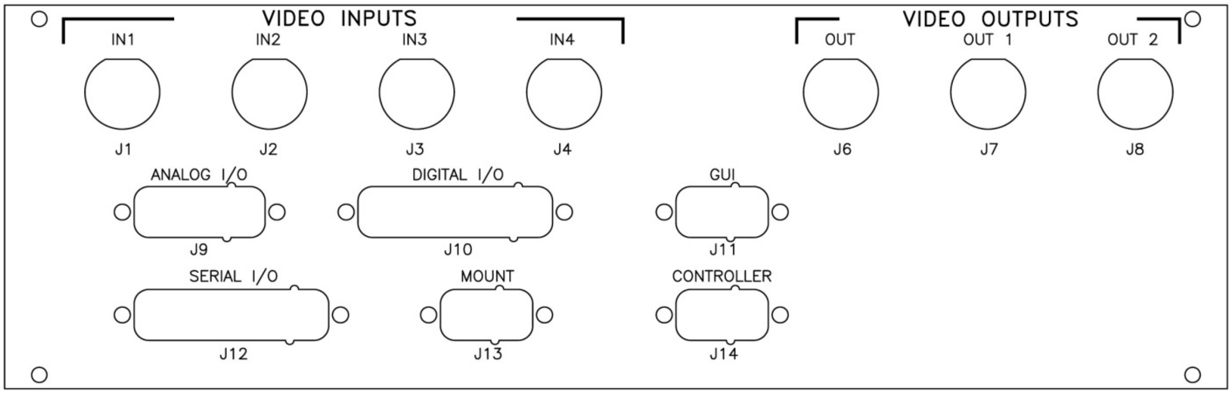

Figure D1.1. Rear Panel Layout 2U Chassis (Rev B)

This 2U 19 inch rack mount chassis typically contains a Model 7005-HD or 7005-CL VME Video Tracker.

D1.1 Connector List

Table D1.1. Inputs/Outputs (Rear Panel)

Name	Function
J1 – IN1	Analog Video Input #1 (1.0V p-p nominal)
J2 – IN2	Analog Video Input #2 (1.0V p-p nominal)
J3 – IN3	Analog Video Input #3 (1.0V p-p nominal)
J4 – IN4	Analog Video Input #4 (1.0V p-p nominal)
J6 – OUT	Analog Video Output (1.0V p-p nominal) with **no** Symbology
J7 – OUT 1	Analog Video Output with Tracker Symbology
J8 – OUT 2	Analog Video Output with Tracker Symbology
J9 – ANALOG I/O	Azimuth and elevation analog error signals (to a servo system) and analog inputs.
J10 – DIGITAL I/O	Azimuth and elevation error data (in parallel digital format) Also includes break lock, on target and coast signals
J11 – GUI	Serial RS-232/422 interface for tracker control (usually connected to the tracker GUI)
J12 – SERIAL I/O	Other serial interfaces (typically for lens control)
J13 – MOUNT	Serial RS-232/422 interface for mount/gimbal control
J14 – CONTROLLER	Interface to 701 or 702 Controller (includes serial interface and power/ground)

D1.2 Connector Pin Out

Table D1.2. Rear Panel Connector Wire List

J No.	Pin	Function	Mating Connector
J1, J2		Analog Video Inputs (Video IN1 & Video IN2)	PL20-2 (BNC Coax Male)
J3, J4		Analog Video Inputs (Video IN3 & Video IN4)	PL20-2 (BNC Coax Male)
J6		Analog Video Output (No Symbology)	PL20-2 (BNC Coax Male)
J7		Analog Video Output (Symbology)	PL20-2 (BNC Coax Male)
J8		Analog Video Output (Symbology)	PL20-2 (BNC Coax Male)

Note: Unless a video switch (optional) has been installed in the chassis, the analog video outputs (J6 through J8) are all the output of the currently selected tracker video source. In this case, J7 and J8 are identical video outputs.

J No.	Pin	Function	Mating Connector
J9		**Analog Error Output DA15S**	**DA15P (ITT)**
	1	Azimuth Analog Error (±5Vdc or ±10Vdc)	
	2	Azimuth Return (Analog Ground)	
	3	Elevation Analog Error (±5Vdc or ±10Vdc)	
	4	Elevation Return (Analog Ground)	
	5	+5Vdc	
	6	Analog Ground	
	7	Analog Ground	
	8	Analog Input 1 (Joystick X)	
	9	Analog Input 2 (Joystick Y)	
	10	Analog Input 3 (Track/Acquire)	
	11	Analog Input 4	
	12	Analog Input 5	
	13	Analog Input 6	
	14	Analog Input 7	
	15	Analog Input 8	

Table D1.3. Rear Panel Connector Wire List (cont'd)

J No.	Pin	Function	Mating Connector
J10		**Digital Error Output DB25S**	**DB25P**
	1	DIGERR1	
	2	DIGERR2	
	3	DIGERR3	
	4	DIGERR4	
	5	DIGERR5	
	6	DIGERR6	
	7	DIGERR7	
	8	DIGERR8	
	9	DIGERR9	
	10	DIGERR10	
	11	DIGERR11	
	12	DIGERR12	
	13	DIGERR13	
	14	DIGERR0	
	15	Data Strobe In	
	16	Digital Ground	
	17	Digital Ground	
	18	Digital Ground	
	19	ID (Azimuth/Elevation Identification Bit)	
	20	Data Strobe Out	
	21	Track / Acquire	
	22	Coast	
	23	On Target	
	24	DIGERR15	
	25	DIGERR14	

**Note: DIGERR bits 0 through 4 indicate fractional pixel values.
DIGERR bits 5 through 15 represent whole pixel values.**

Table D1.4. Rear Panel Connector Wire List (cont'd)

J No.	Pin	Function	Mating Connector
J11		**GUI – Serial Tracker Control and Status**	**DB9F**
	1	UART0 RS422+ TX (output)	
	2	UART0 RS232 / RS422- TX (output)	
	3	UART0 RS323 / RS422- RX (input)	
	4	UART0 RS422+ RX (input)	
	5	Signal Ground	
	6 - 9	Reserved	
J12		**Serial I/O – Auxiliary Serial Ports**	
	1	UART3 RS422+ TX (output)	
	2	UART3 RS232 / RS422- TX (output)	
	3	UART3 RS232 / RS422- RX (input)	
	4	UART3 RS422+ RX (input)	
	5	UART4 RS422+ TX (output)	
	6	UART4 RS232 / RS422- TX (output)	
	7	UART4 RS232 / RS422- RX (input)	
	8	UART4 RS422+ RX (input)	
	9	UART5 RS422+ TX (output)	
	10	UART5 RS232 / RS422- TX (output)	
	11	UART5 RS232 / RS422- RX (input)	
	12	UART5 RS422+ RX (input)	
	13	Signal Ground	
	14	Signal Ground	
	15	Signal Ground	
	16	UART6 RS422+ TX (output)	
	17	UART6 RS232 / RS422- TX (output)	
	18	UART6 RS232 / RS422- RX (input)	
	19	UART6 RS422+ RX (input)	
	20	Signal Ground	
	21	UART7 RS422+ TX (output)	
	22	UART7 RS232 / RS422- TX (output)	
	23	UART7 RS232 / RS422- RX (input)	
	24	UART7 RS422+ RX (input)	
	25	Signal Ground	

Table D1.5. Rear Panel Connector Wire List (cont'd)

J No.	Pin	Function	Mating Connector
J13		**Mount Serial Interface**	
	1	UART2 RS422+ TX (output)	
	2	UART2 RS232 / RS422- TX (output)	
	3	UART2 RS323 / RS422- RX (input)	
	4	UART2 RS422+ RX (input)	
	5	Signal Ground	
	6 - 9	Reserved	
J14		**Controller Interface**	
	1	+5Vdc	
	2	+5Vdc	
	3	+5Vdc	
	4	Signal Ground	
	5	Signal Ground	
	6	UART1 RS422+ TX (output)	
	7	UART1 RS232 / RS422- TX (output)	
	8	UART1 RS323 / RS422- RX (input)	
	9	UART1 RS422+ RX (input)	

D2 Rear Panel Interface – A/N 336131 Rev B

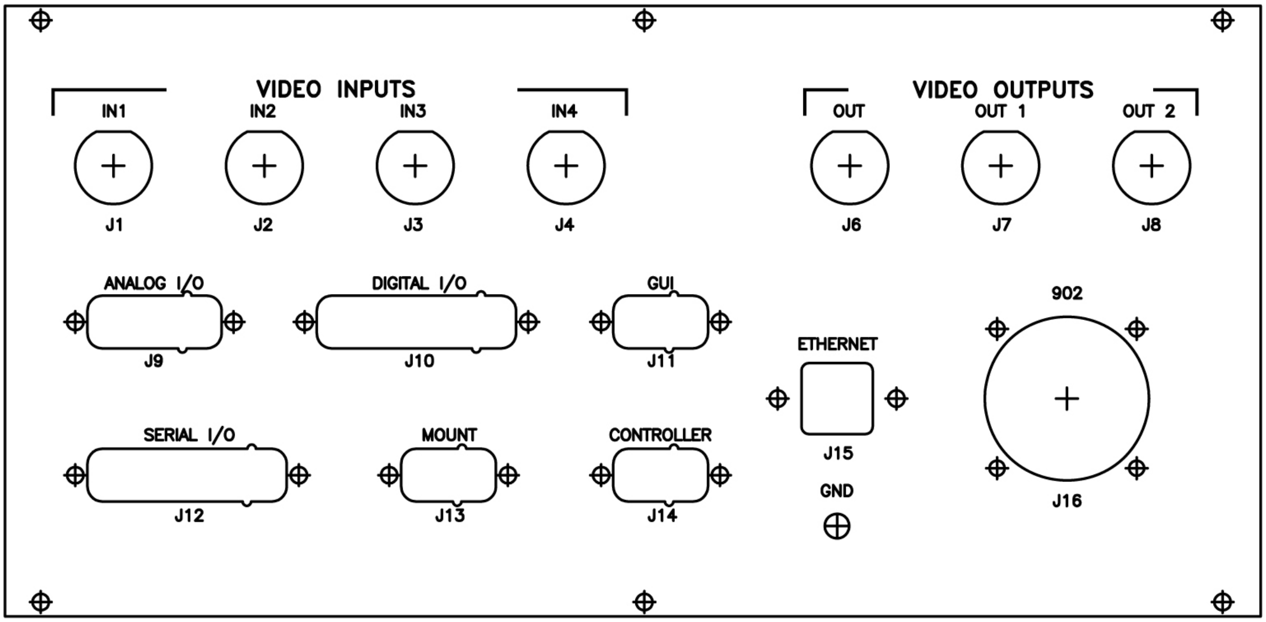

Figure D2.1. Rear Panel Layout, 3U Chassis

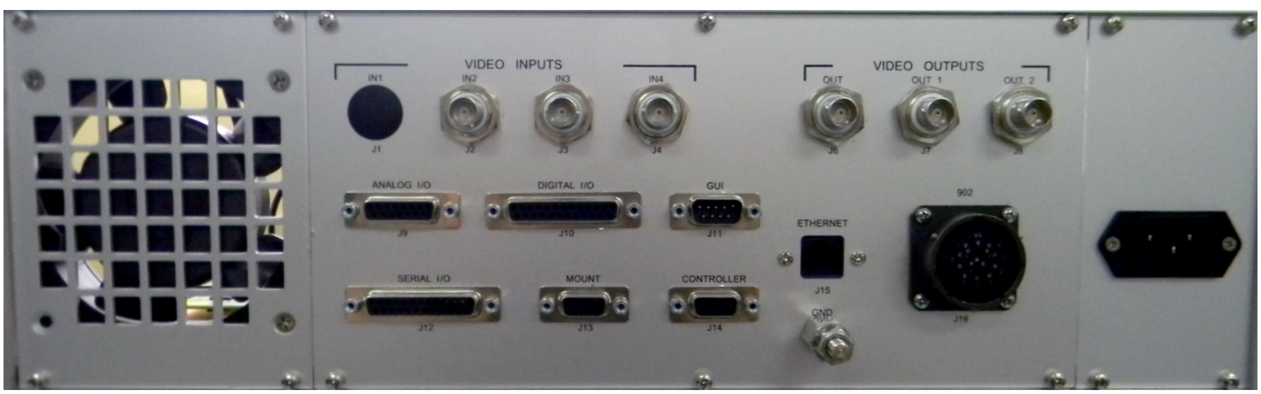

Figure D2.2. Rear Panel Picture, 3U Chassis

This 3U 19 inch rack mount chassis typically contains a Model 7010 PCI Express Video Tracker.

D2.1 Connector List

Table D2.1. Inputs and Outputs, 3U Rear Panel

Name	Function
J1 – IN1	Plugged (analog video input #1 is supplied via J16)
J2 – IN2	Analog Video Input #2 (1.0V p-p nominal)
J3 – IN3	Analog Video Input #3 (1.0V p-p nominal)
J4 – IN4	Analog Video Input #4 (1.0V p-p nominal)
J6 – OUT	Analog Video Output (1.0V p-p nominal) with **no** Symbology
J7 – OUT 1	Analog Video Output with Tracker Symbology
J8 – OUT 2	Analog Video Output with Tracker Symbology
J9 – ANALOG I/O	Azimuth and elevation analog error signals (to a servo system) and analog inputs.
J10 – DIGITAL I/O	Azimuth and elevation error data (in parallel digital format) Also includes break lock, on target and coast signals
J11 – GUI	Serial RS-232/422 interface for tracker control (usually connected to the tracker GUI)
J12 – SERIAL I/O	Other serial interfaces (typically for lens control)
J13 – MOUNT	Serial RS-232/422 interface for mount/gimbal control
J14 – CONTROLLER	Interface to 701 or 702 Controller (includes serial interface and ground)
J15 – ETH	Ethernet interface for tracker control
J16 – 902	Interface to 901 or 902 Camera System (includes serial interface, analog video, AC power and ground)

D2.2 Connector Pin Out

D2.2.1 Video Connectors

Table D2.2. Video Connectors

J No.	Pin	Function	Mating Connector
J1, J2		Analog Video Inputs (Video IN1 & Video IN2)	PL20-2 (BNC Coax Male)
J3, J4		Analog Video Inputs (Video IN3 & Video IN4)	PL20-2 (BNC Coax Male)
J6		Analog Video Output (No Symbology)	PL20-2 (BNC Coax Male)
J7		Analog Video Output (Symbology)	PL20-2 (BNC Coax Male)
J8		Analog Video Output (Symbology)	PL20-2 (BNC Coax Male)

Note: The analog video outputs (J6 through J8) are all the output of the currently selected tracker video source.

D2.2.2 Analog I/O Connector

Table D2.3. Analog I/O Connector

J No.	Pin	Function	Mating Connector
J9		**Analog Error Output DA15S**	**DA15P (ITT)**
	1	Azimuth Analog Error (±5Vdc or ±10Vdc)	
	2	Azimuth Return (Analog Ground)	
	3	Elevation Analog Error (±5Vdc or ±10Vdc)	
	4	Elevation Return (Analog Ground)	
	5	+5Vdc	
	6	Analog Ground	
	7	Analog Ground	
	8	Analog Input 1 (Joystick X)	
	9	Analog Input 2 (Joystick Y)	
	10	Analog Input 3 (Track/Acquire)	
	11	Analog Input 4	
	12	Analog Input 5	
	13	Analog Input 6	
	14	Analog Input 7	
	15	Analog Input 8	

D2.2.3 Digital I/O Connector

Table D2.4. Digital I/O Connector

J No.	Pin	Function	Mating Connector
J10		**Digital Error Output DB25S**	**DB25P**
	1	DIGERR1	
	2	DIGERR2	
	3	DIGERR3	
	4	DIGERR4	
	5	DIGERR5	
	6	DIGERR6	
	7	DIGERR7	
	8	DIGERR8	
	9	DIGERR9	
	10	DIGERR10	
	11	DIGERR11	
	12	DIGERR12	
	13	DIGERR13	
	14	DIGERR0	
	15	Data Strobe In	
	16	Digital Ground	
	17	Digital Ground	
	18	Digital Ground	
	19	ID (Azimuth/Elevation Identification Bit)	
	20	Data Strobe Out	
	21	Track / Acquire	
	22	Coast	
	23	On Target	
	24	DIGERR15	
	25	DIGERR14	

Note: DIGERR bits 0 through 4 indicate fractional pixel values.
DIGERR bits 5 through 15 represent whole pixel values.

D2.2.4 *Serial Interface Connectors*

Table D2.5. Serial Interface Connectors

J No.	Pin	Function	Mating Connector
J11		**GUI – Serial Tracker Control and Status**	**DB9F**
	1	UART0 RS422+ TX (output)	
	2	UART0 RS232 / RS422- TX (output)	
	3	UART0 RS323 / RS422- RX (input)	
	4	UART0 RS422+ RX (input)	
	5	Signal Ground	
	6 - 9	Reserved	
J12		**Serial I/O – Auxiliary Serial Ports**	**DB25P**
	1	Reserved	
	2	Reserved	
	3	Reserved	
	4	Reserved	
	5	UART4 RS422+ TX (output)	
	6	UART4 RS232 / RS422- TX (output)	
	7	UART4 RS232 / RS422- RX (input)	
	8	UART4 RS422+ RX (input)	
	9	UART5 RS422+ TX (output)	
	10	UART5 RS232 / RS422- TX (output)	
	11	UART5 RS232 / RS422- RX (input)	
	12	UART5 RS422+ RX (input)	
	13	Signal Ground	
	14	Signal Ground	
	15	Signal Ground	
	16	UART6 RS422+ TX (output)	
	17	UART6 RS232 / RS422- TX (output)	
	18	UART6 RS232 / RS422- RX (input)	
	19	UART6 RS422+ RX (input)	
	20	Signal Ground	
	21	UART7 RS422+ TX (output)	
	22	UART7 RS232 / RS422- TX (output)	
	23	UART7 RS232 / RS422- RX (input)	
	24	UART7 RS422+ RX (input)	
	25	Signal Ground	

D2.2.5 Mount and Controller Connectors

Table D2.6. Mount and Controller Connectors

J No.	Pin	Function	Mating Connector
J13		**Mount Serial Interface**	**DB9M**
	1	UART2 RS422+ TX (output)	
	2	UART2 RS232 / RS422- TX (output)	
	3	UART2 RS323 / RS422- RX (input)	
	4	UART2 RS422+ RX (input)	
	5	Signal Ground	
	6 - 9	Reserved	
J14		**Controller Interface**	**DB9M**
	1	+5Vdc	
	2	+5Vdc	
	3	+5Vdc	
	4	Signal Ground	
	5	Signal Ground	
	6	UART1 RS422+ TX (output)	
	7	UART1 RS232 / RS422- TX (output)	
	8	UART1 RS323 / RS422- RX (input)	
	9	UART1 RS422+ RX (input)	

D2.2.6 902 Connector

Table D2.7. 902 Connector

J No.	Pin	Function	Mating Connector
J16		**Model 901/902 Camera System Interface**	**MS3116J20-16P / KPT06J20-16P**
	A	Analog Video Input #1 (tip)	
	B	Analog Video Input #1 Return (shield)	
	C	UART3 RS422+ TX (output)	
	D	UART3 RS232 / RS422- TX (output)	
	E	Reserved	
	F	Reserved	
	G	AC Ground / Chassis Ground	
	H	AC Hot	
	J	Reserved	
	K	Signal Ground	
	L	UART3 RS232 / RS422- RX (input)	
	M	UART3 RS422+ RX (input)	
	N	Signal Ground	
	P	AC Neutral	
	R	Reserved	
	S	Reserved	

Appendix E

As Delivered Configuration

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E1 Model 7005-CL/7006-CL R1 VMEbus Tracker Board Jumper Configuration

J1	Analog Video I/O	Analog Video Inputs (4) and Outputs (3)
J2	Analog and Digital I/O	Analog Errors (2), Analog Inputs (8) Digital I/O, Digital Status UART 0-5 and 7 (RS-232/RS-422) UART 6 is not operational.
J3	Camera Link Input	Camera Link Base Digital Video Input
J4	Camera Link Input	Camera Link Full Digital Video Input
J5	Camera Link Output	Camera Link Base Digital Video Output
J6	Cameral Link Output	Camera Link Full Digital Video Output
J7	Ethernet	10/100/1000 Ethernet
S1	Reset Switch	Hard resets FPGA and DSPs
S2	Analog Error Output Range	1-bit DIP switch. Sets ±5 or ±10 voltage range for analog error outputs. 5V = ±5V (default), 10V = ±10V
S3	Video Signal Type	4-bit DIP switch. Selects between differential and single-ended mode for analog video inputs 1 through 4. ON = Differential, OFF(default) = Single-ended SWITCH 1 = Video Input 1
S4	VME Slave Address Selection	8-bit DIP switch. Set for two 4-bit binary values that indicate the upper two characters of the starting address. ON = 1, OFF = 0 SWITCH 1 = LSB
JP3	UART0 RS-422 Jumper	Jumper to select RS-422 for UART0

Table E1.1 Model 7005-CL/7006-CL R1 VMEbus Tracker Board Jumper Configuration

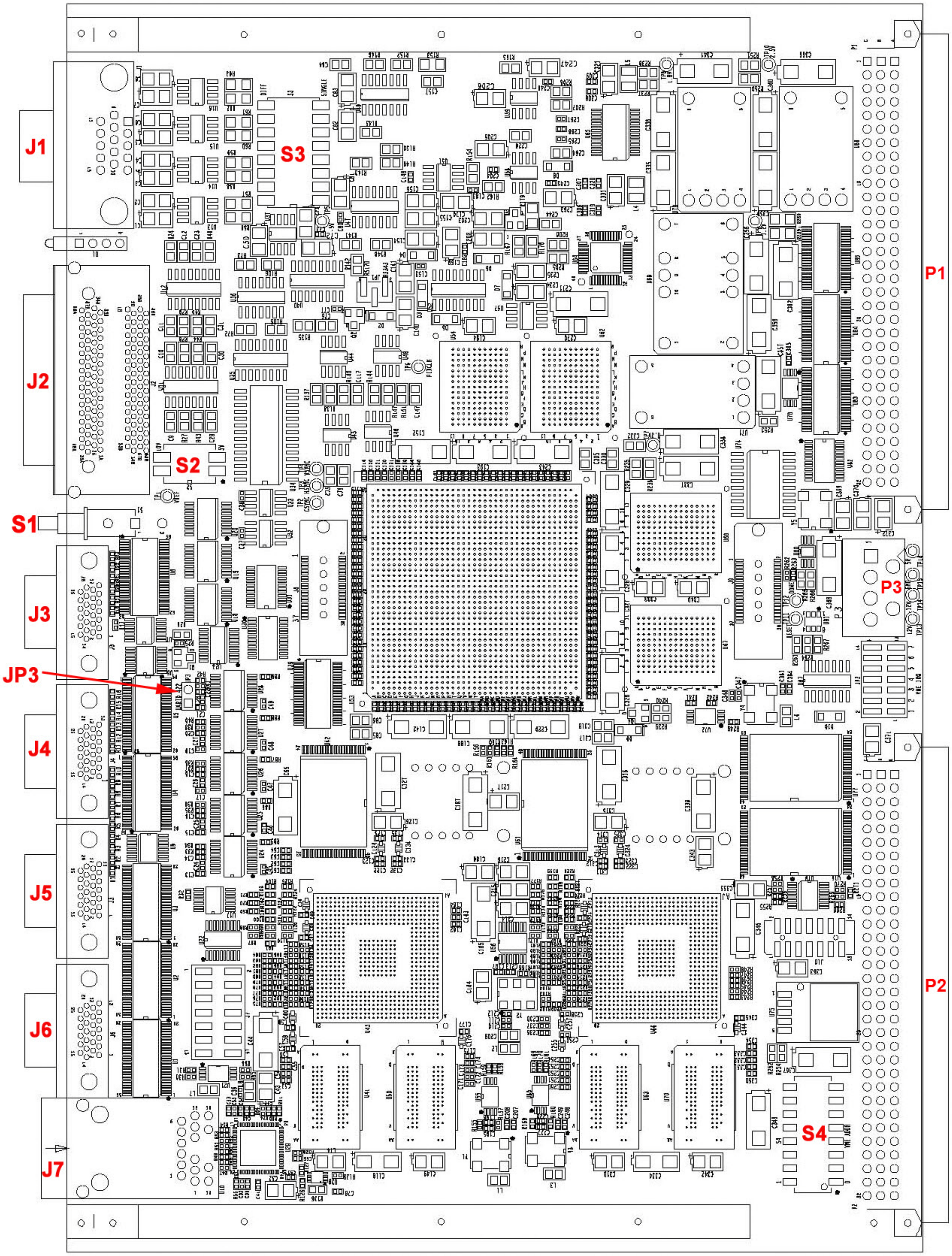


Figure E1.1 Model 7005-CL/7006-CL R1 VMEbus Tracker Board Top Assembly

E2 Model 7005-CL/7006-CL R2 VMEbus Tracker Board Jumper Configuration

J1	Analog Video I/O	Analog Video Inputs (4) and Outputs (3)
J2	Analog and Digital I/O	Analog Errors (2), Analog Inputs (8) Digital I/O, Digital Status UART 0-7 (RS-232/RS-422)
J3	Camera Link Input	Camera Link Base Digital Video Input
J4	Camera Link Input	Camera Link Full Digital Video Input
J5	Camera Link Output	Camera Link Base Digital Video Output
J6	Cameral Link Output	Camera Link Full Digital Video Output
J7	Ethernet	10/100/1000 Ethernet
S1	Reset Switch	Hard resets FPGA and DSPs
S2	Analog Error Output Range	1-bit DIP switch. Sets ±5 or ±10 voltage range for analog error outputs. 5V = ±5V (default), 10V = ±10V
S3	UART0 RS-422 Switch	Switch to select RS-422 for UART0
S4	Video Signal Type	4-bit DIP switch. Selects between differential and single-ended mode for analog video inputs 1 through 4. ON = Differential, OFF(default) = Single-ended SWITCH 1 = Video Input 1
S5	VME Slave Address Selection	8-bit DIP switch. Set for two 4-bit binary values that indicate the upper two characters of the starting address. ON = 1, OFF = 0 SWITCH 1 = LSB

Table E2.1 Model 7005-CL/7006-CL R2 VMEbus Tracker Board Jumper Configuration

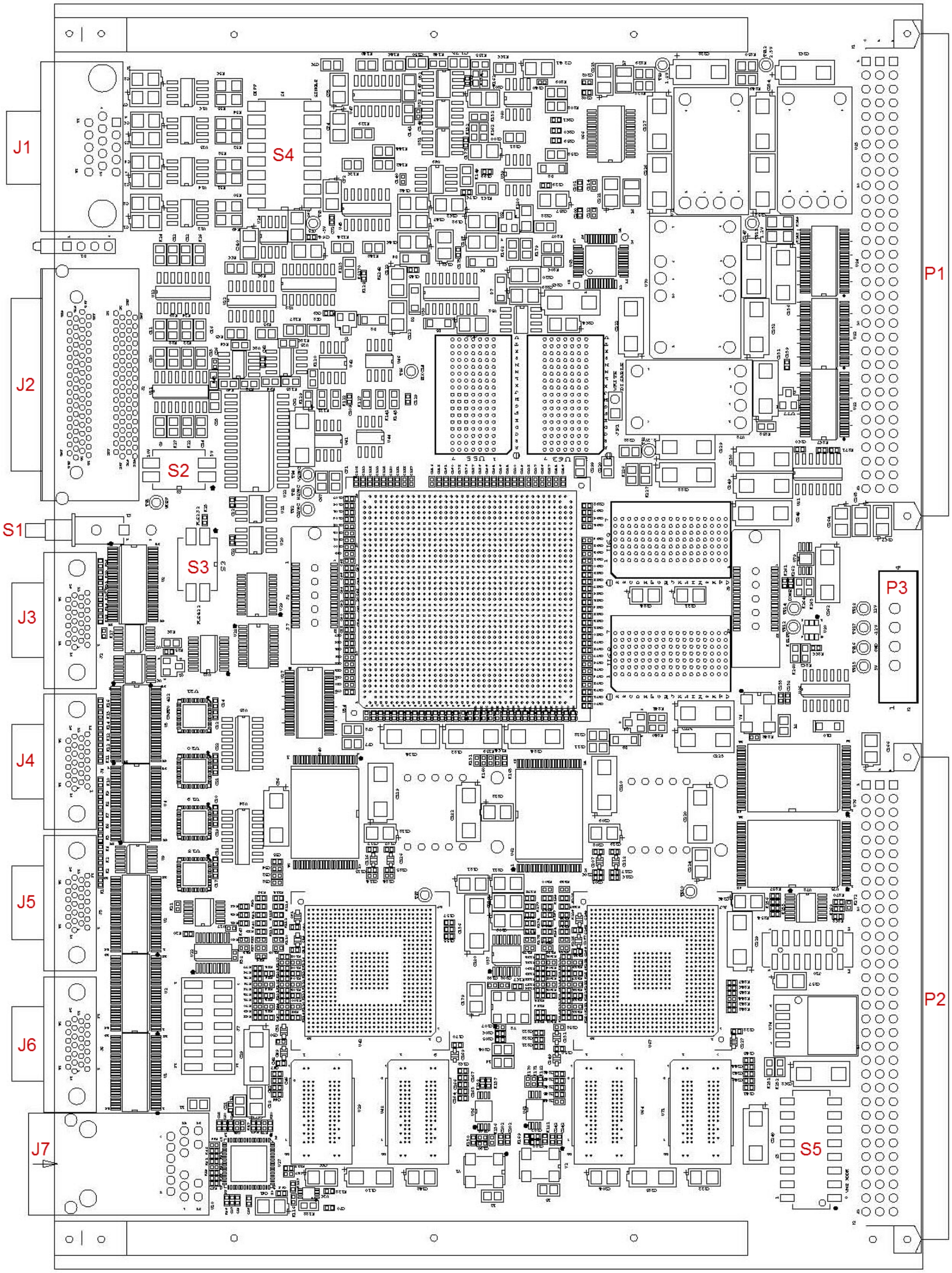


Figure E2.1 Model 7005-CL/7006-CL R2 VMEbus Tracker Board Top Assembly

E3 Model 7005-HD/7006-HD VMEbus Tracker Board Jumper Configuration

J1	Analog Video I/O	Analog Video Inputs (4) and Outputs (3)
J2	Analog and Digital I/O	Analog Errors (2), Analog Inputs (8) Digital I/O, Digital Status UART 0-7 (RS-232/RS-422)
J3	HD-SDI Input 1	High Definition Digital Video Input
J4	HD-SDI Input 2	High Definition Digital Video Input
J5	HD-SDI Output 1	High Definition Digital Video Output (Not Annotated)
J6	HD-SDI Output 2	High Definition Digital Video Output (Annotated)
J7	Ethernet	10/100/1000 Ethernet
S1	Reset Switch	Hard resets FPGA and DSPs
S2	Analog Error Output Range	1-bit DIP switch. Sets ±5 or ±10 voltage range for analog error outputs. 5V = ±5V (default), 10V = ±10V
S3	Video Signal Type	4-bit DIP switch. Selects between differential and single-ended mode for analog video inputs 1 through 4. ON = Differential, OFF(default) = Single-ended SWITCH 1 = Video Input 1
S4	VME Slave Address Selection	8-bit DIP switch. Set for two 4-bit binary values that indicate the upper two characters of the starting address. ON = 1, OFF = 0 SWITCH 1 = LSB
JP3	UART0 RS-422 Jumper	Jumper to select RS-422 for UART0

Table E3.1 Model 7005-HD/7006-HD VMEbus Tracker Board Jumper Configuration

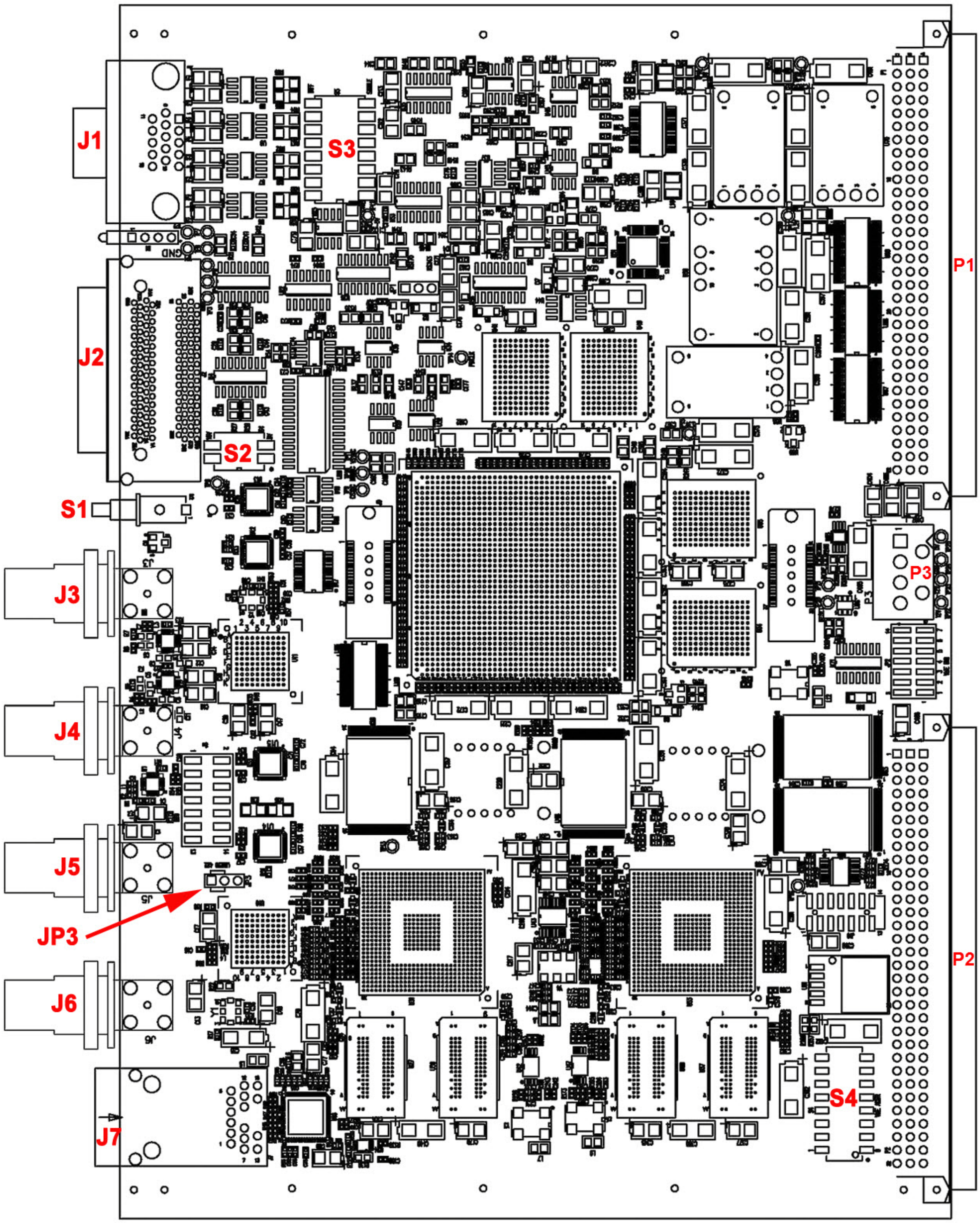


Figure E3.1 Model 7005-HD/7006-HD VMEbus Tracker Board Top Assembly

E4 Model 7007/7008 PCI Tracker Board Jumper Configuration

J1	Analog Video I/O	Analog Video Inputs (4) and Outputs (3)
J2	Analog and Digital I/O and Ethernet	Analog Errors (2), Analog Inputs (8) Digital I/O, Digital Status UART 0-7 (RS-232/RS-422), and Ethernet.
S1	Reset Switch	Hard resets FPGA and DSPs
S2	Video Signal Type	4-bit DIP switch. Selects between differential and single-ended mode for analog video inputs 1 through 4. ON = Differential, OFF(default) = Single-ended SWITCH 1 = Video Input 1
S3	Analog Error Output Range	1-bit DIP switch. Sets ±5 or ±10 voltage range for analog error outputs. 5V = ±5V (default), 10V = ±10V
S4	UART0 RS-232/422 Select Switch	Select between RS-232 and RS-422 for UART0
JP1	Write Protect Jumper	Enable/Disable Write Protect for flash memory

Table E4.1 Model 7007/7008 PCI Tracker Board Jumper Configuration

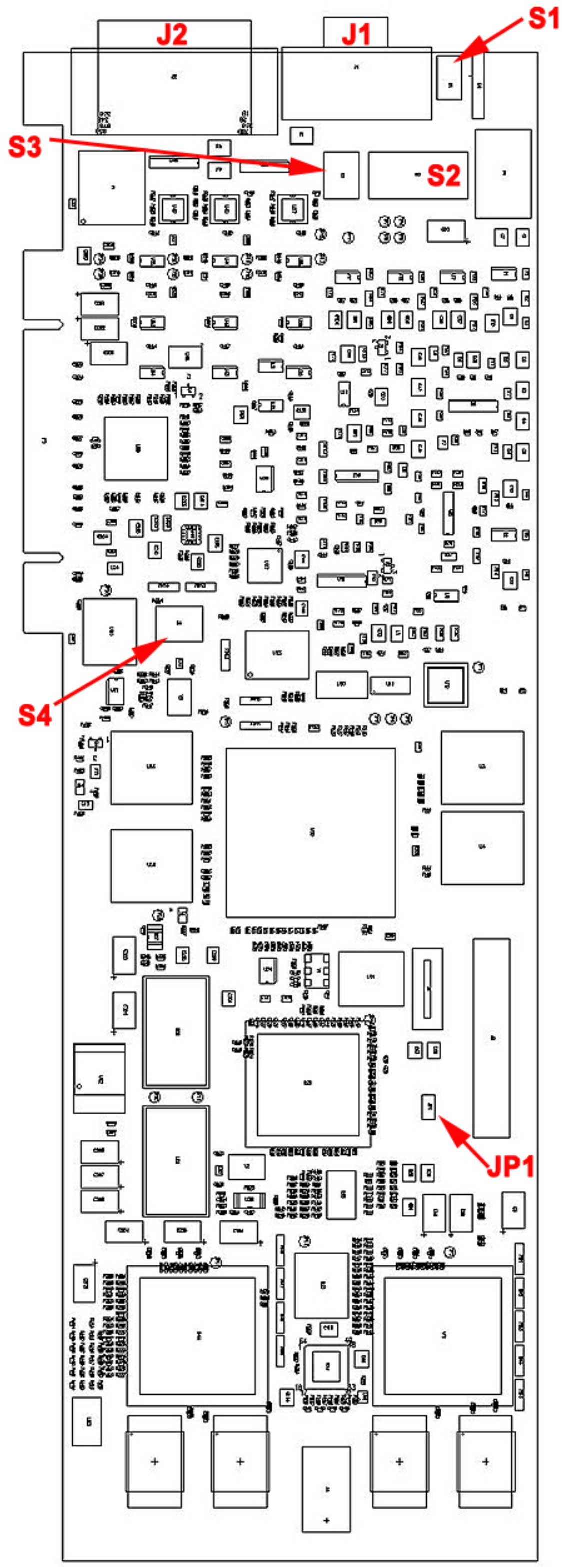


Figure E4.1 Model 7007/7008 PCI Tracker Board Top Assembly

E5 Model 7010/7011 PCI Express Tracker Board Jumper Configuration

J1	Analog Video I/O	Analog Video Inputs (4) and Outputs (3)
J2	Analog and Digital I/O and Ethernet	Analog Errors (2), Analog Inputs (8) Digital I/O, Digital Status UART 0-7 (RS-232/RS-422), and Ethernet.
S1	Reset Switch	Hard resets FPGA and DSPs
S2	Video Signal Type	4-bit DIP switch. Selects between differential and single-ended mode for analog video inputs 1 through 4. ON = Differential, OFF(default) = Single-ended SWITCH 1 = Video Input 1
S3	Analog Error Output Range	1-bit DIP switch. Sets ±5 or ±10 voltage range for analog error outputs. 5V = ±5V (default), 10V = ±10V
S4	UART0 RS-232/422 Select Switch	Select between RS-232 and RS-422 for UART0
JP1	Write Protect Jumper	Enable/Disable Write Protect for flash memory

Table E5.1 Model 7010/7011 PCI Express Tracker Board Jumper Configuration

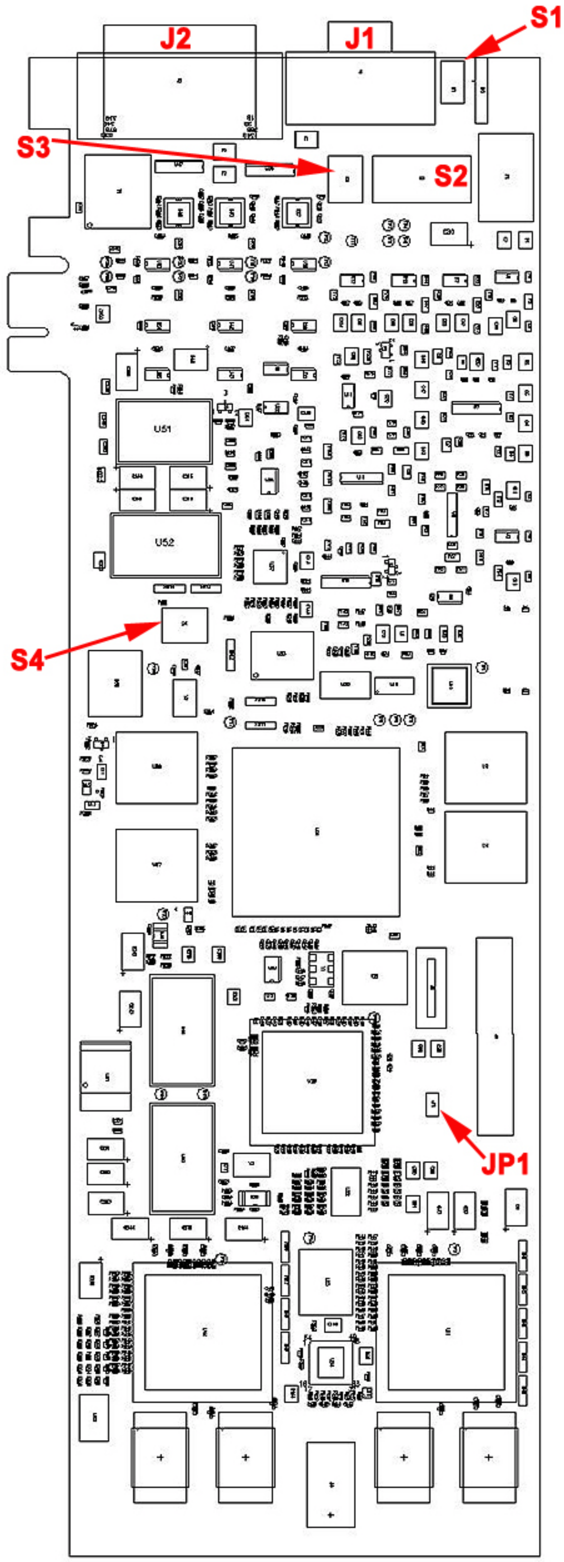


Figure E5.1 Model 7010/7011 PCI Express Tracker Board Top Assembly

E6 Model 7015/7016 VMEbus Tracker Board Jumper Configuration

P1	VMEbus	VMEbus connector (P1)
P2	Tracker I/O	VMEbus connector (P2)
JP2	Write Protect Jumper	Enable/Disable Write Protect for flash memory
JP3	UART0 RS-422 Jumper	Jumper to select RS-422 for UART0

Table E6.1 Model 7015/7016 VMEbus Tracker Board Jumper Configuration

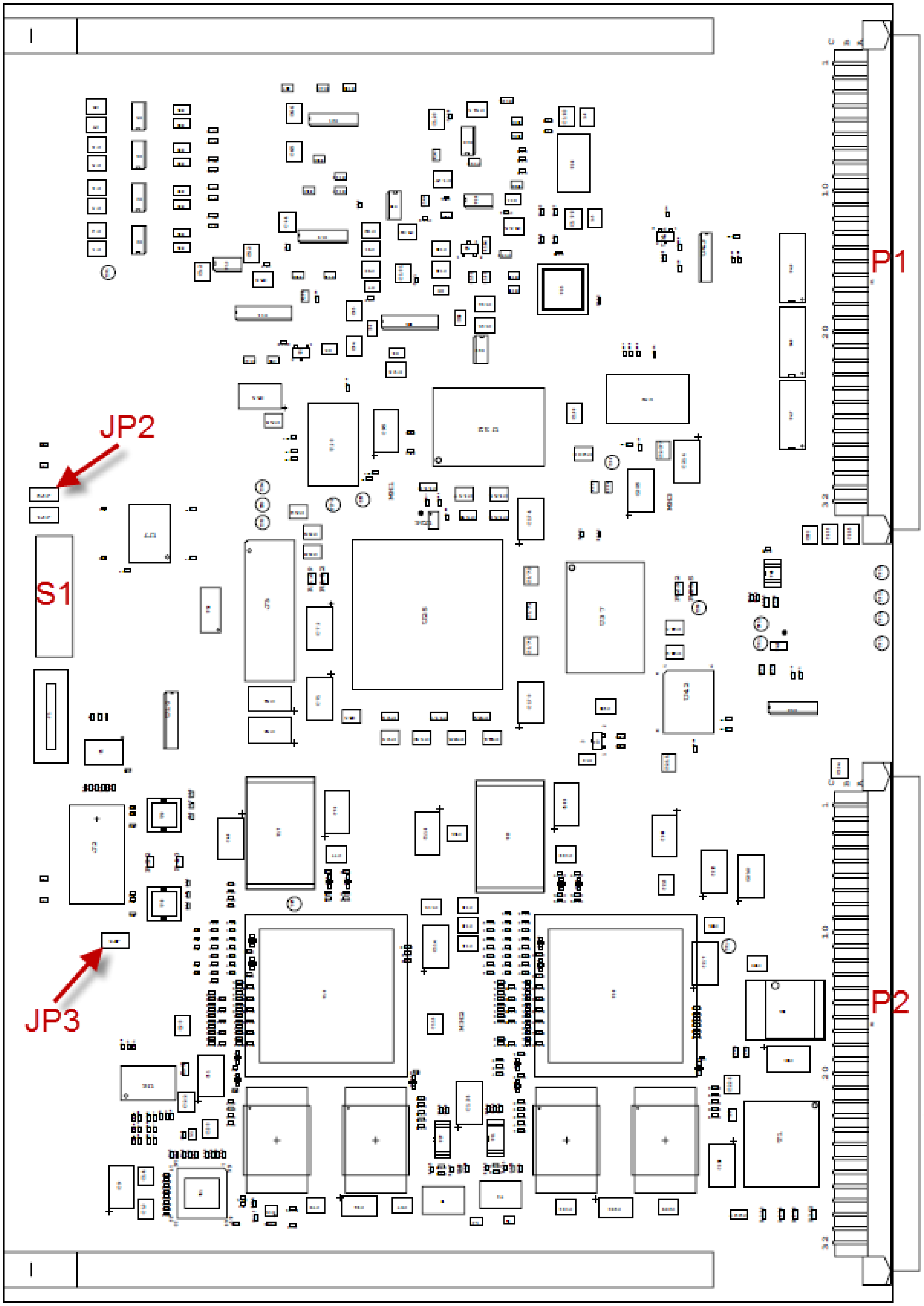


Figure E6.1 Model 7015/7016 VMEbus Tracker Board Top Assembly

E7 Model 7410/7411/7412 PCI Express Tracker Board Jumper Configuration

D1	Power LED	Lit when power is applied
D2	Heartbeat LED	Blinking during normal operation
J1	PC Serial	Standard DB9 Serial for Control UART0, RS-232 only
J4	Ethernet	10/100/1000 Ethernet
J5	DVI-D Input	DVI-D Video Input
J6	Serial I/O	Serial Ports (4), UART0 – UART3
J7	DVI-D Output	DVI-D Video Output
J8	Standalone Power	External DC Power, +12 volts
S1	Reset Switch	Hard resets FPGA and DSPs
S2	RS-232/422 Select Switch	Select between RS-232 and RS-422 for UART0 through UART3
JP1	Write Protect Jumper	Enable/Disable Write Protect for flash memory

Table E7.1 Model 7410/7411/7412 PCI Express Tracker Board Jumper Configuration

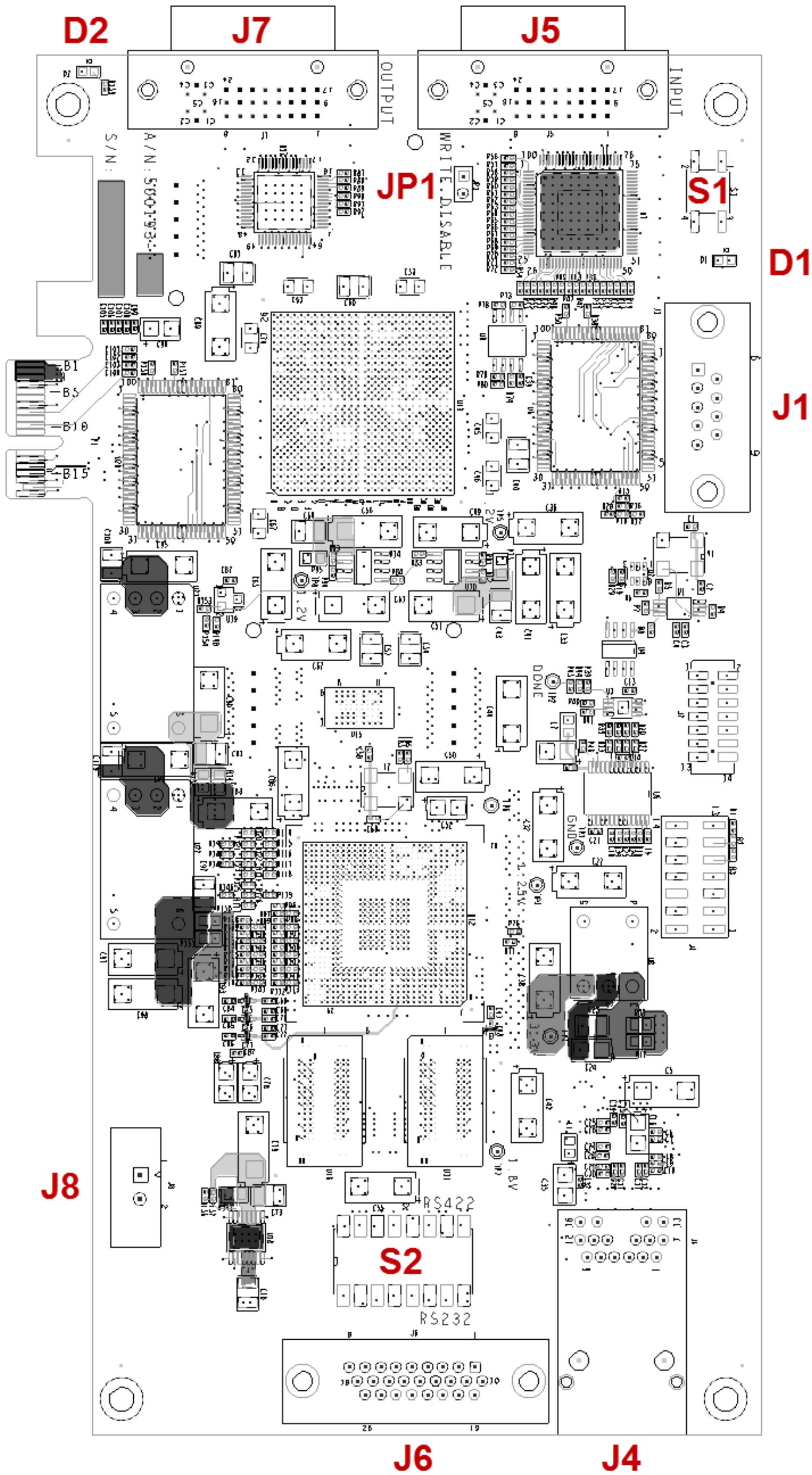


Figure E7.1 Model 7410/7411/7412 PCI Express Tracker Board Top Assembly

E8 Camera Link (CL) Daughter Board Jumper Configuration

J1	Camera Link I/O (Base & Full)	Digital Video Inputs/Outputs

Table E8.1 Camera Link (CL) Daughter Board Jumper Configuration

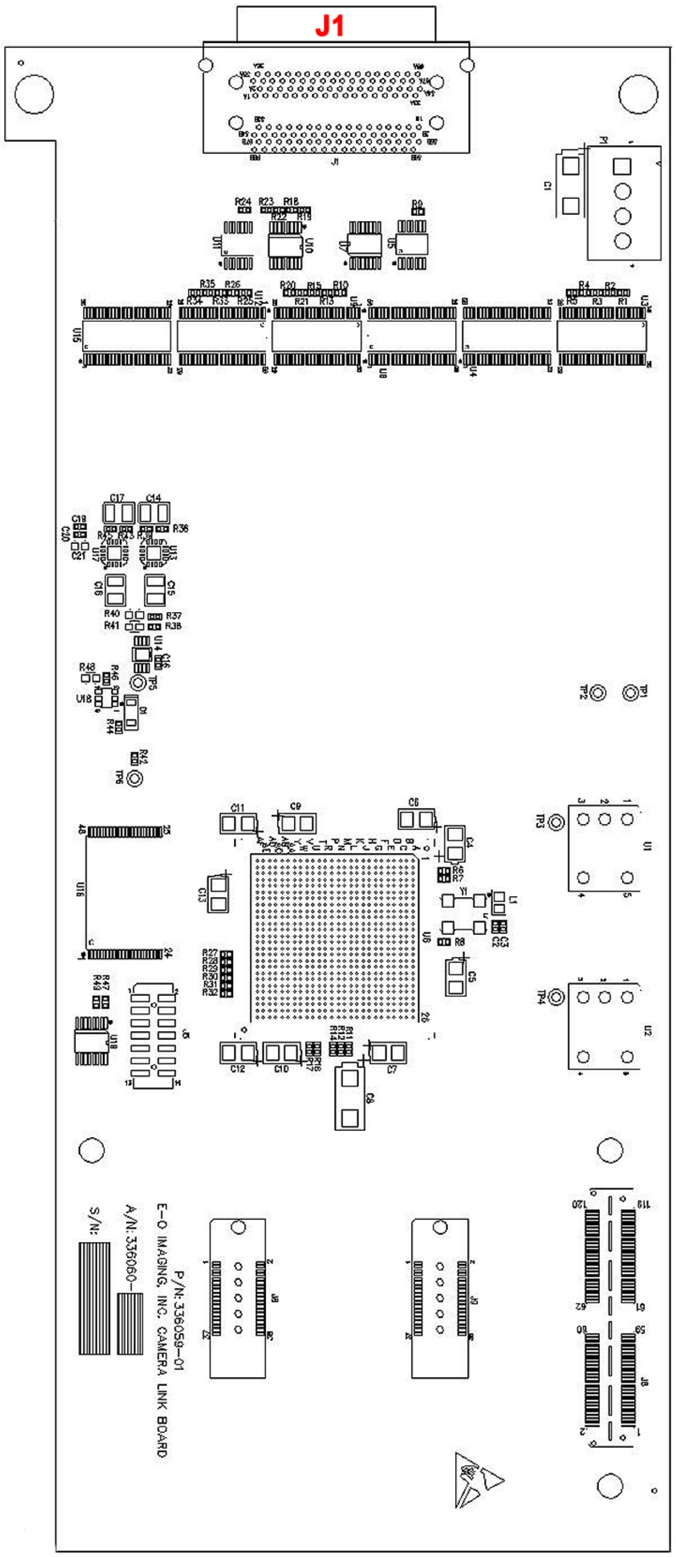


Figure E8.1 Camera Link (CL) Daughter Board Top Assembly

E9 HD-SDI Daughter Board Jumper Configuration

J1	HD-SDI Input 1	High Definition Digital Video Input
J2	HD-SDI Input 2	High Definition Digital Video Input
J3	HD-SDI Output 1	High Definition Digital Video Output of selected input (unannotated)
J4	HD-SDI Output 2	High Definition Digital Video Output of selected input (annotated)

Table E9.1 HD-SDI Daughter Board Jumper Configuration

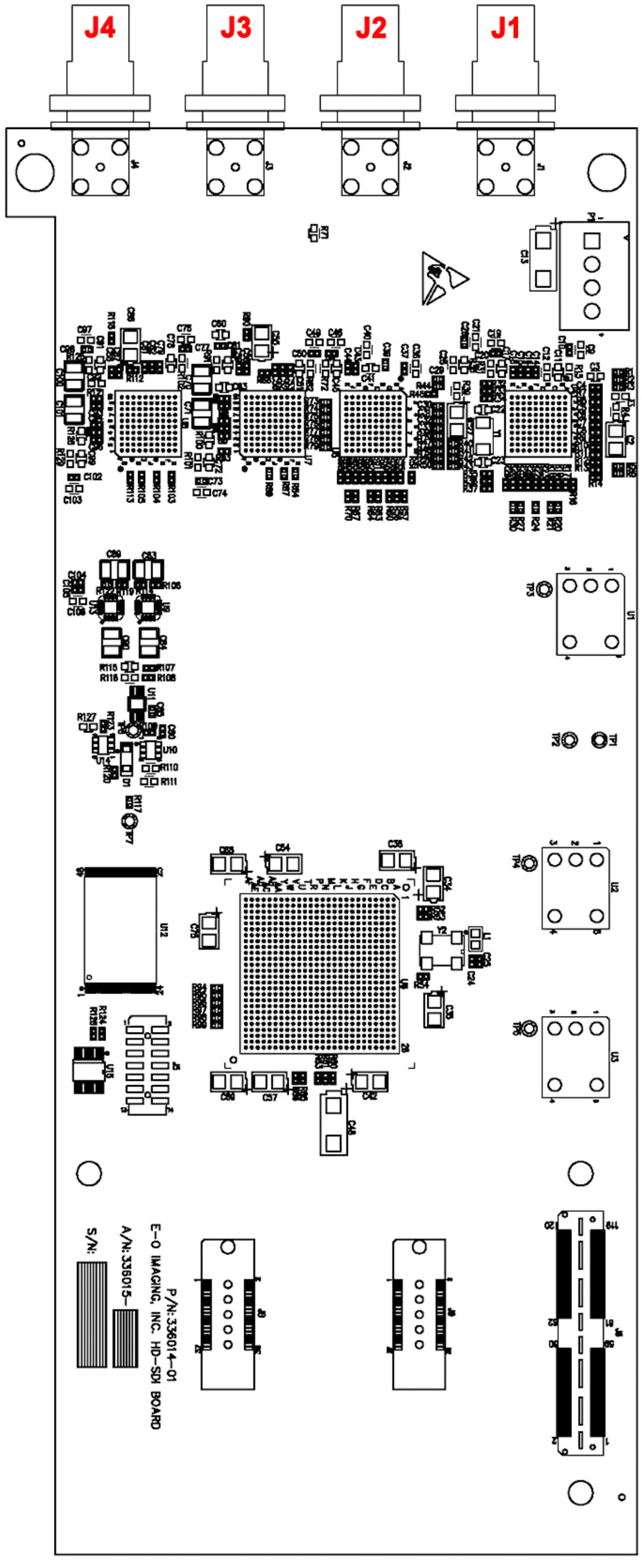


Figure E9.1 HD-SDI Daughter Board Top Assembly

E10 DVI-D Daughter Board Jumper Configuration

J1	DVI-D Input	DVI-D Video Input
J2	DVI-D Output	DVI-D Video Output

Table E10.1 DVI-D Daughter Board Jumper Configuration

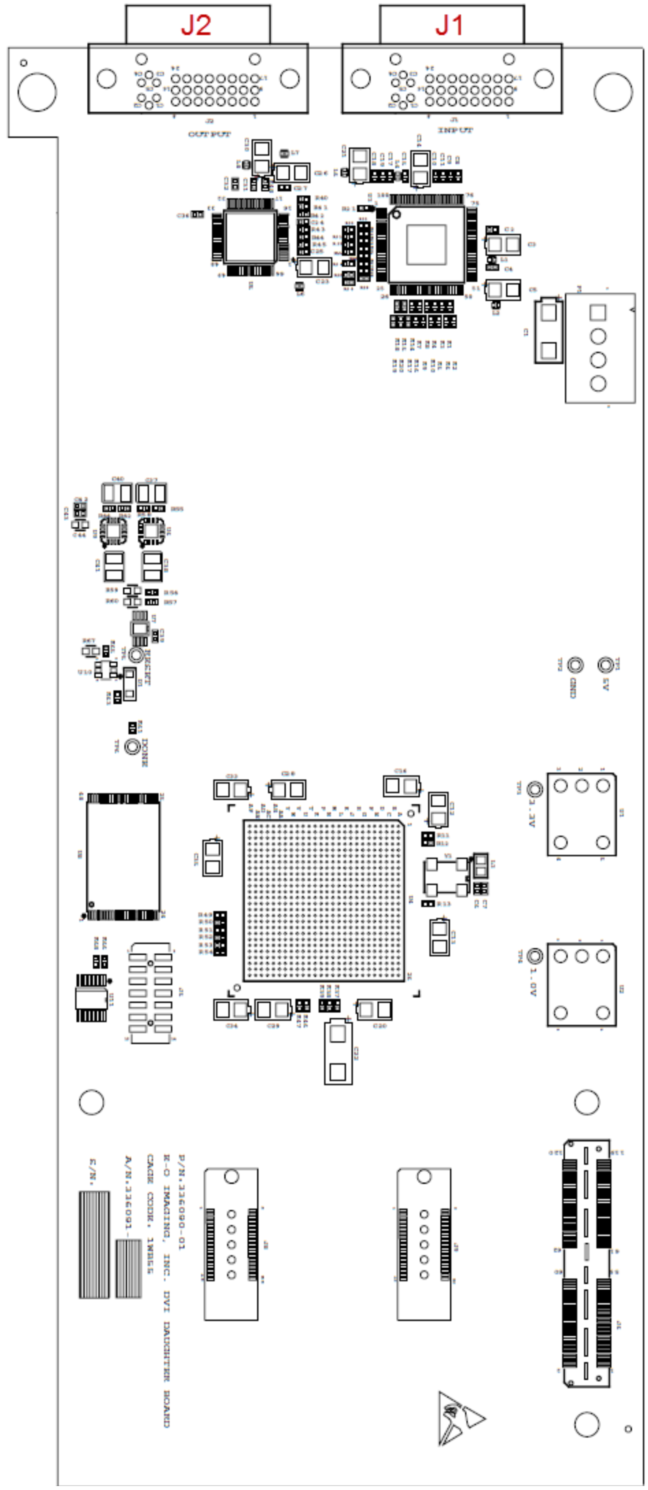


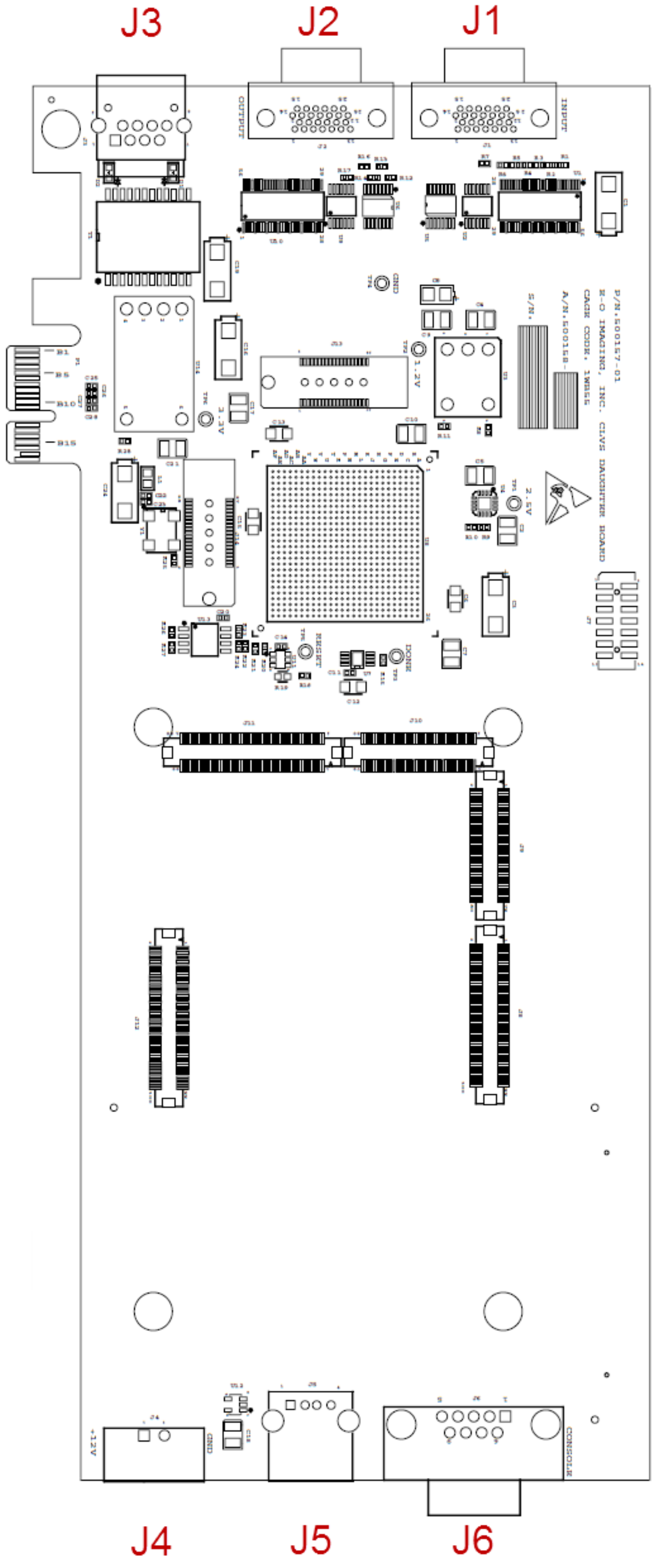
Figure E10.1 DVI-D Daughter Board Top Assembly

ELECTRO-OPTICAL IMAGING, INC.

E11 CLVS Daughter Board Jumper Configuration

J1	Camera Link Base Input	Camera Link video input
J2	Camera Link Base Output	Camera Link video output
J3	Ethernet	10/100/1000 Ethernet for video stream output
J4	Standalone Power	External DC Power, +12 volts
J5	USB	(NOT SUPPORTED)
J6	Maintenance Terminal	Standard DB9 Serial for maintenance terminal, RS-232

Table E11.1 CLVS Daughter Board Jumper Configuration



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Appendix F

Front Panel Connector I/O and Cable I/O Definitions

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F1 Digital Video Interface

F1.1 Camera Link Base Input and Output

The Model 7007/7008 PCI and 7010/7011 PCI Express Video Trackers with a CLVS Daughter Board support a Camera Link base digital video interface. All signals follow the Camera Link standard. The interface has the following characteristics:

a. 8, 10, 12, 14 or 16-bit grayscale data
b. Resolutions up to 2048 pixels by 2048 lines
c. Frame rates up to 250 Hz
d. Pixel clock rates up to 170 MHz
e. Camera control signals passed through

F1.2 Camera Link Full Input and Output

The Model 7005-CL and 7006-CL VME Video Trackers and the 7007/7008 PCI and 7010/7011 PCI Express Video Trackers with a Camera Link (CL) Daughter Board support a Camera Link full digital video interface. All signals follow the Camera Link standard. The interface has the following characteristics:

a. 8, 10, 12, 14 or 16-bit grayscale data
b. Resolutions up to 2048 pixels by 2048 lines
c. Frame rates up to 250 Hz
d. Pixel clock rates up to 200 MHz
e. Camera control signals passed through

F1.3 Digital Video Interface (DVI) Input and Output

The Model 7007/7008 PCI and 7010/7011 PCI Express Video Trackers with a DVI-D Daughter Board and the Model 7410/7411/7412 PCI Express Video Trackers support one (1) Digital Video Interface (DVI) input and one (1) Digital Video Interface output. All signals follow the DVI standard. The interface has the following characteristics:

a. Resolutions up to 1920 pixels by 1080 lines
b. Frame rates up to 60 Hz
c. Pixel clock rates up to 150 MHz

F1.4 HD-SDI Inputs and Outputs

The Model 7005-HD and 7006-HD VME Video Trackers and the 7007/7008 PCI and 7010/7011 PCI Express Video Trackers with a HD-SDI Daughter Board support two (2) HD-SDI inputs and provide two (2) HD-SDI outputs. All signals follow the SD/HD-SDI standard. The interface has the following characteristics:

a. SMPTE 259M, 344M and 292M standards
b. 480i, 480p, 576i, 576p, 720p, 1080i and 1080p video formats

F2 Model 7005-CL/7006-CL I/O Connector Definition

The connectors on the Model 7005-CL/7006-CL VME tracker board are described in the following paragraphs.

F2.1 Model 7005-CL/7006-CL Front Panel

The connectors on the front panel of the Model 7005-CL/7006-CL VME tracker board are described in the following paragraphs.

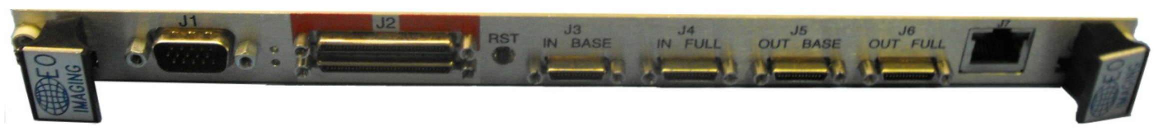

Figure F2.1 Model 7005-CL/7006-CL Front Panel

F2.2 Analog Video Connector

The analog video connector (J1) on the tracker board is a 15-pin male connector, AMP 749767-1. The mating connector is a 15-pin high-density female connector, PDI-15RHS-SW-H.

Table F2.1 Analog Video Connector - Connection Definitions:

1.	Video In 1 (+)	6.	Video In 1 (-)	11.	Video 1 Out
2.	Video In 2 (+)	7.	Video In 2 (-)	12.	Ground
3.	Video In 3 (-)	8.	Video In 4 (+)	13.	Video In 4 (-)
4.	Video In 3 (+)	9.	Ground	14.	Video 2 Out
5.	Video Out (no annotation)	10.	Ground	15.	Ground

F2.3 VHDCI I/O Connector A - White

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The bottom/left 68-pin female VHDCI connector is colored white and is used for serial communications, analog I/O and digital status.

Table F2.2 VHDCI I/O Connector (J2A) - Connection Definitions:

1.	Not Used	35.	+5 Volts
2.	Digital Ground	36.	+5 Volts
3.	Digital Ground	37.	+5 Volts
4.	+5 or +10 Volts (switch selectable, analog ref)	38.	+5 Volts
5.	-5 or -10 Volts (switch selectable, analog ref)	39.	+5 Volts
6.	Analog Ground	40.	Digital Ground

7.	Analog Input 1	41.	Digital Ground
8.	Analog Input 2	42.	Digital Ground
9.	Analog Input 3	43.	Digital Ground
10.	Analog Input 4	44.	Digital Ground
11.	Analog Ground	45.	Not Used
12.	Analog Input 5	46.	Not Used
13.	Analog Input 6	47.	UARTs Disable (connector keying)
14.	Analog Input 7	48.	Digital Ground
15.	Analog Input 8	49.	Digital Ground
16.	Analog Ground	50.	UART4 RS-422 (+) TX Out
17.	Analog Output 1 (Azimuth Error)	51.	UART4 RS-422 (-) / RS-232 TX Out
18.	Analog Output 2 (Elevation Error)	52.	UART4 RS-422 (+) RX In
19.	Analog Ground	53.	UART4 RS-422 (-) / RS-232 RX In
20.	Analog Output 3	54.	Digital Ground
21.	Analog Output 4	55.	UART3 RS-422 (+) TX Out
22.	Digital Ground	56.	UART3 RS-422 (-) / RS-232 TX Out
23.	On Target	57.	UART3 RS-422 (+) RX In
24.	Track/Acquire	58.	UART3 RS-422 (-) / RS-232 RX In
25.	Coast	59.	Digital Ground
26.	Not Used	60.	UART2 RS-422 (+) TX Out
27.	Short to pin 28 (connector keying)	61.	UART2 RS-422 (-) / RS-232 TX Out
28.	Short to pin 27 (connector keying)	62.	UART2 RS-422 (+) RX In
29.	Not Used	63.	UART2 RS-422 (-) / RS-232 RX In
30.	Digital Ground	64.	Digital Ground
31.	UART0 RS-422 (+) TX Out	65.	UART1 RS-422 (+) TX Out
32.	UART0 RS-422 (-) / RS-232 TX Out	66.	UART1 RS-422 (-) / RS-232 TX Out
33.	UART0 RS-422 (+) RX In	67.	UART1 RS-422 (+) RX In
34.	UART0 RS-422 (-) / RS-232 RX In	68.	UART1 RS-422 (-) / RS-232 RX In

F2.3.1 VHDCI I/O Cable A – White

The bottom/left 68-pin female VHDCI connector on the tracker is colored white and is used for serial communications, analog I/O and digital status. The white I/O Cable A connects to the tracker and provides three low-density connectors for easy access to the tracker I/O. These three connectors are described in the following paragraphs.

F2.3.2 GUI / UART0 Connector

The GUI (Graphical User Interface) connector (P1) is a standard DB9 female used for serial communications (RS-232/422). The wiring is standard for a typical PC computer serial port.

Table F2.3 GUI / UART0 Connector (P1) - Connection Definitions:

1. UART0 RS-422 (+) TX Out
2. UART0 RS-422 (-) / RS-232 TX Out
3. UART0 RS-422 (-) / RS-232 RX In
4. UART0 RS-422 (+) RX In
5. Digital Ground
6. Not Used
7. Not Used
8. Not Used
9. Not Used

F2.3.3 Analog I/O Connector

The analog I/O connector (P2) is a standard DB25 female.

Table F2.4 Analog I/O Connector (P2) - Connection Definitions:

1. Digital Ground	14. +5 or +10 Volts (switch selectable)
2. -5 or -10 Volts (switch selectable)	15. Analog Ground
3. Analog Input 1	16. Analog Input 2
4. Analog Input 3	17. Analog Input 4
5. Analog Ground	18. Analog Input 5
6. Analog Input 6	19. Analog Input 7
7. Analog Input 8	20. Analog Ground
8. Analog Output 1 (Azimuth Error)	21. Analog Output 2 (Elevation Error)
9. Analog Ground	22. Analog Output 3
10. Analog Output 4	23. Digital Ground
11. On Target	24. Track / Acquire
12. Coast	25. Not Used
13. Not Used	

F2.3.4 Serial I/O Connector

The serial I/O connector (P3) is a 44-pin female connector.

Table F2.5 Serial I/O Connector (P3) - Connection Definitions:

1. +5 Volts	16. +5 Volts	31. Digital Ground
2. +5 Volts	17. +5 Volts	32. Digital Ground
3. Digital Ground	18. +5 Volts	33. Digital Ground
4. Digital Ground	19. Not Used	34. Digital Ground
5. UART4 RS-422 (+) RX In	20. UART4 RS-422 (-) / RS-232 RX In	35. Digital Ground
6. UART4 RS-422 (+) TX Out	21. UART4 RS-422 (-) / RS-232 TX Out	36. Not Used
7. Digital Ground	22. Not Used	37. Not Used
8. UART3 RS-422 (+) RX In	23. UART3 RS-422 (-) / RS-232 RX In	38. UARTs Disable
9. UART3 RS-422 (+) TX Out	24. UART3 RS-422 (-) / RS-232 TX Out	39. Not Used
10. Digital Ground	25. Not Used	40. Not Used
11. UART2 RS-422 (+) RX In	26. UART2 RS-422 (-) / RS-232 RX In	41. Digital Ground
12. UART2 RS-422 (+) TX Out	27. UART2 RS-422 (-) / RS-232 TX Out	42. Not Used
13. Digital Ground	28. Not Used	43. Not Used
14. UART1 RS-422 (+) RX In	29. UART1 RS-422 (-) / RS-232 RX In	44. Not Used
15. UART1 RS-422 (+) TX Out	30. UART1 RS-422 (-) / RS-232 TX Out	

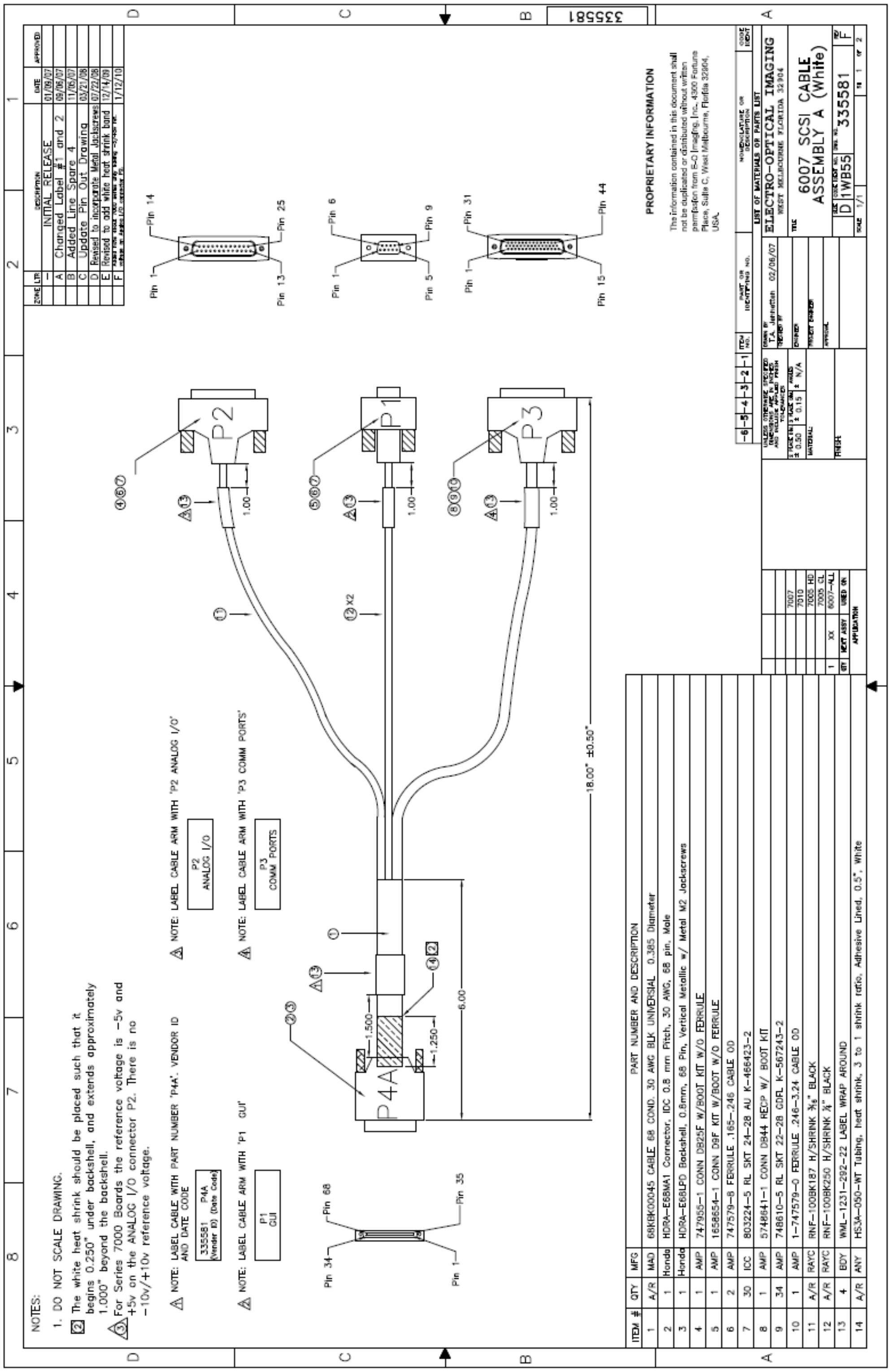

Figure F2.2 White Cable Assembly Drawing

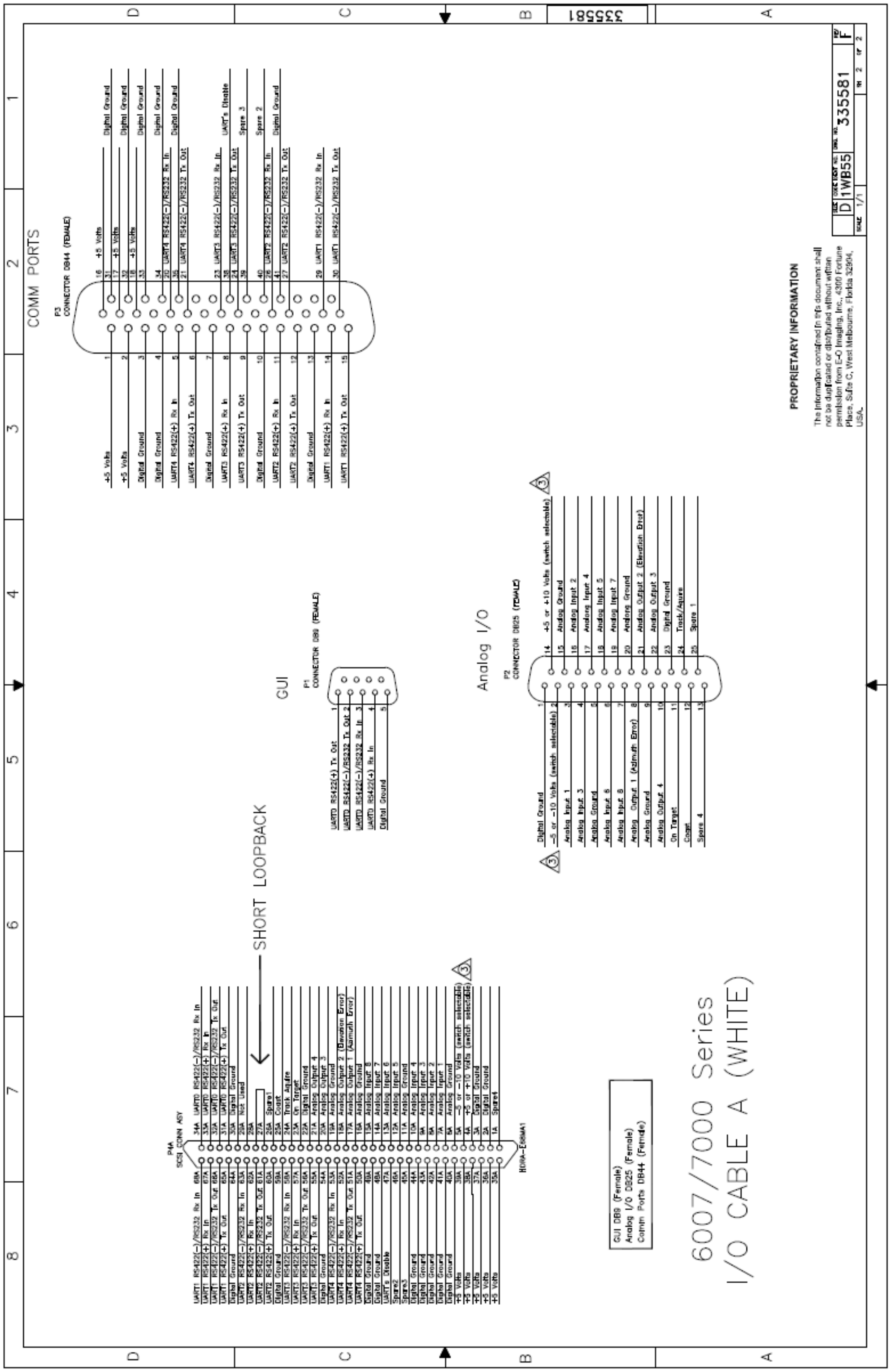

Figure F2.3 White Cable Assembly Drawing

F2.4 VHDCI I/O Connector B - Red

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The top/right 68-pin female VHDCI connector is colored red and is used to for Serial I/O and digital I/O.

Table F2.6 VHDCI I/O Connector (J2B) - Connection Definitions:

1.	Not Used	35.	DIO Port B Bit 7 / Digital Error 15
2.	Not Used	36.	DIO Port B Bit 6 / Digital Error 14
3.	Not Used	37.	DIO Port B Bit 5 / Digital Error 13
4.	Not Used	38.	DIO Port B Bit 4 / Digital Error 12
5.	Not Used	39.	DIO Port B Bit 3 / Digital Error 11
6.	Not Used	40.	DIO Port B Bit 2 / Digital Error 10
7.	Not Used	41.	DIO Port B Bit 1 / Digital Error 9
8.	Not Used	42.	DIO Port B Bit 0 / Digital Error 8
9.	Not Used	43.	DIO Port A Bit 7 / Digital Error 7
10.	Not Used	44.	DIO Port A Bit 6 / Digital Error 6
11.	Not Used	45.	DIO Port A Bit 5 / Digital Error 5
12.	Not Used	46.	DIO Port A Bit 4 / Digital Error 4
13.	Not Used	47.	PORT_ENABLE_N
14.	Not Used	48.	Digital Ground 4
15.	Not Used	49.	DIO Port A Bit 3 / Digital Error 3
16.	Not Used	50.	DIO Port A Bit 2 / Digital Error 2
17.	Not Used	51.	DIO Port A Bit 1 / Digital Error 1
18.	Not Used	52.	DIO Port A Bit 0 / Digital Error 0
19.	Not Used	53.	DIO Data Strobe Input
20.	Not Used	54.	Digital Ground 3
21.	Not Used	55.	DIO Data Strobe Output (for digital errors)
22.	Not Used	56.	Digital Error ID (Azimuth/Elevation)
23.	Not Used	57.	Not Used
24.	Not Used	58.	Not Used
25.	Not Used	59.	Signal Ground 2
26.	Not Used	60.	Not Used
27.	Not Used	61.	UART 6_RS-422 Tx +
28.	Not Used	62.	UART 6_RS-422 Tx - / RS-232 Tx
29.	Not Used	63.	UART 6_RS-422 Rx +
30.	Digital Ground 1	64.	UART 6_RS-422 Rx - / RS-232 Rx
31.	UART 5_RS-422 Tx +	65.	UART 7_RS-422 Tx +
32.	UART 5_RS-422 Tx - / RS-232 Tx	66.	UART 7_RS-422 Tx - / RS-232 Tx
33.	UART 5_RS-422 Rx +	67.	UART 7_RS-422 Rx +
34.	UART 5_RS-422 Rx - / RS-232 Rx	68.	UART 7_RS-422 Rx - / RS-232 Rx

F2.4.1 VHDCI I/O Cable B – Red

The top/right 68-pin female VHDCI connector on the tracker is colored red and is used for Serial I/O and Digital I/O (digital track errors). The red I/O Cable B (P/N 336084) connects to the tracker and provides two low-density connectors for easy access to the tracker I/O. These two connectors are described in the following paragraphs.

F2.4.2 Digital I/O Connector

The Digital I/O Connector (P3) is a standard DB25 male.

Table F2.7 Digital I/O Connector (P3) - Connection Definitions:

1. DIO Port A Bit 0 / Digital Error 0	14. DIO Port A Bit 1 / Digital Error 1
2. DIO Port A Bit 2 / Digital Error 2	15. DIO Port A Bit 3 / Digital Error 3
3. DIO Port A Bit 4 / Digital Error 4	16. DIO Port A Bit 5 / Digital Error 5
4. DIO Port A Bit 6 / Digital Error 6	17. DIO Port A Bit 7 / Digital Error 7
5. Digital Ground 1	18. Not Used
6. Not Used	19. DIO Port B Bit 0 / Digital Error 8
7. DIO Port B Bit 1 / Digital Error 9	20. DIO Port B Bit 2 / Digital Error 10
8. DIO Port B Bit 3 / Digital Error 11	21. DIO Port B Bit 4 / Digital Error 12
9. DIO Port B Bit 5 / Digital Error 13	22. DIO Port B Bit 6 / Digital Error 14
10. DIO Port B Bit 7 / Digital Error 15	23. Not Used
11. Not Used	24. Digital Error ID (Azimuth/Elevation)
12. DIO Data Strobe Input	25. DIO Data Strobe Output
13. Not Used	

F2.4.3 Serial I/O Connector

The Serial I/O Connector (P4) is a High Density DB15 male.

Table F2.8 Serial I/O Connector (P4) - Connection Definitions:

1. Digital Ground 2	9. UART 6_RS-422 Rx - / RS-232 Rx
2. UART 5_RS-422 Tx - / RS-232 Tx	10. UART 6_RS-422 Rx +
3. UART 5_RS-422 Tx +	11. Digital Ground 4
4. UART 5_RS-422 Rx - / RS-232 Rx	12. UART 7_RS-422 Tx - / RS-232 Tx
5. UART 5_RS-422 Rx +	13. UART 7_RS-422 Tx +
6. Digital Ground 3	14. UART 7_RS-422 Rx - / RS-232 Rx
7. UART 6_RS-422 Tx - / RS-232 Tx	15. UART 7_RS-422 Rx +
8. UART 6_RS-422 Tx +	

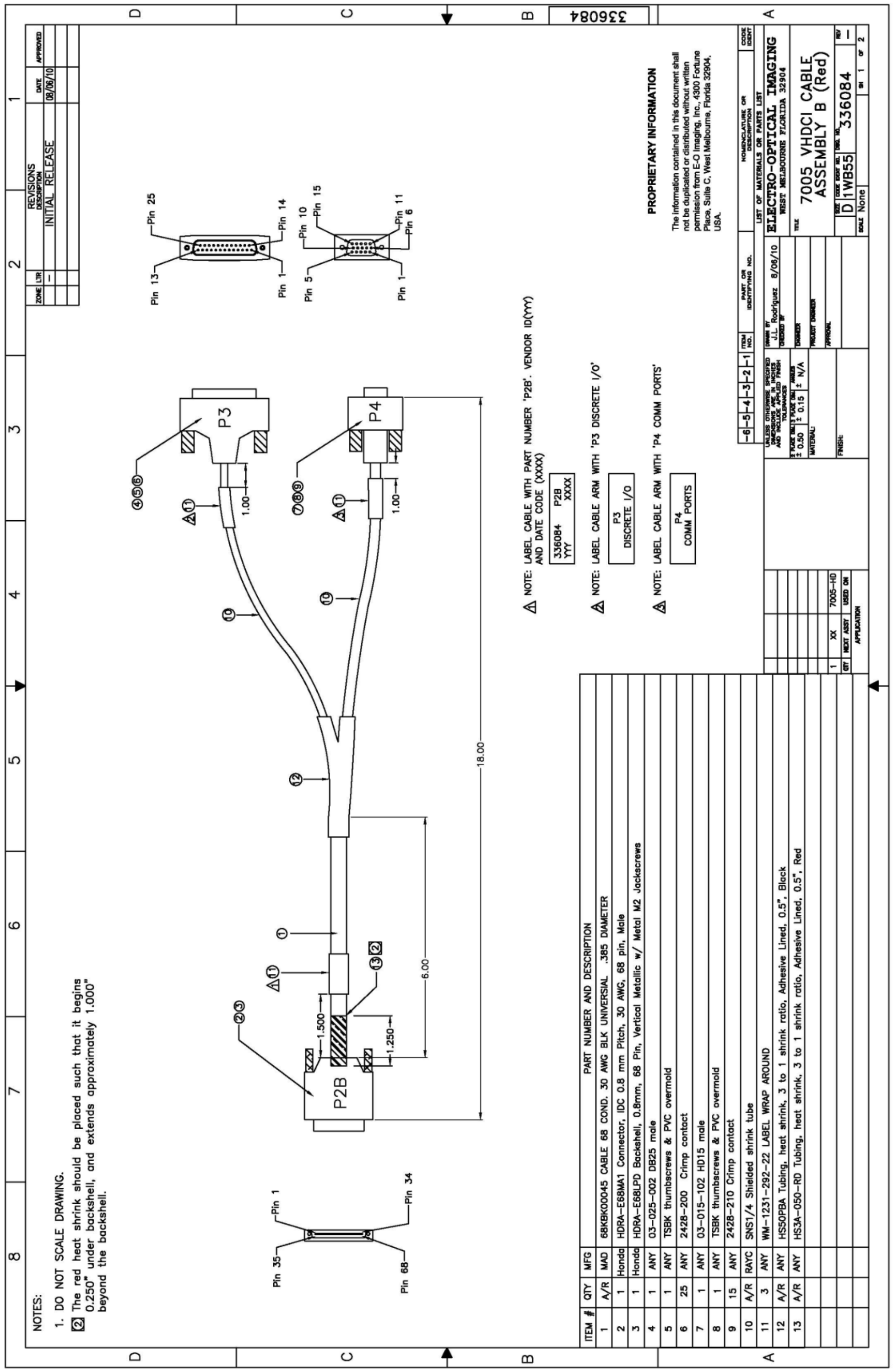

Figure F2.4 Red Cable Assembly Drawing

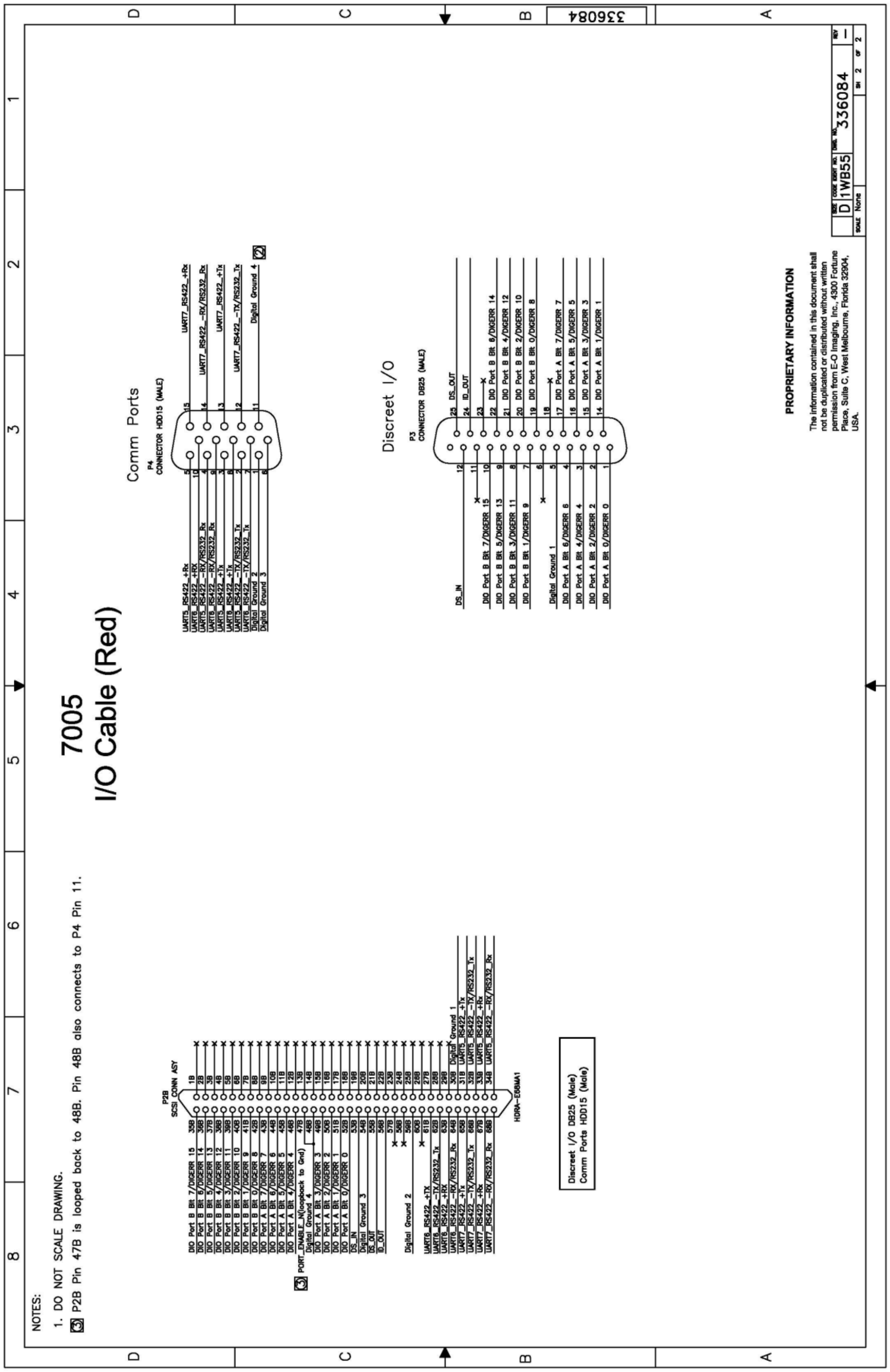

Figure F2.5 Red Cable Assembly Drawing

F2.5 Mini Camera Link Connectors

The Mini Camera Link connectors (J3-J6) on the tracker board are 26-pin MDR female connector, EC26LFDT2. The mating connector is a male 26-pin connector.

Table F2.9 HD-SDI Video Connectors (J3-J6) - Connection Definitions:

J3. Camera Link Digital Video In – Base	Base Digital Video Input
J4. Camera Link Digital Video In – Full	Full Digital Video Input
J5. Camera Link Digital Video Out – Base	Base Digital Video Output
J6. Camera Link Digital Video Out – Full	Full Digital Video Output

F2.6 Ethernet Connector

The Ethernet connector (J7) on the tracker board is a female RJ-45 connector, JK0654219. The mating connector is a male RJ-45 connector.

Table F2.10 Ethernet Connector (J7) - Connection Definitions:

1. MDI P 0
2. MDI N 0
3. MDI P 1
4. MDI P 2
5. MDI N 2
6. MDI N 1
7. MDI P 3
8. MDI N 3

F2.7 VME Connectors

The VME connectors on the tracker board connect to J1 and J2 on the VMEbus. These are 96 pin connectors, AMP Part # 6509133-5.

F2.7.1 VME P1 Connector

Table F2.11 VME P1 Connector - Connection Definition:

Pin Number	Row A	Row B	Row C
1	D00	BBSY*	D08
2	D01	BCLR*	D09
3	D02	ACFAIL*	D10
4	D03	BG0IN*	D11
5	D04	BG0OUT*	D12
6	D05	BG1IN*	D13
7	D06	BG1OUT*	D14
8	D07	BG2IN*	D15
9	GND	BG2OUT*	GND
10	SYSCLK	BG3IN*	SYSFAIL*
11	GND	BG3OUT*	BERR*
12	DS1*	BR0*	SYSRESET*
13	DS0*	BR1*	LWORD*
14	WRITE*	BR2*	AM5
15	GND	BR3*	A23
16	DTACK*	AM0	A22
17	GND	AM1	A21
18	AS*	AM2	A20
19	GND	AM3	A19
20	IACK*	GND	A18
21	IACKIN*	(††) SERCLK	A17
22	IACKOUT*	(††) SERDAT*	A16
23	AM4	GND	A15
24	A07	IRQ7*	A14
25	A06	IRQ6*	A13
26	A05	IRQ5*	A12
27	A04	IRQ4*	A11

Pin Number	Row A	Row B	Row C
28	A03	IRQ3*	A10
29	A02	IRQ2*	A09
30	A01	IRQ1*	A08
31	-12 VDC	+5VSTDBY	+12 VDC
32	+5 VDC	+5 VDC	+5 VDC

F2.7.2 VME P2 Connector

Table F2.12 VME P2 Connector - Connection Definition:

Pin Number	Row A	Row B	Row C
1	User Defined	+5 VDC	VIDEO IN #1 (+) IN
2	User Defined	DIGITAL GND	ANALOG GND
3	UART0 RS232/422- RX	(†) RESERVED	VIDEO IN #1 (-) IN
4	UART0 RS422+ RX	A24	User Defined
5	UART0 RS232/422- TX	A25	VIDEO IN #2 (+) IN
6	UART0 RS422+ TX	A26	ANALOG GND
7	DIGITAL GND	A27	VIDEO IN #2 (-) IN
8	UART1 RS232/422- RX	A28	User Defined
9	UART1 RS422+ RX	A29	VIDEO IN #3 (+) IN
10	UART1 RS232/422- TX	A30	ANALOG GND
11	UART1 RS422+ TX	A31	VIDEO IN #3 (-) IN
12	DIGITAL GND	DIGITAL GND	User Defined
13	User Defined	+5 VDC	VIDEO IN #4 (+) IN
14	UART2 RS232/422- RX	D16	ANALOG GND
15	UART2 RS422+ RX	D17	VIDEO IN #4 (-) IN
16	UART2 RS232/422- TX	D18	User Defined
17	UART2 RS422+ TX	D19	VIDEO OUT #1
18	DIGITAL GND	D20	ANALOG GND
19	UART3 RS232/422- RX	D21	VIDEO OUT #2
20	UART3 RS422+ RX	D22	ANALOG GND
21	UART3 RS232/422- TX	D23	VIDEO OUT
22	UART3 RS422+ TX	DIGITAL GND	ANALOG GND
23	DIGITAL GND	D24	ANALOG IN #1

Pin Number	Row A	Row B	Row C
24	ON TARGET STATUS	D25	ANALOG GND
25	COAST STATUS	D26	ANALOG IN #2
26	TRACK/ACQ STATUS	D27	ANALOG GND
27	DIGITAL GND	D28	ANALOG IN #3
28	ELEVATION ERROR OUT	D29	ANALOG GND
29	ANALOG GND	D30	ANALOG IN #4
30	AZIMUTH ERROR OUT	D31	ANALOG GND
31	ANALOG GND	GND	-5 VDC
32	User Defined	+5 VDC	User Defined

Notes: (†) RESERVED was redefined as RETRY*, and (††) SERCLK & SERDAT* were changed to user defined pins in the proposed VME64 enhancements.

F3 Model 7005-HD/7006-HD I/O Connector Definition

The connectors on the Model 7005-HD/7006-HD VME tracker board are described in the following paragraphs.

F3.1 Model 7005-HD/7006-HD Front Panel

The connectors on the front panel of the Model 7005-HD/7006-HD VME tracker board are described in the following paragraphs.

Figure F3.1 Model 7005-HD/7006-HD Front Panel

F3.2 Analog Video Connector

The analog video connector (J1) on the tracker board is a 15-pin male connector, AMP 749767-1. The mating connector is a 15-pin high-density female connector, PDI-15RHS-SW-H.

Table F3.1 Analog Video Connector - Connection Definitions:

1. Video In 1 (+)	6. Video In 1 (-)	11. Video 1 Out
2. Video In 2 (+)	7. Video In 2 (-)	12. Ground
3. Video In 3 (-)	8. Video In 4 (+)	13. Video In 4 (-)
4. Video In 3 (+)	9. Ground	14. Video 2 Out
5. Video Out (no annotation)	10. Ground	15. Ground

F3.3 VHDCI I/O Connector A - White

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The bottom/left 68-pin female VHDCI connector is colored white and is used for serial communications, analog I/O and digital status.

Table F3.2 VHDCI I/O Connector (J2A) - Connection Definitions:

1.	Not Used	35.	+5 Volts
2.	Digital Ground	36.	+5 Volts
3.	Digital Ground	37.	+5 Volts
4.	+5 or +10 Volts (switch selectable, analog ref)	38.	+5 Volts
5.	-5 or -10 Volts (switch selectable, analog ref)	39.	+5 Volts
6.	Analog Ground	40.	Digital Ground
7.	Analog Input 1	41.	Digital Ground
8.	Analog Input 2	42.	Digital Ground
9.	Analog Input 3	43.	Digital Ground
10.	Analog Input 4	44.	Digital Ground
11.	Analog Ground	45.	Not Used
12.	Analog Input 5	46.	Not Used
13.	Analog Input 6	47.	UARTs Disable (connector keying)
14.	Analog Input 7	48.	Digital Ground
15.	Analog Input 8	49.	Digital Ground
16.	Analog Ground	50.	UART4 RS-422 (+) TX Out
17.	Analog Output 1 (Azimuth Error)	51.	UART4 RS-422 (-) / RS-232 TX Out
18.	Analog Output 2 (Elevation Error)	52.	UART4 RS-422 (+) RX In
19.	Analog Ground	53.	UART4 RS-422 (-) / RS-232 RX In
20.	Analog Output 3	54.	Digital Ground
21.	Analog Output 4	55.	UART3 RS-422 (+) TX Out
22.	Digital Ground	56.	UART3 RS-422 (-) / RS-232 TX Out
23.	On Target	57.	UART3 RS-422 (+) RX In
24.	Track/Acquire	58.	UART3 RS-422 (-) / RS-232 RX In
25.	Coast	59.	Digital Ground
26.	Not Used	60.	UART2 RS-422 (+) TX Out
27.	Short to pin 28 (connector keying)	61.	UART2 RS-422 (-) / RS-232 TX Out
28.	Short to pin 27 (connector keying)	62.	UART2 RS-422 (+) RX In
29.	Not Used	63.	UART2 RS-422 (-) / RS-232 RX In
30.	Digital Ground	64.	Digital Ground
31.	UART0 RS-422 (+) TX Out	65.	UART1 RS-422 (+) TX Out
32.	UART0 RS-422 (-) / RS-232 TX Out	66.	UART1 RS-422 (-) / RS-232 TX Out
33.	UART0 RS-422 (+) RX In	67.	UART1 RS-422 (+) RX In
34.	UART0 RS-422 (-) / RS-232 RX In	68.	UART1 RS-422 (-) / RS-232 RX In

F3.3.1 VHDCI I/O Cable A – White

The bottom/left 68-pin female VHDCI connector on the tracker is colored white and is used for serial communications, analog I/O and digital status. The white I/O Cable A connects to the tracker and provides three low-density connectors for easy access to the tracker I/O. These three connectors are described in the following paragraphs.

F3.3.2 GUI / UART0 Connector

The GUI (Graphical User Interface) connector (P1) is a standard DB9 female used for serial communications (RS-232/422). The wiring is standard for a typical PC computer serial port.

Table F3.3 GUI / UART0 Connector (P1) - Connection Definitions:

1.	UART0 RS-422 (+) TX Out
2.	UART0 RS-422 (-) / RS-232 TX Out
3.	UART0 RS-422 (-) / RS-232 RX In
4.	UART0 RS-422 (+) RX In
5.	Digital Ground
6.	Not Used
7.	Not Used
8.	Not Used
9.	Not Used

F3.3.3 Analog I/O Connector

The analog I/O connector (P2) is a standard DB25 female.

Table F3.4 Analog I/O Connector (P2) - Connection Definitions:

1. Digital Ground	14. +5 or +10 Volts (switch selectable)
2. -5 or -10 Volts (switch selectable)	15. Analog Ground
3. Analog Input 1	16. Analog Input 2
4. Analog Input 3	17. Analog Input 4
5. Analog Ground	18. Analog Input 5
6. Analog Input 6	19. Analog Input 7
7. Analog Input 8	20. Analog Ground
8. Analog Output 1 (Azimuth Error)	21. Analog Output 2 (Elevation Error)
9. Analog Ground	22. Analog Output 3
10. Analog Output 4	23. Digital Ground
11. On Target	24. Track / Acquire

12. Coast	25. Not Used
13. Not Used	

F3.3.4 Serial I/O Connector

The serial I/O connector (P3) is a 44-pin female connector.

Table F3.5 Serial I/O Connector (P3) - Connection Definitions:

1. +5 Volts	16. +5 Volts	31. Digital Ground
2. +5 Volts	17. +5 Volts	32. Digital Ground
3. Digital Ground	18. +5 Volts	33. Digital Ground
4. Digital Ground	19. Not Used	34. Digital Ground
5. UART4 RS-422 (+) RX In	20. UART4 RS-422 (-) / RS-232 RX In	35. Digital Ground
6. UART4 RS-422 (+) TX Out	21. UART4 RS-422 (-) / RS-232 TX Out	36. Not Used
7. Digital Ground	22. Not Used	37. Not Used
8. UART3 RS-422 (+) RX In	23. UART3 RS-422 (-) / RS-232 RX In	38. UARTs Disable
9. UART3 RS-422 (+) TX Out	24. UART3 RS-422 (-) / RS-232 TX Out	39. Not Used
10. Digital Ground	25. Not Used	40. Not Used
11. UART2 RS-422 (+) RX In	26. UART2 RS-422 (-) / RS-232 RX In	41. Digital Ground
12. UART2 RS-422 (+) TX Out	27. UART2 RS-422 (-) / RS-232 TX Out	42. Not Used
13. Digital Ground	28. Not Used	43. Not Used
14. UART1 RS-422 (+) RX In	29. UART1 RS-422 (-) / RS-232 RX In	44. Not Used
15. UART1 RS-422 (+) TX Out	30. UART1 RS-422 (-) / RS-232 TX Out	

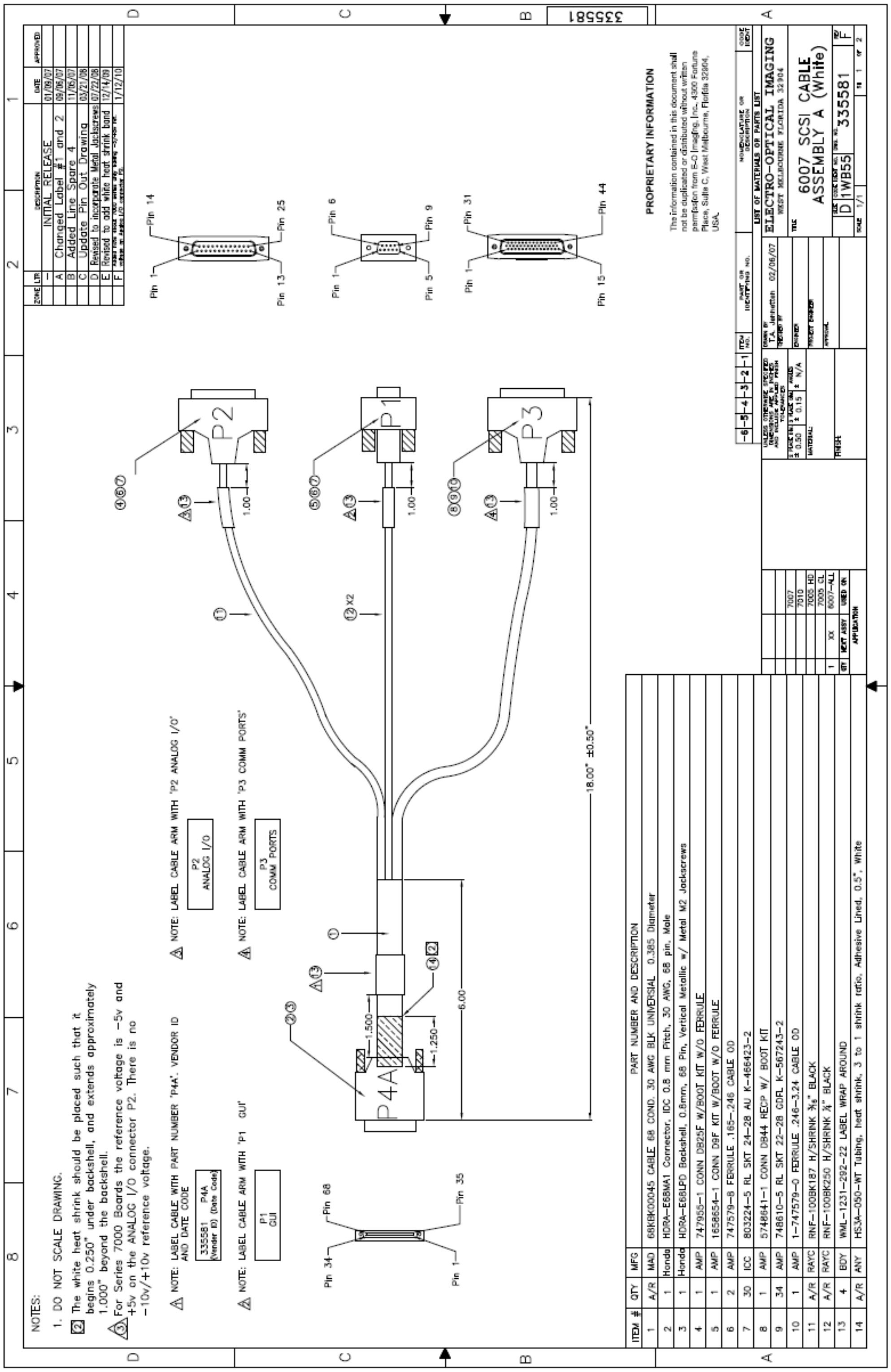

Figure F3.2 White Cable Assembly Drawing

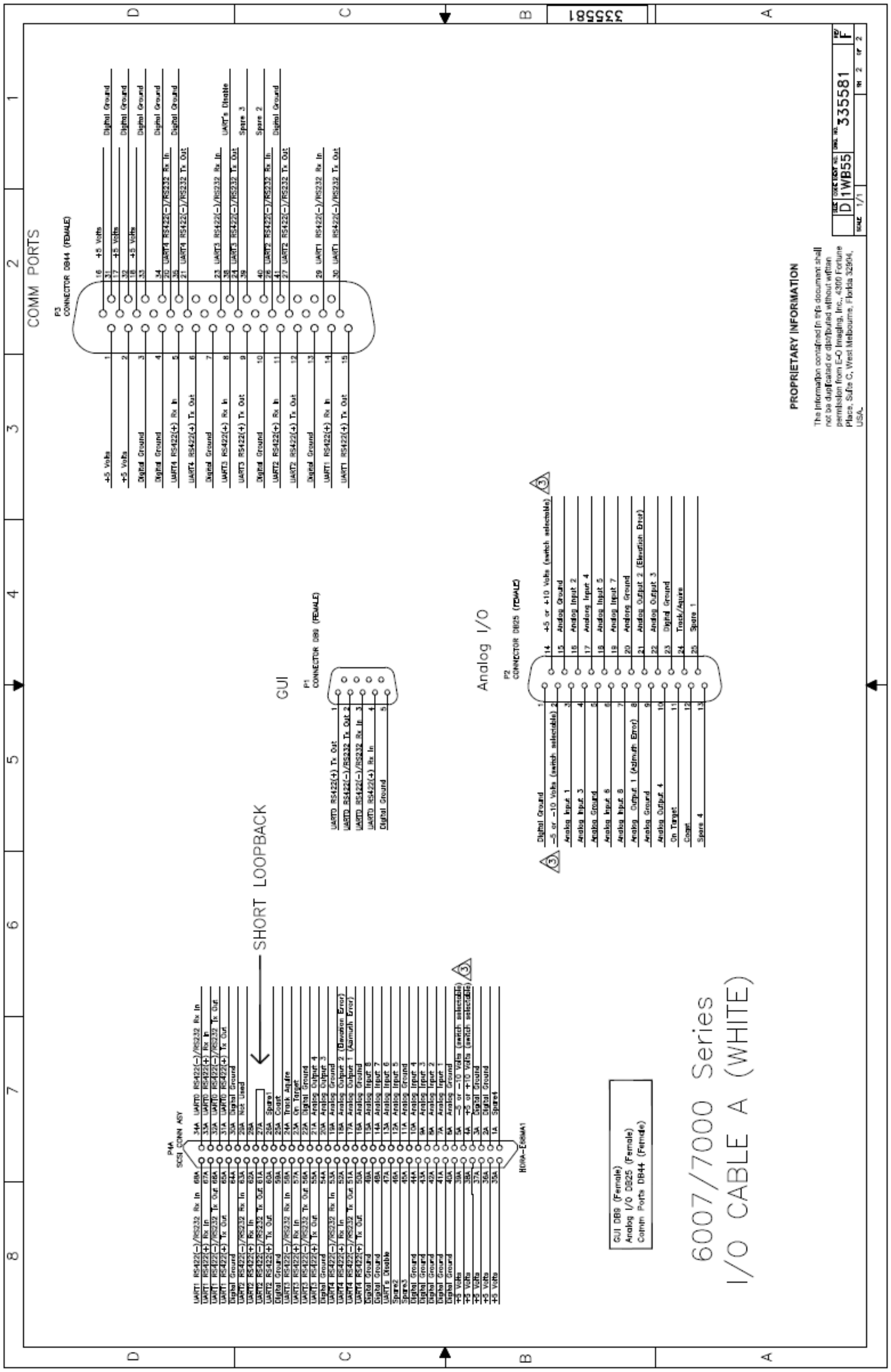

Figure F3.3 White Cable Assembly Drawing

F3.4 VHDCI I/O Connector B - Red

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The top/right 68-pin female VHDCI connector is colored red and is used to for Serial I/O and digital I/O.

Table F3.6 VHDCI I/O Connector (J2B) - Connection Definitions:

1.	Not Used	35.	DIO Port B Bit 7 / Digital Error 15
2.	Not Used	36.	DIO Port B Bit 6 / Digital Error 14
3.	Not Used	37.	DIO Port B Bit 5 / Digital Error 13
4.	Not Used	38.	DIO Port B Bit 4 / Digital Error 12
5.	Not Used	39.	DIO Port B Bit 3 / Digital Error 11
6.	Not Used	40.	DIO Port B Bit 2 / Digital Error 10
7.	Not Used	41.	DIO Port B Bit 1 / Digital Error 9
8.	Not Used	42.	DIO Port B Bit 0 / Digital Error 8
9.	Not Used	43.	DIO Port A Bit 7 / Digital Error 7
10.	Not Used	44.	DIO Port A Bit 6 / Digital Error 6
11.	Not Used	45.	DIO Port A Bit 5 / Digital Error 5
12.	Not Used	46.	DIO Port A Bit 4 / Digital Error 4
13.	Not Used	47.	PORT_ENABLE_N
14.	Not Used	48.	Digital Ground 4
15.	Not Used	49.	DIO Port A Bit 3 / Digital Error 3
16.	Not Used	50.	DIO Port A Bit 2 / Digital Error 2
17.	Not Used	51.	DIO Port A Bit 1 / Digital Error 1
18.	Not Used	52.	DIO Port A Bit 0 / Digital Error 0
19.	Not Used	53.	DIO Data Strobe Input
20.	Not Used	54.	Digital Ground 3
21.	Not Used	55.	DIO Data Strobe Output (for digital errors)
22.	Not Used	56.	Digital Error ID (Azimuth/Elevation)
23.	Not Used	57.	Not Used
24.	Not Used	58.	Not Used
25.	Not Used	59.	Signal Ground 2
26.	Not Used	60.	Not Used
27.	Not Used	61.	UART 6_RS-422 Tx +
28.	Not Used	62.	UART 6_RS-422 Tx - / RS-232 Tx
29.	Not Used	63.	UART 6_RS-422 Rx +
30.	Digital Ground 1	64.	UART 6_RS-422 Rx - / RS-232 Rx
31.	UART 5_RS-422 Tx +	65.	UART 7_RS-422 Tx +
32.	UART 5_RS-422 Tx - / RS-232 Tx	66.	UART 7_RS-422 Tx - / RS-232 Tx
33.	UART 5_RS-422 Rx +	67.	UART 7_RS-422 Rx +
34.	UART 5_RS-422 Rx - / RS-232 Rx	68.	UART 7_RS-422 Rx - / RS-232 Rx

F3.4.1 VHDCI I/O Cable B – Red

The top/right 68-pin female VHDCI connector on the tracker is colored red and is used for Serial I/O and Digital I/O (digital track errors). The red I/O Cable B (P/N 336084) connects to the tracker and provides two low-density connectors for easy access to the tracker I/O. These two connectors are described in the following paragraphs.

F3.4.2 Digital I/O Connector

The Digital I/O Connector (P3) is a standard DB25 male.

Table F3.7 Digital I/O Connector (P3) - Connection Definitions:

1. DIO Port A Bit 0 / Digital Error 0	14. DIO Port A Bit 1 / Digital Error 1
2. DIO Port A Bit 2 / Digital Error 2	15. DIO Port A Bit 3 / Digital Error 3
3. DIO Port A Bit 4 / Digital Error 4	16. DIO Port A Bit 5 / Digital Error 5
4. DIO Port A Bit 6 / Digital Error 6	17. DIO Port A Bit 7 / Digital Error 7
5. Digital Ground 1	18. Not Used
6. Not Used	19. DIO Port B Bit 0 / Digital Error 8
7. DIO Port B Bit 1 / Digital Error 9	20. DIO Port B Bit 2 / Digital Error 10
8. DIO Port B Bit 3 / Digital Error 11	21. DIO Port B Bit 4 / Digital Error 12
9. DIO Port B Bit 5 / Digital Error 13	22. DIO Port B Bit 6 / Digital Error 14
10. DIO Port B Bit 7 / Digital Error 15	23. Not Used
11. Not Used	24. Digital Error ID (Azimuth/Elevation)
12. DIO Data Strobe Input	25. DIO Data Strobe Output
13. Not Used	

F3.4.3 Serial I/O Connector

The Serial I/O Connector (P4) is a High Density DB15 male.

Table F3.8 Serial I/O Connector (P4) - Connection Definitions:

1. Digital Ground 2	9. UART 6_RS-422 Rx - / RS-232 Rx
2. UART 5_RS-422 Tx - / RS-232 Tx	10. UART 6_RS-422 Rx +
3. UART 5_RS-422 Tx +	11. Digital Ground 4
4. UART 5_RS-422 Rx - / RS-232 Rx	12. UART 7_RS-422 Tx - / RS-232 Tx
5. UART 5_RS-422 Rx +	13. UART 7_RS-422 Tx +
6. Digital Ground 3	14. UART 7_RS-422 Rx - / RS-232 Rx
7. UART 6_RS-422 Tx - / RS-232 Tx	15. UART 7_RS-422 Rx +
8. UART 6_RS-422 Tx +	

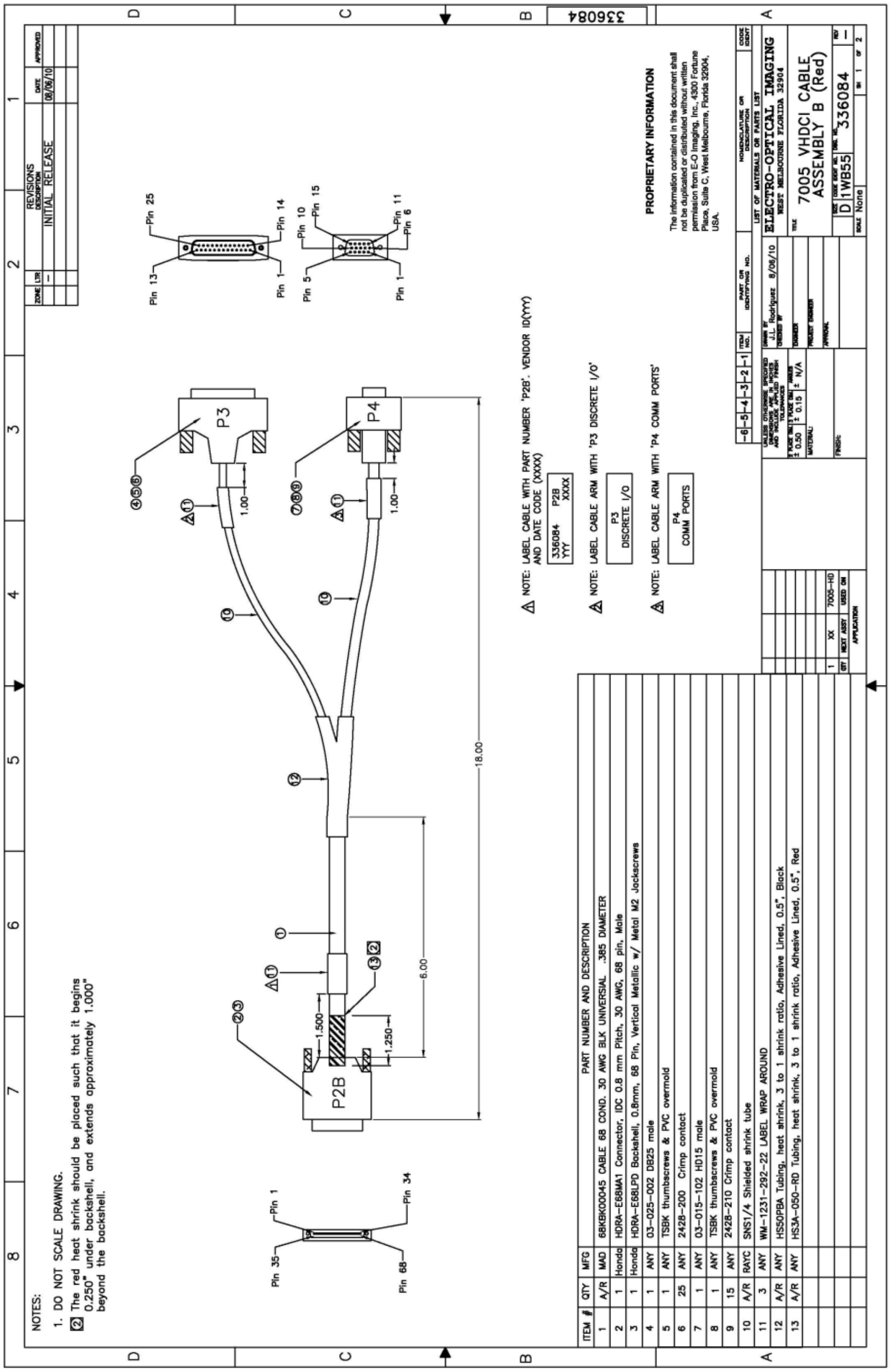

Figure F3.4 Red Cable Assembly Drawing

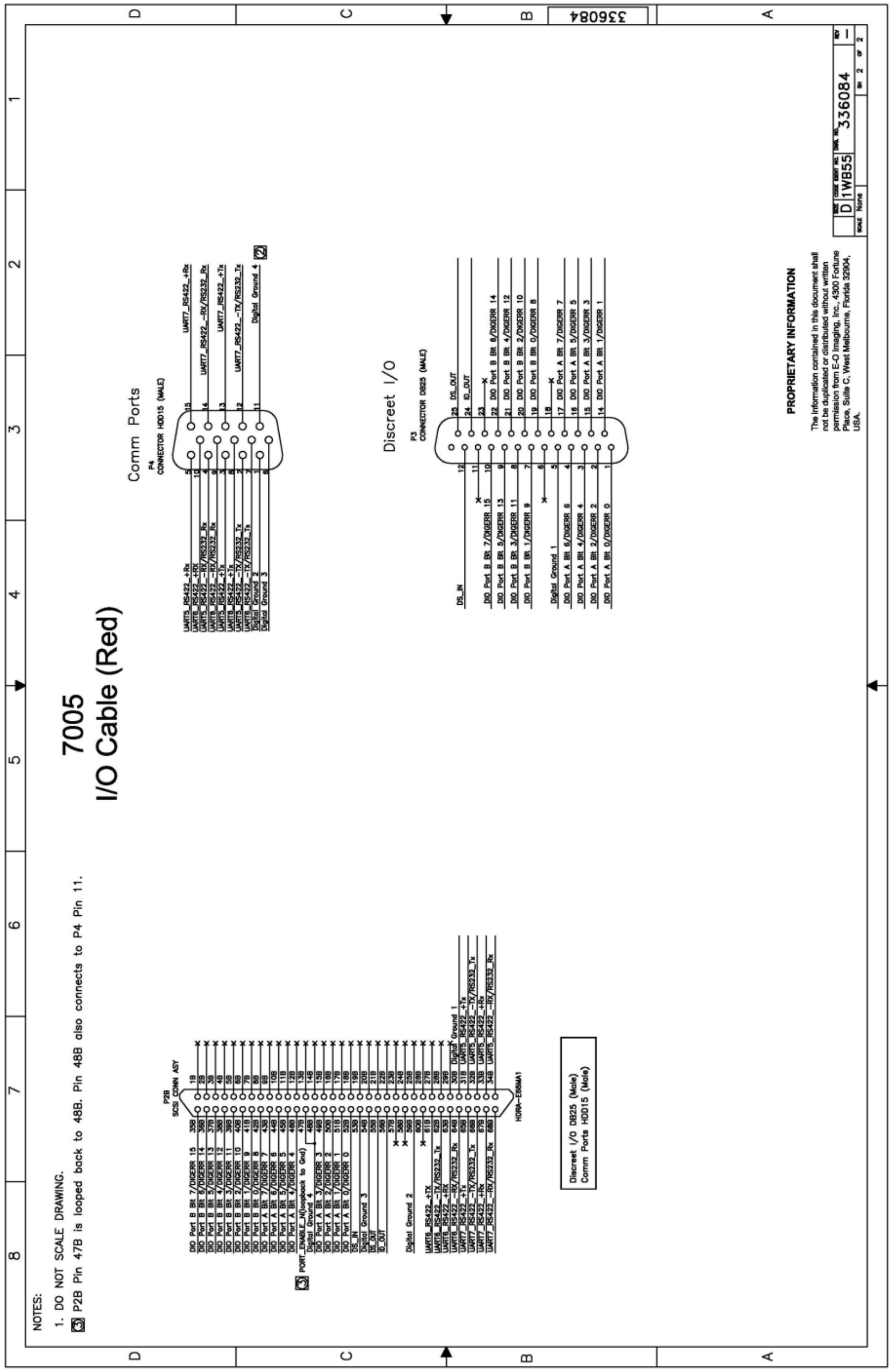

Figure F3.5 Red Cable Assembly Drawing

F3.5 HD-SDI Connectors

The HD-SDI connectors (J3-J6) on the tracker board are BNC female connector, UCBBJR26. The mating connector is a male BNC connector.

Table F3.9 HD-SDI Video Connectors (J3-J6) - Connection Definitions:

J3. HD-SDI Digital Video In 1	HD Video In 1
J4. HD-SDI Digital Video In 2	HD Video In 2
J5. HD-SDI Digital Video Out 1	Unannotated Selected HD Video Out
J6. HD-SDI Digital Video Out 2	Annotated Selected HD Video Out

F3.6 Ethernet Connector

The Ethernet connector (J7) on the tracker board is a female RJ-45 connector, JK0654219. The mating connector is a male RJ-45 connector.

Table F3.10 Ethernet Connector (J7) - Connection Definitions:

1. MDI P 0
2. MDI N 0
3. MDI P 1
4. MDI P 2
5. MDI N 2
6. MDI N 1
7. MDI P 3
8. MDI N 3

F3.7 VME Connectors

The VME connectors on the tracker board connect to J1 and J2 on the VMEbus. These are 96 pin connectors, AMP Part # 6509133-5.

F3.7.1 VME P1 Connector

Table F3.11 VME P1 Connector - Connection Definition:

Pin Number	Row A	Row B	Row C
1	D00	BBSY*	D08
2	D01	BCLR*	D09
3	D02	ACFAIL*	D10
4	D03	BG0IN*	D11
5	D04	BG0OUT*	D12
6	D05	BG1IN*	D13
7	D06	BG1OUT*	D14
8	D07	BG2IN*	D15
9	GND	BG2OUT*	GND
10	SYSCLK	BG3IN*	SYSFAIL*
11	GND	BG3OUT*	BERR*
12	DS1*	BR0*	SYSRESET*
13	DS0*	BR1*	LWORD*
14	WRITE*	BR2*	AM5
15	GND	BR3*	A23
16	DTACK*	AM0	A22
17	GND	AM1	A21
18	AS*	AM2	A20
19	GND	AM3	A19
20	IACK*	GND	A18
21	IACKIN*	(††) SERCLK	A17
22	IACKOUT*	(††) SERDAT*	A16
23	AM4	GND	A15
24	A07	IRQ7*	A14
25	A06	IRQ6*	A13
26	A05	IRQ5*	A12
27	A04	IRQ4*	A11

Pin Number	Row A	Row B	Row C
28	A03	IRQ3*	A10
29	A02	IRQ2*	A09
30	A01	IRQ1*	A08
31	-12 VDC	+5VSTDBY	+12 VDC
32	+5 VDC	+5 VDC	+5 VDC

F3.7.2 VME P2 Connector

Table F3.12 VME P2 Connector - Connection Definition:

Pin Number	Row A	Row B	Row C
1	User Defined	+5 VDC	VIDEO IN #1 (+) IN
2	User Defined	DIGITAL GND	ANALOG GND
3	UART0 RS232/422- RX	(†) RESERVED	VIDEO IN #1 (-) IN
4	UART0 RS422+ RX	A24	User Defined
5	UART0 RS232/422- TX	A25	VIDEO IN #2 (+) IN
6	UART0 RS422+ TX	A26	ANALOG GND
7	DIGITAL GND	A27	VIDEO IN #2 (-) IN
8	UART1 RS232/422- RX	A28	User Defined
9	UART1 RS422+ RX	A29	VIDEO IN #3 (+) IN
10	UART1 RS232/422- TX	A30	ANALOG GND
11	UART1 RS422+ TX	A31	VIDEO IN #3 (-) IN
12	DIGITAL GND	DIGITAL GND	User Defined
13	User Defined	+5 VDC	VIDEO IN #4 (+) IN
14	UART2 RS232/422- RX	D16	ANALOG GND
15	UART2 RS422+ RX	D17	VIDEO IN #4 (-) IN
16	UART2 RS232/422- TX	D18	User Defined
17	UART2 RS422+ TX	D19	VIDEO OUT #1
18	DIGITAL GND	D20	ANALOG GND
19	UART3 RS232/422- RX	D21	VIDEO OUT #2
20	UART3 RS422+ RX	D22	ANALOG GND
21	UART3 RS232/422- TX	D23	VIDEO OUT
22	UART3 RS422+ TX	DIGITAL GND	ANALOG GND
23	DIGITAL GND	D24	ANALOG IN #1

24	ON TARGET STATUS	D25	ANALOG GND
25	COAST STATUS	D26	ANALOG IN #2
26	TRACK/ACQ STATUS	D27	ROLL P
27	DIGITAL GND	D28	ANALOG IN #3
28	ELEVATION ERROR OUT	D29	ROLL N
29	ANALOG GND	D30	ANALOG IN #4
30	AZIMUTH ERROR OUT	D31	ANALOG GND
31	ANALOG GND	GND	-5 VDC
32	ELEVATION N	+5 VDC	AZIMUTH N

Notes: (†) RESERVED was redefined as RETRY*, and (††) SERCLK & SERDAT* were changed to user defined pins in the proposed VME64 enhancements.

F4 Model 7007/7008 I/O Connector Definition

The connectors on the Model 7007/7008 PCI tracker board are described in the following paragraphs.

F4.1 Model 7007/7008 Rear Panel

The connectors on the rear panel of the Model 7007/7008 PCI tracker board are described in the following paragraphs.

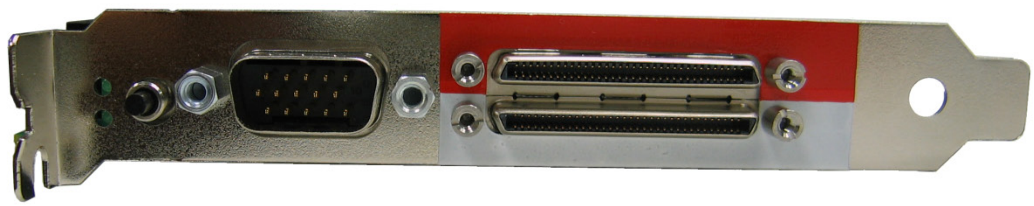

Figure F4.1 Model 7007/7008 Rear Panel

F4.2 Analog Video Connector

The analog video connector (J1) on the tracker board is a 15-pin male connector, AMP 749767-1. The mating connector is a 15-pin high-density female connector, PDI-15RHS-SW-H.

Table F4.1 Analog Video Connector - Connection Definitions:

1. Video In 1 (+)	6. Video In 1 (-)	11. Video 1 Out
2. Video In 2 (+)	7. Video In 2 (-)	12. Ground
3. Video In 3 (-)	8. Video In 4 (+)	13. Video In 4 (-)
4. Video In 3 (+)	9. Ground	14. Video 2 Out
5. Video Out (no annotation)	10. Ground	15. Ground

F4.3 VHDCI I/O Connector A - White

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The bottom/left 68-pin female VHDCI connector is colored white and is used for serial communications, analog I/O and digital status.

Table F4.2 VHDCI I/O Connector (J2A) - Connection Definitions:

1.	Not Used	35.	+5 Volts
2.	Digital Ground	36.	+5 Volts
3.	Digital Ground	37.	+5 Volts
4.	+5 or +10 Volts (switch selectable, analog ref)	38.	+5 Volts
5.	-5 or -10 Volts (switch selectable, analog ref)	39.	+5 Volts
6.	Analog Ground	40.	Digital Ground

7.	Analog Input 1	41.	Digital Ground
8.	Analog Input 2	42.	Digital Ground
9.	Analog Input 3	43.	Digital Ground
10.	Analog Input 4	44.	Digital Ground
11.	Analog Ground	45.	Not Used
12.	Analog Input 5	46.	Not Used
13.	Analog Input 6	47.	UARTs Disable (connector keying)
14.	Analog Input 7	48.	Digital Ground
15.	Analog Input 8	49.	Digital Ground
16.	Analog Ground	50.	UART4 RS-422 (+) TX Out
17.	Analog Output 1 (Azimuth Error)	51.	UART4 RS-422 (-) / RS-232 TX Out
18.	Analog Output 2 (Elevation Error)	52.	UART4 RS-422 (+) RX In
19.	Analog Ground	53.	UART4 RS-422 (-) / RS-232 RX In
20.	Analog Output 3	54.	Digital Ground
21.	Analog Output 4	55.	UART3 RS-422 (+) TX Out
22.	Digital Ground	56.	UART3 RS-422 (-) / RS-232 TX Out
23.	On Target	57.	UART3 RS-422 (+) RX In
24.	Track/Acquire	58.	UART3 RS-422 (-) / RS-232 RX In
25.	Coast	59.	Digital Ground
26.	Not Used	60.	UART2 RS-422 (+) TX Out
27.	Short to pin 28 (connector keying)	61.	UART2 RS-422 (-) / RS-232 TX Out
28.	Short to pin 27 (connector keying)	62.	UART2 RS-422 (+) RX In
29.	Not Used	63.	UART2 RS-422 (-) / RS-232 RX In
30.	Digital Ground	64.	Digital Ground
31.	UART0 RS-422 (+) TX Out	65.	UART1 RS-422 (+) TX Out
32.	UART0 RS-422 (-) / RS-232 TX Out	66.	UART1 RS-422 (-) / RS-232 TX Out
33.	UART0 RS-422 (+) RX In	67.	UART1 RS-422 (+) RX In
34.	UART0 RS-422 (-) / RS-232 RX In	68.	UART1 RS-422 (-) / RS-232 RX In

F4.3.1 VHDCI I/O Cable A – White

The bottom/left 68-pin female VHDCI connector on the tracker is colored white and is used for serial communications, analog I/O and digital status. The white I/O Cable A connects to the tracker and provides three low-density connectors for easy access to the tracker I/O. These three connectors are described in the following paragraphs.

F4.3.2 GUI / UART0 Connector

The GUI (Graphical User Interface) connector (P1) is a standard DB9 female used for serial communications (RS-232/422). The wiring is standard for a typical PC computer serial port.

Table F4.3 GUI / UART0 Connector (P1)- Connection Definitions:

1.	UART0 RS-422 (+) TX Out
2.	UART0 RS-422 (-) / RS-232 TX Out

3.	UART0 RS-422 (-) / RS-232 RX In
4.	UART0 RS-422 (+) RX In
5.	Digital Ground
6.	Not Used
7.	Not Used
8.	Not Used
9.	Not Used

F4.3.3 Analog I/O Connector

The analog I/O connector (P2) is a standard DB25 female.

Table F4.4 Analog I/O Connector (P2) - Connection Definitions:

1. Digital Ground	14. +5 or +10 Volts (switch selectable)
2. -5 or -10 Volts (switch selectable)	15. Analog Ground
3. Analog Input 1	16. Analog Input 2
4. Analog Input 3	17. Analog Input 4
5. Analog Ground	18. Analog Input 5
6. Analog Input 6	19. Analog Input 7
7. Analog Input 8	20. Analog Ground
8. Analog Output 1 (Azimuth Error)	21. Analog Output 2 (Elevation Error)
9. Analog Ground	22. Analog Output 3
10. Analog Output 4	23. Digital Ground
11. On Target	24. Track / Acquire
12. Coast	25. Not Used
13. Not Used	

F4.3.4 Serial I/O Connector

The serial I/O connector (P3) is a 44-pin female connector.

Table F4.5 Serial I/O Connector (P3) - Connection Definitions:

1. +5 Volts	16. +5 Volts	31. Digital Ground
2. +5 Volts	17. +5 Volts	32. Digital Ground
3. Digital Ground	18. +5 Volts	33. Digital Ground
4. Digital Ground	19. Not Used	34. Digital Ground
5. UART4 RS-422 (+) RX In	20. UART4 RS-422 (-) / RS-232 RX In	35. Digital Ground

6.	UART4 RS-422 (+) TX Out	21.	UART4 RS-422 (-) / RS-232 TX Out	36.	Not Used
7.	Digital Ground	22.	Not Used	37.	Not Used
8.	UART3 RS-422 (+) RX In	23.	UART3 RS-422 (-) / RS-232 RX In	38.	UARTs Disable
9.	UART3 RS-422 (+) TX Out	24.	UART3 RS-422 (-) / RS-232 TX Out	39.	Not Used
10.	Digital Ground	25.	Not Used	40.	Not Used
11.	UART2 RS-422 (+) RX In	26.	UART2 RS-422 (-) / RS-232 RX In	41.	Digital Ground
12.	UART2 RS-422 (+) TX Out	27.	UART2 RS-422 (-) / RS-232 TX Out	42.	Not Used
13.	Digital Ground	28.	Not Used	43.	Not Used
14.	UART1 RS-422 (+) RX In	29.	UART1 RS-422 (-) / RS-232 RX In	44.	Not Used
15.	UART1 RS-422 (+) TX Out	30.	UART1 RS-422 (-) / RS-232 TX Out		

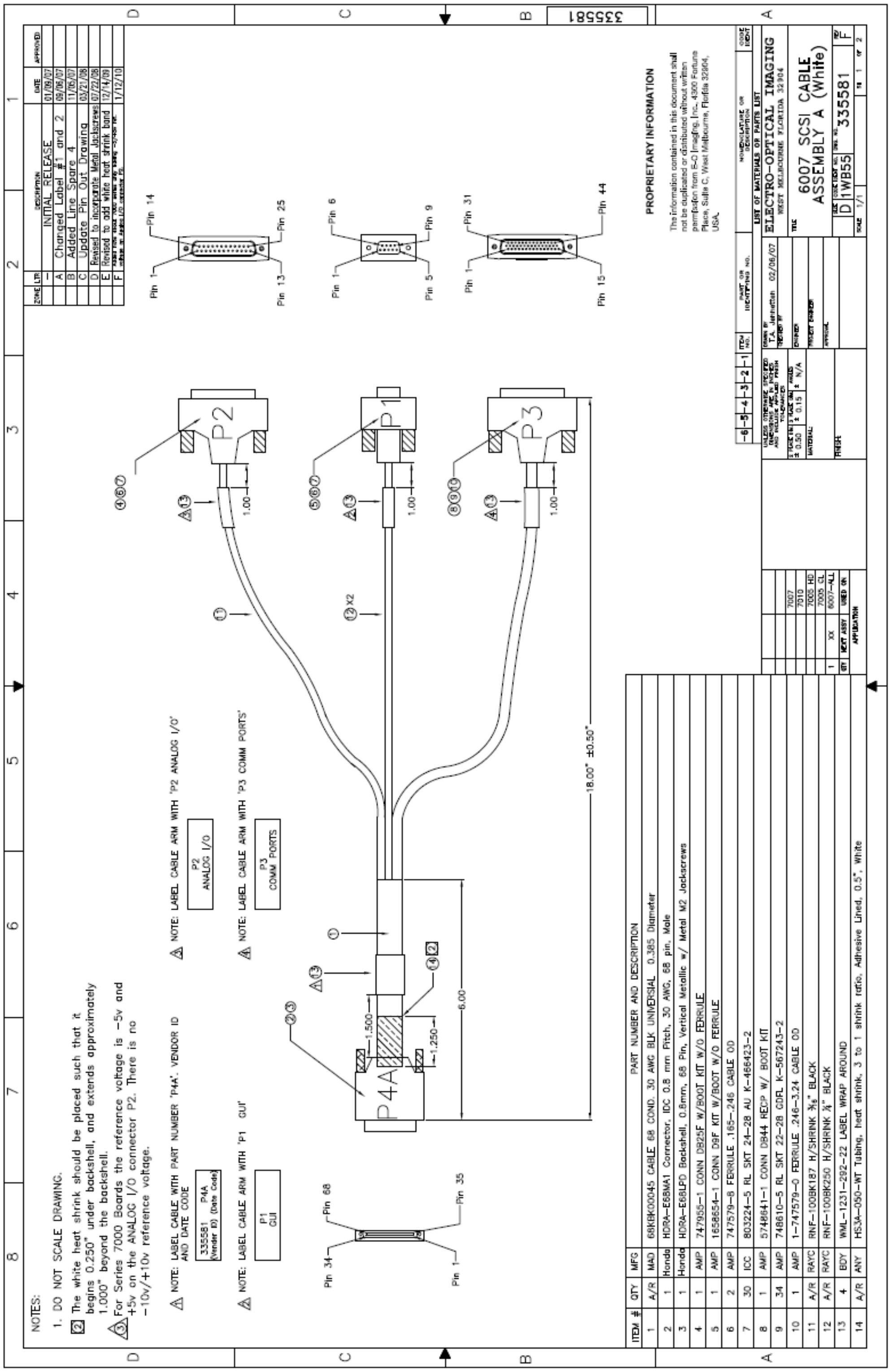

Figure F4.2 White Cable Assembly Drawing

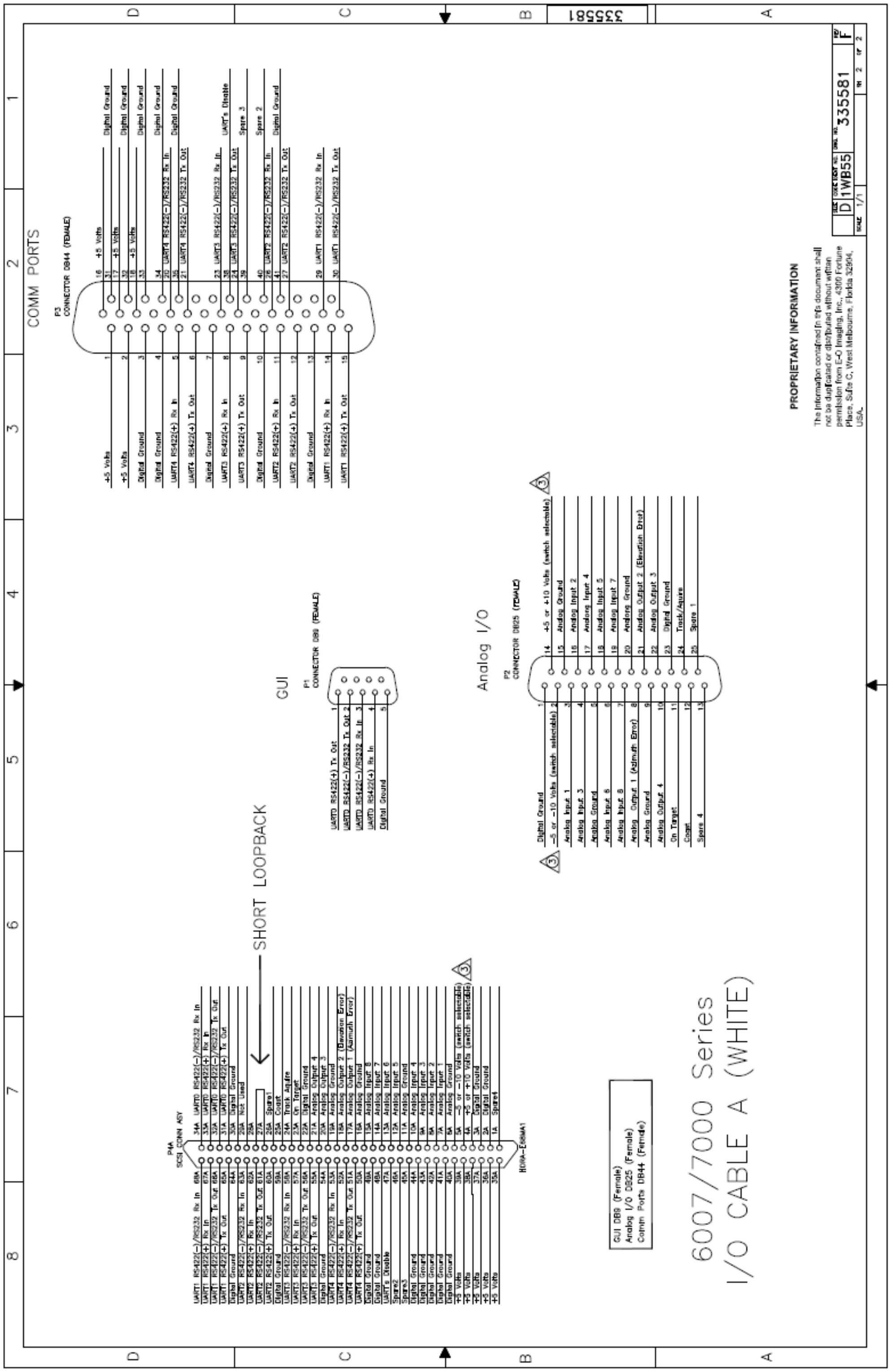

Figure F4.3 White Cable Assembly Drawing

F4.4 VHDCI I/O Connector B - Red

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The top/right 68-pin female VHDCI connector is colored red and is used for Ethernet, Serial I/O, and Digital I/O.

Table F4.6 VHDCI I/O Connector (J2B) - Connection Definitions:

1.	Not Used	35.	DIO Port B Bit 7 / Digital Error 15
2.	Not Used	36.	DIO Port B Bit 6 / Digital Error 14
3.	Not Used	37.	DIO Port B Bit 5 / Digital Error 13
4.	Not Used	38.	DIO Port B Bit 4 / Digital Error 12
5.	Not Used	39.	DIO Port B Bit 3 / Digital Error 11
6.	Not Used	40.	DIO Port B Bit 2 / Digital Error 10
7.	Not Used	41.	DIO Port B Bit 1 / Digital Error 9
8.	Not Used	42.	DIO Port B Bit 0 / Digital Error 8
9.	Not Used	43.	DIO Port A Bit 7 / Digital Error 7
10.	Not Used	44.	DIO Port A Bit 6 / Digital Error 6
11.	Not Used	45.	DIO Port A Bit 5 / Digital Error 5
12.	Not Used	46.	DIO Port A Bit 4 / Digital Error 4
13.	Not Used	47.	PORT_ENABLE_N (looped back to pin 48 as well)
14.	Not Used	48.	Digital Ground 4
15.	Not Used	49.	DIO Port A Bit 3 / Digital Error 3
16.	Not Used	50.	DIO Port A Bit 2 / Digital Error 2
17.	Not Used	51.	DIO Port A Bit 1 / Digital Error 1
18.	Not Used	52.	DIO Port A Bit 0 / Digital Error 0
19.	MX3_N GIG-ETH	53.	DIO Data Strobe Input
20.	MX3_P GIG-ETH	54.	Digital Ground 3
21.	MX2_N GIG-ETH	55.	DIO Data Strobe Output (for digital errors)
22.	MX2_P GIG-ETH	56.	Digital Error ID (Azimuth/Elevation)
23.	MX1_N GIG-ETH	57.	Not Used
24.	MX1_P GIG-ETH	58.	Not Used
25.	MX0_N GIG-ETH	59.	Digital Ground 2
26.	MX0_P GIG-ETH	60.	Not Used
27.	Not Used	61.	UART 6_RS-422 Tx +
28.	Not Used	62.	UART 6_RS-422 Tx - / RS-232 Tx
29.	Not Used	63.	UART 6_RS-422 Rx +
30.	Digital Ground 1	64.	UART 6_RS-422 Rx - / RS-232 Rx
31.	UART 5_RS-422 Tx +	65.	UART 7_RS-422 Tx +
32.	UART 5_RS-422 Tx - / RS-232 Tx	66.	UART 7_RS-422 Tx - / RS-232 Tx
33.	UART 5_RS-422 Rx +	67.	UART 7_RS-422 Rx +
34.	UART 5_RS-422 Rx - / RS-232 Rx	68.	UART 7_RS-422 Rx - / RS-232 Rx

F4.4.1 VHDCI I/O Cable B – Red

The top/right 68-pin female VHDCI connector on the tracker is colored red and is used for Ethernet, Serial I/O, and Digital I/O (digital track errors). The red I/O Cable B connects to the tracker and provides three low-density connectors for easy access to the tracker I/O. These three connectors are described in the following paragraphs.

F4.4.2 Digital I/O Connector

The Digital I/O Connector (P3) is a standard DB25 male.

Table F4.7 Digital I/O Connector (P3) - Connection Definitions:

1. DIO Port A Bit 0 / Digital Error 0	14. DIO Port A Bit 1 / Digital Error 1
2. DIO Port A Bit 2 / Digital Error 2	15. DIO Port A Bit 3 / Digital Error 3
3. DIO Port A Bit 4 / Digital Error 4	16. DIO Port A Bit 5 / Digital Error 5
4. DIO Port A Bit 6 / Digital Error 6	17. DIO Port A Bit 7 / Digital Error 7
5. Digital Ground 1	18. Not Used
6. Not Used	19. DIO Port B Bit 0 / Digital Error 8
7. DIO Port B Bit 1 / Digital Error 9	20. DIO Port B Bit 2 / Digital Error 10
8. DIO Port B Bit 3 / Digital Error 11	21. DIO Port B Bit 4 / Digital Error 12
9. DIO Port B Bit 5 / Digital Error 13	22. DIO Port B Bit 6 / Digital Error 14
10. DIO Port B Bit 7 / Digital Error 15	23. Not Used
11. Not Used	24. Digital Error ID (Azimuth/Elevation)
12. DIO Data Strobe Input	25. DIO Data Strobe Output
13. Not Used	

F4.4.3 Serial I/O Connector

The Serial I/O Connector (P4) is a High Density DB15 male.

Table F4.8 Serial I/O Connector (P4) - Connection Definitions:

1. Digital Ground 2	9. UART 6_RS-422 Rx - / RS-232 Rx
2. UART 5_RS-422 Tx - / RS-232 Tx	10. UART 6_RS-422 Rx +
3. UART 5_RS-422 Tx +	11. Digital Ground 4
4. UART 5_RS-422 Rx - / RS-232 Rx	12. UART 7_RS-422 Tx - / RS-232 Tx
5. UART 5_RS-422 Rx +	13. UART 7_RS-422 Tx +
6. Digital Ground 3	14. UART 7_RS-422 Rx - / RS-232 Rx
7. UART 6_RS-422 Tx - / RS-232 Tx	15. UART 7_RS-422 Rx +
8. UART 6_RS-422 Tx +	

F4.4.4 Ethernet Connector

The Ethernet Connector (P5) on the tracker board is a female RJ-45 connector, JK0654219. The mating connector is a male RJ-45 connector.

Table F4.9 Ethernet Connector (P5) - Connection Definitions:

1.	MX0 P
2.	MX0 N
3.	MXI P
4.	MX2 P
5.	MX2 N
6.	MX1 N
7.	MX3 P
8.	MX3 N

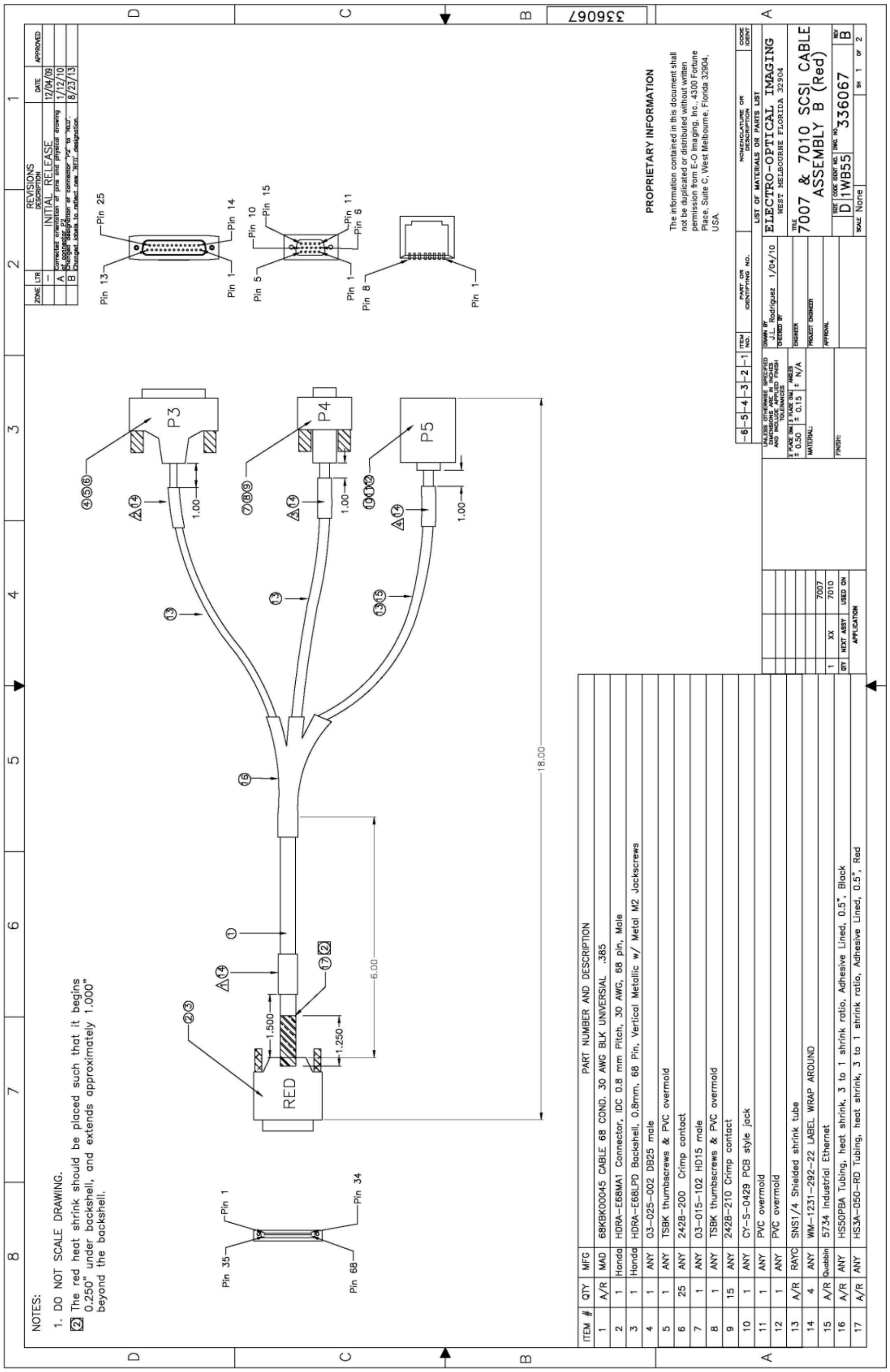

Figure F4.4 Red Cable Assembly Drawing

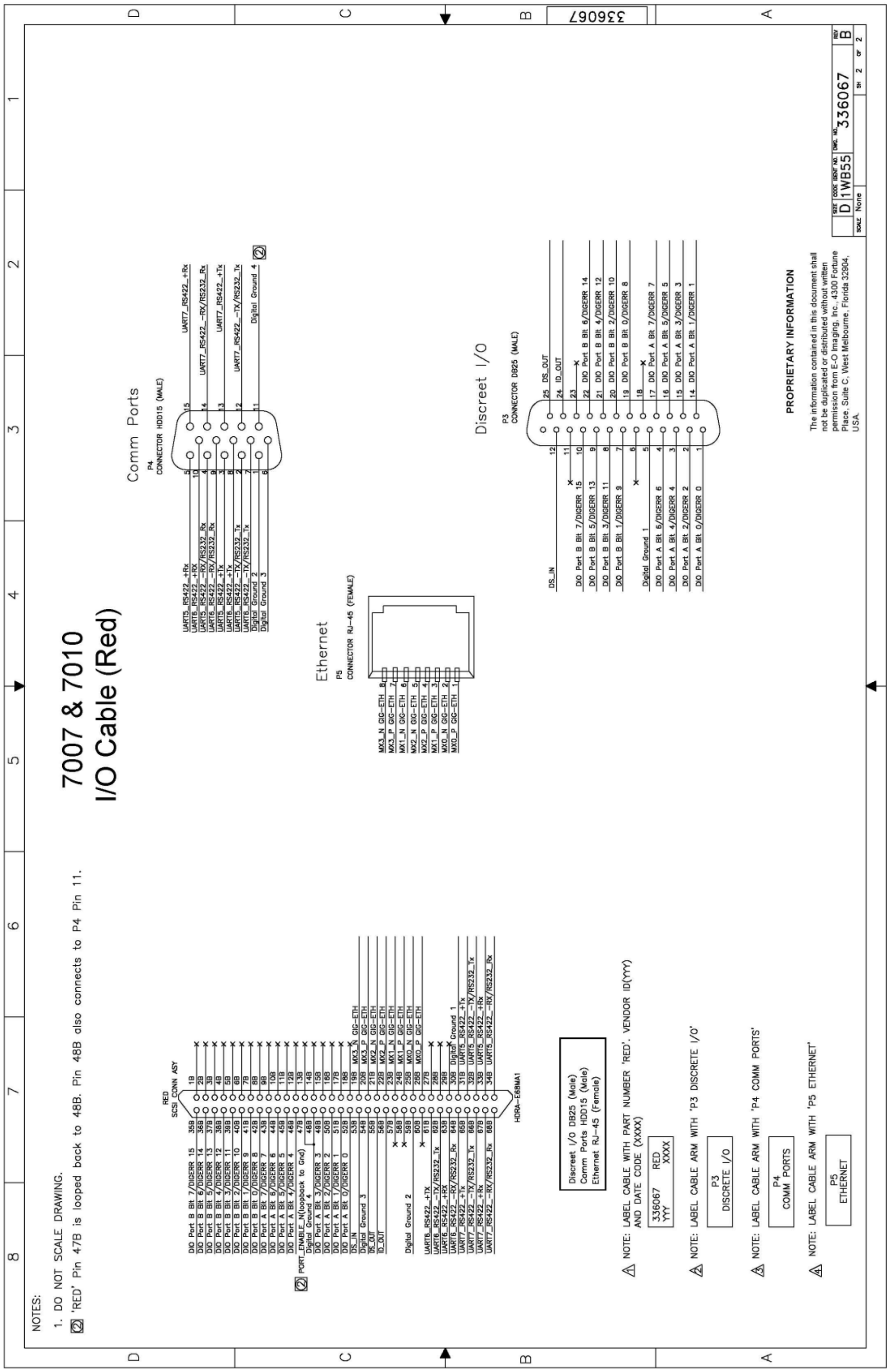

Figure F4.5 Red Cable Assembly Drawing

F5 Model 7010/7011 I/O Connector Definition

The connectors on the Model 7010/7011 Express tracker board are described in the following paragraphs.

F5.1 Model 7010/7011 Rear Panel

The connectors on the rear panel of the Model 7010/7011 PCI Express tracker board are described in the following paragraphs.

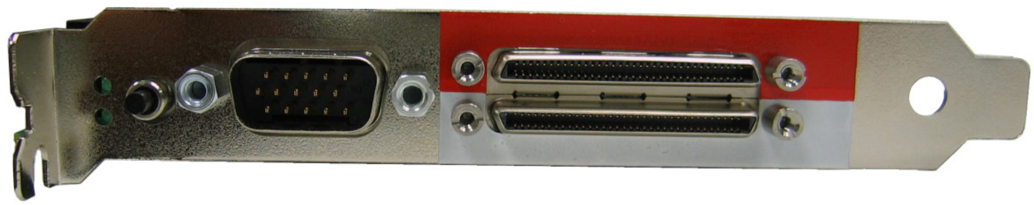

Figure F5.1 Model 7010/7011 Rear Panel

F5.2 Analog Video Connector

The analog video connector (J1) on the tracker board is a 15-pin male connector, AMP 749767-1. The mating connector is a 15-pin high-density female connector, PDI-15RHS-SW-H.

Table F5.1 Analog Video Connector - Connection Definitions:

1. Video In 1 (+)	6. Video In 1 (-)	11. Video 1 Out
2. Video In 2 (+)	7. Video In 2 (-)	12. Ground
3. Video In 3 (-)	8. Video In 4 (+)	13. Video In 4 (-)
4. Video In 3 (+)	9. Ground	14. Video 2 Out
5. Video Out (no annotation)	10. Ground	15. Ground

F5.3 VHDCI I/O Connector A - White

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The bottom/left 68-pin female VHDCI connector is colored white and is used for serial communications, analog I/O and digital status.

Table F5.2 VHDCI I/O Connector (J2A) - Connection Definitions:

1.	Not Used	35.	+5 Volts
2.	Digital Ground	36.	+5 Volts
3.	Digital Ground	37.	+5 Volts
4.	+5 or +10 Volts (switch selectable, analog ref)	38.	+5 Volts
5.	-5 or -10 Volts (switch selectable, analog ref)	39.	+5 Volts
6.	Analog Ground	40.	Digital Ground

7.	Analog Input 1	41.	Digital Ground
8.	Analog Input 2	42.	Digital Ground
9.	Analog Input 3	43.	Digital Ground
10.	Analog Input 4	44.	Digital Ground
11.	Analog Ground	45.	Not Used
12.	Analog Input 5	46.	Not Used
13.	Analog Input 6	47.	UARTs Disable (connector keying)
14.	Analog Input 7	48.	Digital Ground
15.	Analog Input 8	49.	Digital Ground
16.	Analog Ground	50.	UART4 RS-422 (+) TX Out
17.	Analog Output 1 (Azimuth Error)	51.	UART4 RS-422 (-) / RS-232 TX Out
18.	Analog Output 2 (Elevation Error)	52.	UART4 RS-422 (+) RX In
19.	Analog Ground	53.	UART4 RS-422 (-) / RS-232 RX In
20.	Analog Output 3	54.	Digital Ground
21.	Analog Output 4	55.	UART3 RS-422 (+) TX Out
22.	Digital Ground	56.	UART3 RS-422 (-) / RS-232 TX Out
23.	On Target	57.	UART3 RS-422 (+) RX In
24.	Track/Acquire	58.	UART3 RS-422 (-) / RS-232 RX In
25.	Coast	59.	Digital Ground
26.	Not Used	60.	UART2 RS-422 (+) TX Out
27.	Short to pin 28 (connector keying)	61.	UART2 RS-422 (-) / RS-232 TX Out
28.	Short to pin 27 (connector keying)	62.	UART2 RS-422 (+) RX In
29.	Not Used	63.	UART2 RS-422 (-) / RS-232 RX In
30.	Digital Ground	64.	Digital Ground
31.	UART0 RS-422 (+) TX Out	65.	UART1 RS-422 (+) TX Out
32.	UART0 RS-422 (-) / RS-232 TX Out	66.	UART1 RS-422 (-) / RS-232 TX Out
33.	UART0 RS-422 (+) RX In	67.	UART1 RS-422 (+) RX In
34.	UART0 RS-422 (-) / RS-232 RX In	68.	UART1 RS-422 (-) / RS-232 RX In

F5.3.1 VHDCI I/O Cable A – White

The bottom/left 68-pin female VHDCI connector on the tracker is colored white and is used for serial communications, analog I/O and digital status. The white I/O Cable A connects to the tracker and provides three low-density connectors for easy access to the tracker I/O. These three connectors are described in the following paragraphs.

F5.3.2 GUI / UART0 Connector

The GUI (Graphical User Interface) connector (P1) is a standard DB9 female used for serial communications (RS-232/422). The wiring is standard for a typical PC computer serial port.

Table F5.3 GUI / UART0 Connector (P1)- Connection Definitions:

1.	UART0 RS-422 (+) TX Out
2.	UART0 RS-422 (-) / RS-232 TX Out

3.	UART0 RS-422 (-) / RS-232 RX In
4.	UART0 RS-422 (+) RX In
5.	Digital Ground
6.	Not Used
7.	Not Used
8.	Not Used
9.	Not Used

F5.3.3 Analog I/O Connector

The analog I/O connector (P2) is a standard DB25 female.

Table F5.4 Analog I/O Connector (P2) - Connection Definitions:

1. Digital Ground	14. +5 or +10 Volts (switch selectable)
2. -5 or -10 Volts (switch selectable)	15. Analog Ground
3. Analog Input 1	16. Analog Input 2
4. Analog Input 3	17. Analog Input 4
5. Analog Ground	18. Analog Input 5
6. Analog Input 6	19. Analog Input 7
7. Analog Input 8	20. Analog Ground
8. Analog Output 1 (Azimuth Error)	21. Analog Output 2 (Elevation Error)
9. Analog Ground	22. Analog Output 3
10. Analog Output 4	23. Digital Ground
11. On Target	24. Track / Acquire
12. Coast	25. Not Used
13. Not Used	

F5.3.4 Serial I/O Connector

The serial I/O connector (P3) is a 44-pin female connector.

Table F5.5 Serial I/O Connector (P3) - Connection Definitions:

1. +5 Volts	16. +5 Volts	31. Digital Ground
2. +5 Volts	17. +5 Volts	32. Digital Ground
3. Digital Ground	18. +5 Volts	33. Digital Ground
4. Digital Ground	19. Not Used	34. Digital Ground
5. UART4 RS-422 (+) RX In	20. UART4 RS-422 (-) / RS-232 RX In	35. Digital Ground

6.	UART4 RS-422 (+) TX Out	21.	UART4 RS-422 (-) / RS-232 TX Out	36.	Not Used
7.	Digital Ground	22.	Not Used	37.	Not Used
8.	UART3 RS-422 (+) RX In	23.	UART3 RS-422 (-) / RS-232 RX In	38.	UARTs Disable
9.	UART3 RS-422 (+) TX Out	24.	UART3 RS-422 (-) / RS-232 TX Out	39.	Not Used
10.	Digital Ground	25.	Not Used	40.	Not Used
11.	UART2 RS-422 (+) RX In	26.	UART2 RS-422 (-) / RS-232 RX In	41.	Digital Ground
12.	UART2 RS-422 (+) TX Out	27.	UART2 RS-422 (-) / RS-232 TX Out	42.	Not Used
13.	Digital Ground	28.	Not Used	43.	Not Used
14.	UART1 RS-422 (+) RX In	29.	UART1 RS-422 (-) / RS-232 RX In	44.	Not Used
15.	UART1 RS-422 (+) TX Out	30.	UART1 RS-422 (-) / RS-232 TX Out		

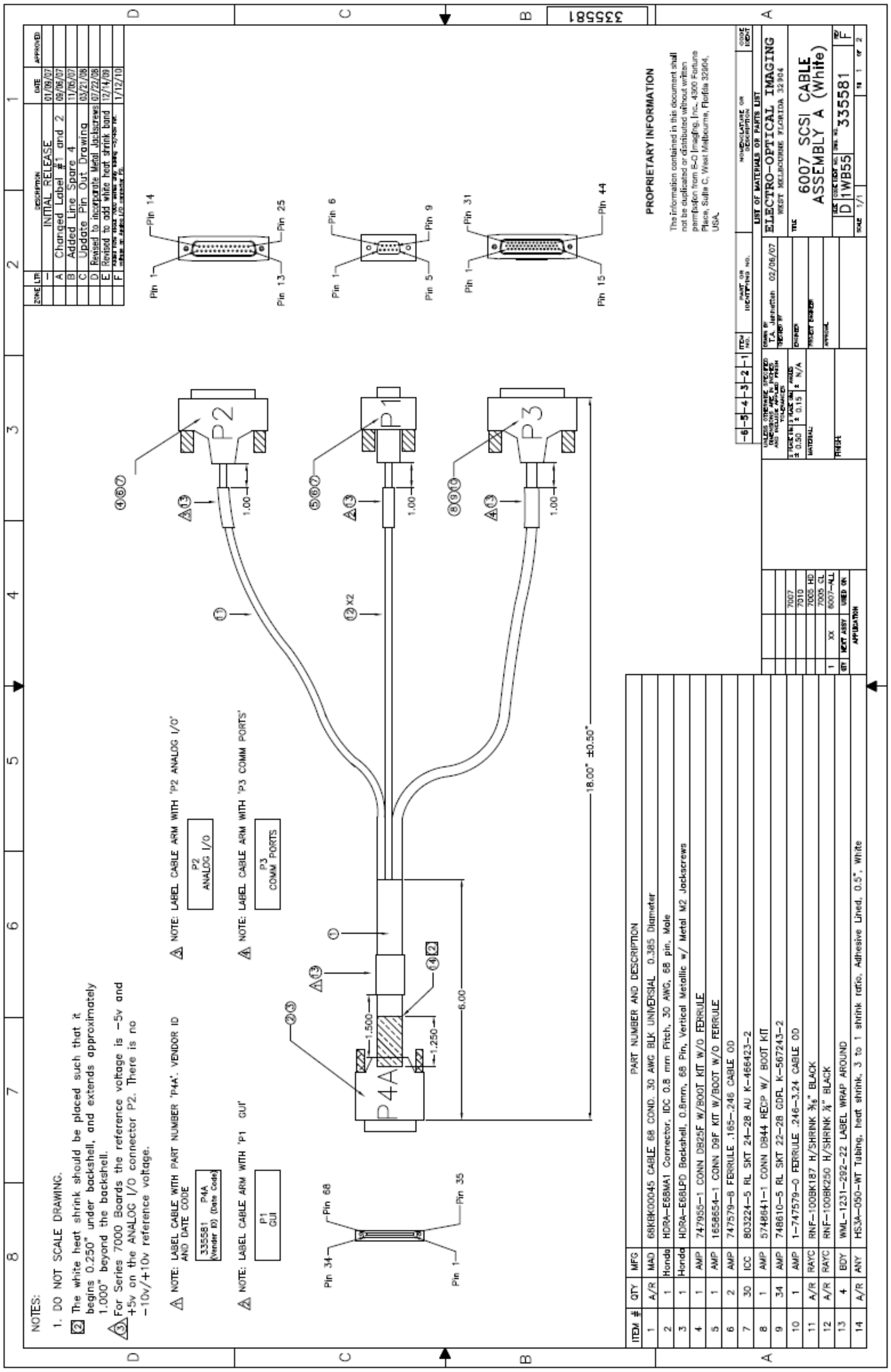

Figure F5.2 White Cable Assembly Drawing

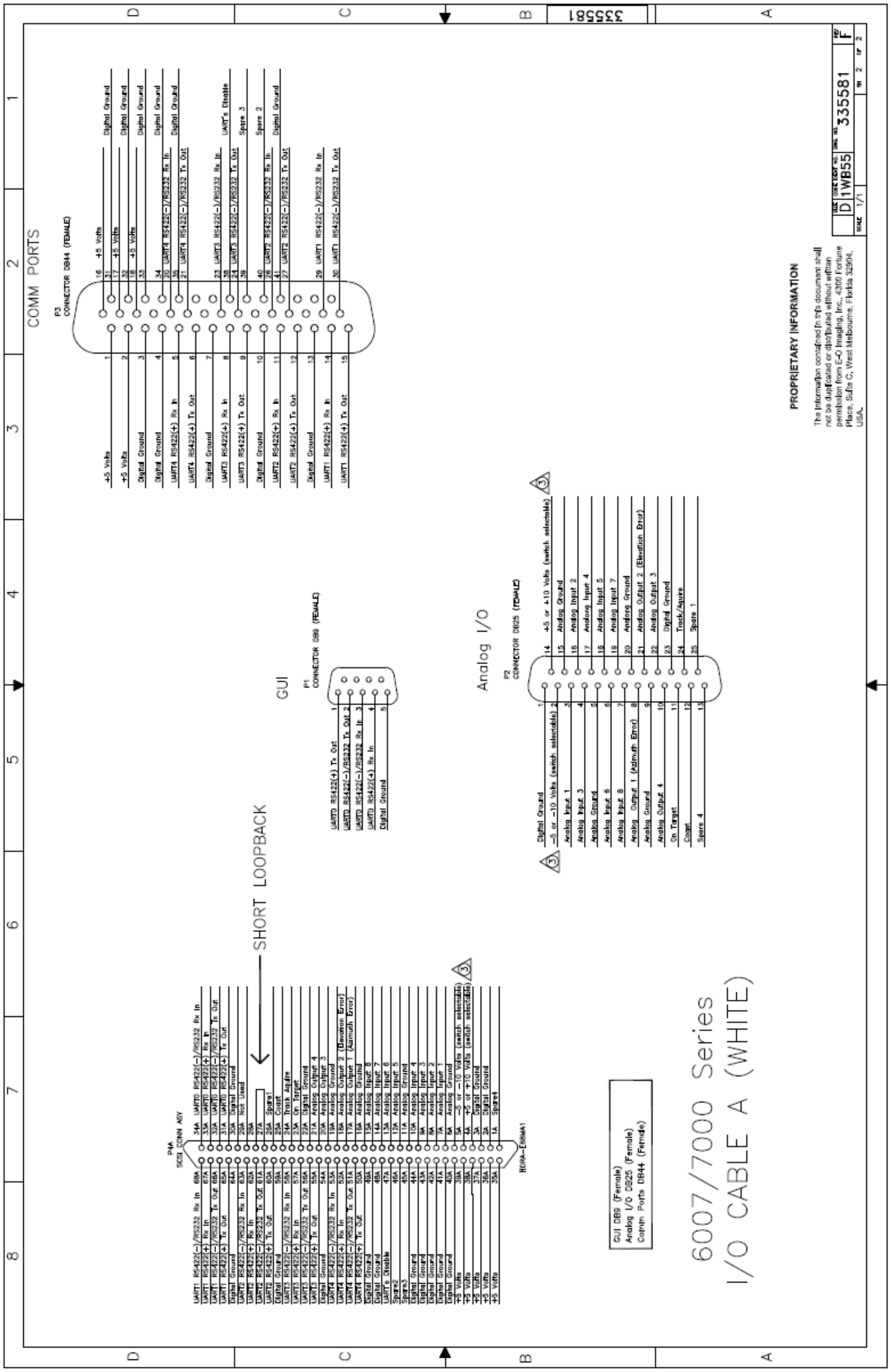

Figure F5.3 White Cable Assembly Drawing

F5.4 VHDCI I/O Connector B - Red

The tracker uses a dual stacked VHDCI connector (J2) for all I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The top/right 68-pin female VHDCI connector is colored red and is used for Ethernet, Serial I/O, and Digital I/O.

Table F5.6 VHDCI I/O Connector (J2B) - Connection Definitions:

1.	Not Used	35.	DIO Port B Bit 7 / Digital Error 15
2.	Not Used	36.	DIO Port B Bit 6 / Digital Error 14
3.	Not Used	37.	DIO Port B Bit 5 / Digital Error 13
4.	Not Used	38.	DIO Port B Bit 4 / Digital Error 12
5.	Not Used	39.	DIO Port B Bit 3 / Digital Error 11
6.	Not Used	40.	DIO Port B Bit 2 / Digital Error 10
7.	Not Used	41.	DIO Port B Bit 1 / Digital Error 9
8.	Not Used	42.	DIO Port B Bit 0 / Digital Error 8
9.	Not Used	43.	DIO Port A Bit 7 / Digital Error 7
10.	Not Used	44.	DIO Port A Bit 6 / Digital Error 6
11.	Not Used	45.	DIO Port A Bit 5 / Digital Error 5
12.	Not Used	46.	DIO Port A Bit 4 / Digital Error 4
13.	Not Used	47.	PORT_ENABLE_N (looped back to pin 48 as well)
14.	Not Used	48.	Digital Ground 4
15.	Not Used	49.	DIO Port A Bit 3 / Digital Error 3
16.	Not Used	50.	DIO Port A Bit 2 / Digital Error 2
17.	Not Used	51.	DIO Port A Bit 1 / Digital Error 1
18.	Not Used	52.	DIO Port A Bit 0 / Digital Error 0
19.	MX3_N GIG-ETH	53.	DIO Data Strobe Input
20.	MX3_P GIG-ETH	54.	Digital Ground 3
21.	MX2_N GIG-ETH	55.	DIO Data Strobe Output (for digital errors)
22.	MX2_P GIG-ETH	56.	Digital Error ID (Azimuth/Elevation)
23.	MX1_N GIG-ETH	57.	Not Used
24.	MX1_P GIG-ETH	58.	Not Used
25.	MX0_N GIG-ETH	59.	Digital Ground 2
26.	MX0_P GIG-ETH	60.	Not Used
27.	Not Used	61.	UART 6_RS-422 Tx +
28.	Not Used	62.	UART 6_RS-422 Tx - / RS-232 Tx
29.	Not Used	63.	UART 6_RS-422 Rx +
30.	Digital Ground 1	64.	UART 6_RS-422 Rx - / RS-232 Rx
31.	UART 5_RS-422 Tx +	65.	UART 7_RS-422 Tx +
32.	UART 5_RS-422 Tx - / RS-232 Tx	66.	UART 7_RS-422 Tx - / RS-232 Tx
33.	UART 5_RS-422 Rx +	67.	UART 7_RS-422 Rx +
34.	UART 5_RS-422 Rx - / RS-232 Rx	68.	UART 7_RS-422 Rx - / RS-232 Rx

F5.4.1 VHDCI I/O Cable B – Red

The top/right 68-pin female VHDCI connector on the tracker is colored red and is used for Ethernet, Serial I/O, and Digital I/O (digital track errors). The red I/O Cable B connects to the tracker and provides three low-density connectors for easy access to the tracker I/O. These three connectors are described in the following paragraphs.

F5.4.2 Digital I/O Connector

The Digital I/O Connector (P3) is a standard DB25 male.

Table F5.7 Digital I/O Connector (P3) - Connection Definitions:

1. DIO Port A Bit 0 / Digital Error 0	14. DIO Port A Bit 1 / Digital Error 1
2. DIO Port A Bit 2 / Digital Error 2	15. DIO Port A Bit 3 / Digital Error 3
3. DIO Port A Bit 4 / Digital Error 4	16. DIO Port A Bit 5 / Digital Error 5
4. DIO Port A Bit 6 / Digital Error 6	17. DIO Port A Bit 7 / Digital Error 7
5. Digital Ground 1	18. Not Used
6. Not Used	19. DIO Port B Bit 0 / Digital Error 8
7. DIO Port B Bit 1 / Digital Error 9	20. DIO Port B Bit 2 / Digital Error 10
8. DIO Port B Bit 3 / Digital Error 11	21. DIO Port B Bit 4 / Digital Error 12
9. DIO Port B Bit 5 / Digital Error 13	22. DIO Port B Bit 6 / Digital Error 14
10. DIO Port B Bit 7 / Digital Error 15	23. Not Used
11. Not Used	24. Digital Error ID (Azimuth/Elevation)
12. DIO Data Strobe Input	25. DIO Data Strobe Output
13. Not Used	

F5.4.3 Serial I/O Connector

The Serial I/O Connector (P4) is a High Density DB15 male.

Table F5.8 Serial I/O Connector (P4) - Connection Definitions:

1. Digital Ground 2	9. UART 6_RS-422 Rx - / RS-232 Rx
2. UART 5_RS-422 Tx - / RS-232 Tx	10. UART 6_RS-422 Rx +
3. UART 5_RS-422 Tx +	11. Digital Ground 4
4. UART 5_RS-422 Rx - / RS-232 Rx	12. UART 7_RS-422 Tx - / RS-232 Tx
5. UART 5_RS-422 Rx +	13. UART 7_RS-422 Tx +
6. Digital Ground 3	14. UART 7_RS-422 Rx - / RS-232 Rx
7. UART 6_RS-422 Tx - / RS-232 Tx	15. UART 7_RS-422 Rx +
8. UART 6_RS-422 Tx +	

F5.4.4 Ethernet Connector

The Ethernet Connector (P5) on the tracker board is a female RJ-45 connector, JK0654219. The mating connector is a male RJ-45 connector.

Table F5.9 Ethernet Connector (P5) - Connection Definitions:

1. MX0 P
2. MX0 N
3. MXI P
4. MX2 P
5. MX2 N
6. MX1 N
7. MX3 P
8. MX3 N

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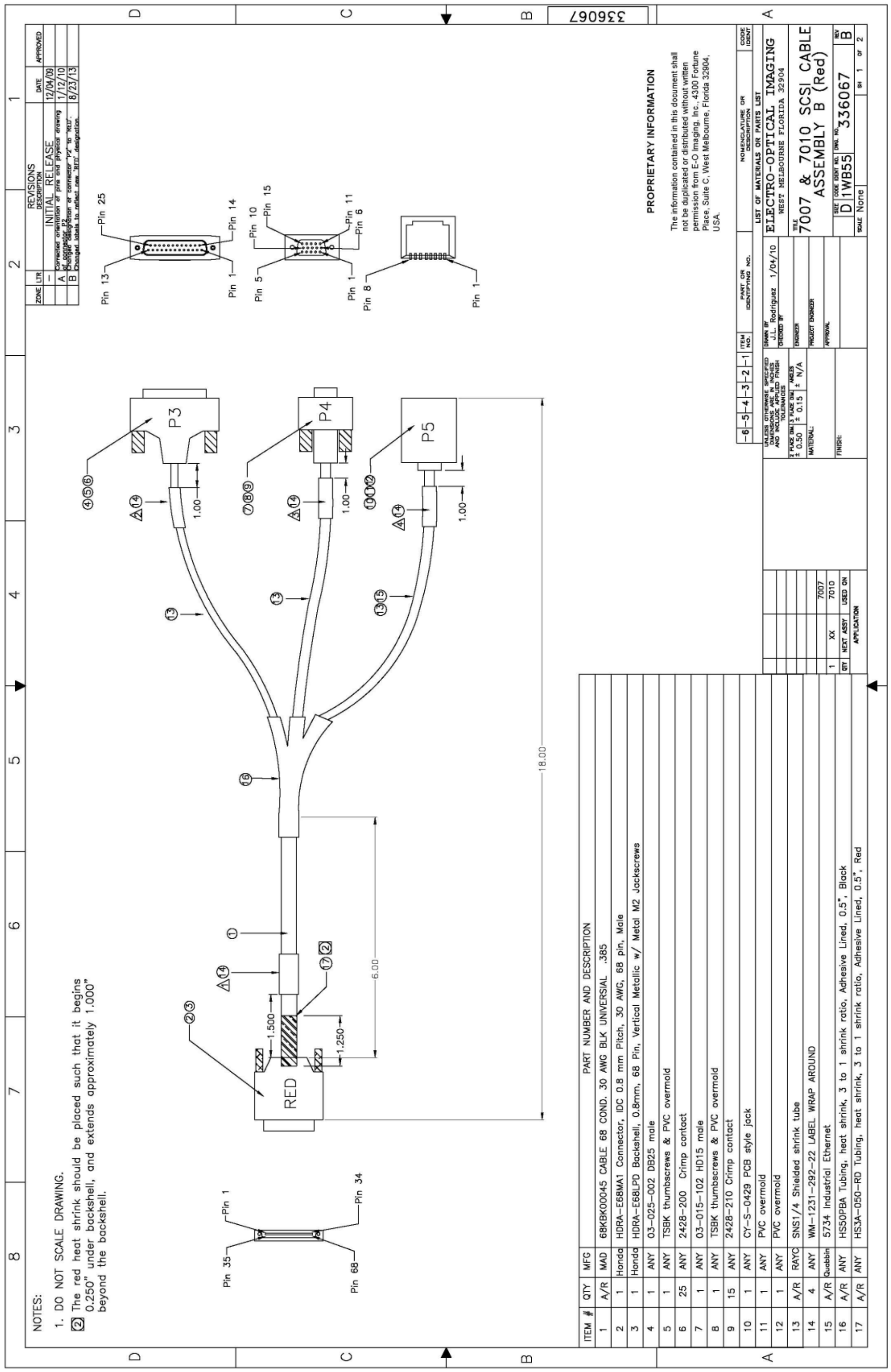

Figure F5.4 Red Cable Assembly Drawing

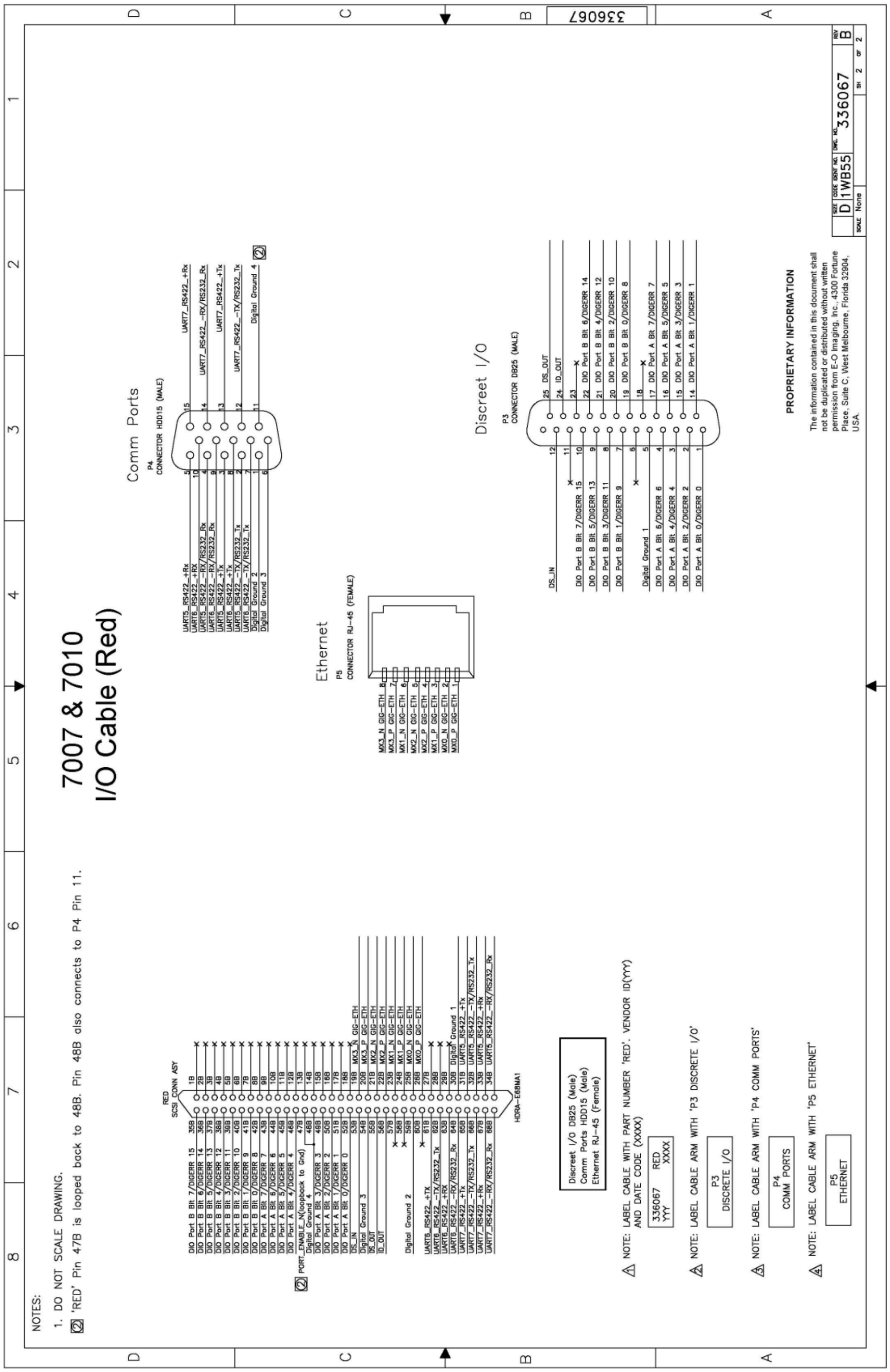

Figure F5.5 Red Cable Assembly Drawing

F6 Model 7015/7016 I/O Connector Definition

The connectors on the Model 7015/7016 VMEbus tracker board are described in the following paragraphs.

F6.1 Model 7015/7016 Front Panel

There are no I/O connections on the Model 7015/7016 front panel. All tracker I/O connections are made via the VMEbus and are noted below (reference F6.2).

F6.2 VME Connectors

The VME connectors on the tracker board connect to J1 and J2 on the VMEbus. These are 96 pin connectors, AMP Part # 6509133-5.

F6.2.1 VME P1 Connector

Table F6.1 VME P1 Connector – Connection Definitions:

Pin Number	Row A	Row B	Row C
1	D00	BBSY*	D08
2	D01	BCLR*	D09
3	D02	ACFAIL*	D10
4	D03	BG0IN*	D11
5	D04	BG0OUT*	D12
6	D05	BG1IN*	D13
7	D06	BG1OUT*	D14
8	D07	BG2IN*	D15
9	GND	BG2OUT*	GND
10	SYSCLK	BG3IN*	SYSFAIL*
11	GND	BG3OUT*	BERR*
12	DS1*	BR0*	SYSRESET*
13	DS0*	BR1*	LWORD*
14	WRITE*	BR2*	AM5
15	GND	BR3*	A23
16	DTACK*	AM0	A22
17	GND	AM1	A21
18	AS*	AM2	A20
19	GND	AM3	A19
20	IACK*	GND	A18

Pin Number	Row A	Row B	Row C
21	IACKIN*	(††) SERCLK	A17
22	IACKOUT*	(††) SERDAT*	A16
23	AM4	GND	A15
24	A07	IRQ7*	A14
25	A06	IRQ6*	A13
26	A05	IRQ5*	A12
27	A04	IRQ4*	A11
28	A03	IRQ3*	A10
29	A02	IRQ2*	A09
30	A01	IRQ1*	A08
31	-12 VDC	+5VSTDBY	+12 VDC
32	+5 VDC	+5 VDC	+5 VDC

F6.2.2 VME P2 Connector

Table F6.2 VME P2 Connector – Connection Definitions:

Pin Number	Row A	Row B	Row C
1	n/c	+5 VDC	VIDEO IN #1 (+)
2	n/c	DIGITAL GND	ANALOG GND
3	UART0 RS232/422- RX	(†) RESERVED	VIDEO IN #1 (-)
4	UART0 RS422+ RX	A24 (not used)	n/c
5	UART0 RS232/422- TX	A25 (not used)	VIDEO IN #2 (+)
6	UART0 RS422+ TX	A26 (not used)	ANALOG GND
7	DIGITAL GND	A27 (not used)	VIDEO IN #2 (-)
8	UART1 RS232/422- RX	A28 (not used)	n/c
9	UART1 RS422+ RX	A29 (not used)	VIDEO IN #3 (+)
10	UART1 RS232/422- TX	A30 (not used)	ANALOG GND
11	UART1 RS422+ TX	A31 (not used)	VIDEO IN #3 (-)
12	DIGITAL GND	DIGITAL GND	n/c
13	n/c	+5 VDC	VIDEO IN #4 (+)
14	UART2 RS232/422- RX	D16 (not used)	ANALOG GND
15	UART2 RS422+ RX	D17 (not used)	VIDEO IN #4 (-)
16	UART2 RS232/422- TX	D18 (not used)	n/c

Pin Number	Row A	Row B	Row C
17	UART2 RS422+ TX	D19 (not used)	VIDEO OUT #1
18	DIGITAL GND	D20 (not used)	ANALOG GND
19	UART3 RS232/422- RX	D21 (not used)	VIDEO OUT #2
20	UART3 RS422+ RX	D22 (not used)	ANALOG GND
21	UART3 RS232/422- TX	D23 (not used)	VIDEO OUT #3
22	UART3 RS422+ TX	DIGITAL GND	ANALOG GND
23	DIGITAL GND	D24 (not used)	n/c
24	n/c	D25 (not used)	n/c
25	n/c	D26 (not used)	n/c
26	n/c	D27 (not used)	n/c
27	n/c	D28 (not used)	n/c
28	n/c	D29 (not used)	n/c
29	ETHERNET BI-DD+	D30 (not used)	ETHERNET BI-DC+
30	ETHERNET BI-DD-	D31 (not used)	ETHERNET BI-DC-
31	ETHERNET BI-DB+	GND	ETHERNET BI-DA+
32	ETHERNET BI-DB-	+5 VDC	ETHERNET BI-DA-

Notes: (†) RESERVED was redefined as RETRY*, and (††) SERCLK & SERDAT* were changed to user defined pins in the proposed VME64 enhancements.

F7 Model 7410/7411/7412 I/O Connector Definition

The connectors on the Model 7410 /7411/7412 PCI Express tracker board are described in the following paragraphs.

F7.1 Model 7410/7411/7412 Rear Panel

The connectors on the rear panel of the Model 7410/7411/7412 PCI Express tracker board are described in the following paragraphs.

Figure F7.1 Model 7010/7011/7412 Rear Panel

F7.1.1 Digital Video Interface (DVI) Connectors

The DVI-D input connector (J5) and the DVI-D output connector (J7) are standard Digital Video Interface (DVI-D) connectors. The pins marked (NC) are not connected to the board. The pins marked (LOOP) are directly connected from the input connector (J5) to the output connector (J7) and are unused on the board. The mating connector and cable assembly is a standard DVI cable.

Table F7.1 Digital Video Interface (DVI) Connectors - Connection Definitions:

1. TMDS Data 2-	14. DDC +5V (LOOP)
2. TMDS Data 2+	15. Ground
3. TMDS Data 2/4 Shield	16. DDC Hot Plug Detect (LOOP)
4. TMDS Data 4- (NC)	17. TMDS Data 0-
5. TMDS Data 4+ (NC)	18. TMDS Data 0+
6. DDC Clock (LOOP)	19. TMDS Data 0/5 Shield
7. DDC Data (LOOP)	20. TMDS Data 5- (NC)
8. Analog Vertical Sync (LOOP)	21 TMDS Data 5+ (NC)
9. TMDS Data 1-	22. TMDS Clock Shield
10. TMDS Data 1+	23. TMDS Clock+
11. TMDS Data 1/3 Shield	24. TMDS Clock-
12. TMDS Data 3- (NC)	
13. TMDS Data 3+ (NC)	C3. Analog Blue (LOOP)
C1. Analog Red (LOOP)	C4. Analog Horizontal Sync (LOOP)

C2. Analog Green (LOOP)	C5. Analog Ground

F7.2 Model 7410/7411/7412 Aux Connectors

The connectors on the top and front edge of the Model 7410/7411/7412 PCI Express tracker board are described in the following paragraphs.

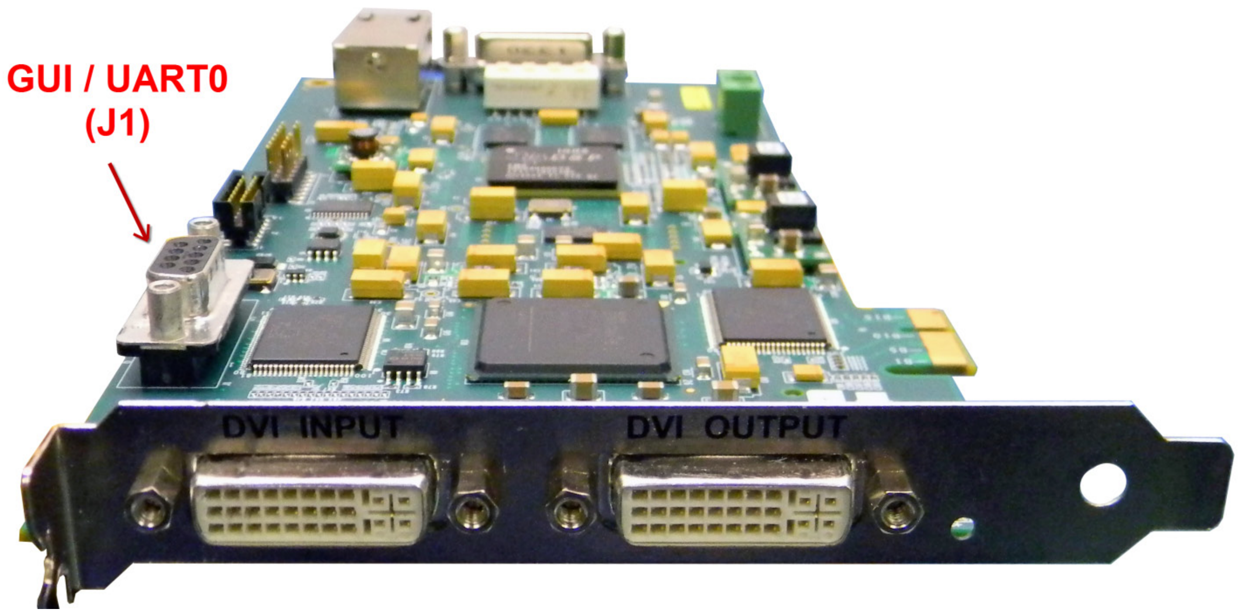

Figure F7.2 Model 7010/7011/7412 GUI/UART0 Connector

F7.2.1 GUI / UART0 Connector

The GUI (Graphical User Interface) connector (J1) is a standard DB9 female used for serial communications (RS-232 only). The wiring is standard for a typical PC computer serial port.

Table F7.2 GUI / UART0 Connector (J1) - Connection Definitions:

1.	Not Used
2.	UART0 RS-232 TX Out
3.	UART0 RS-232 RX In
4.	Not Used
5.	Ground
6.	Not Used
7.	Not Used
8.	Not Used
9.	Not Used

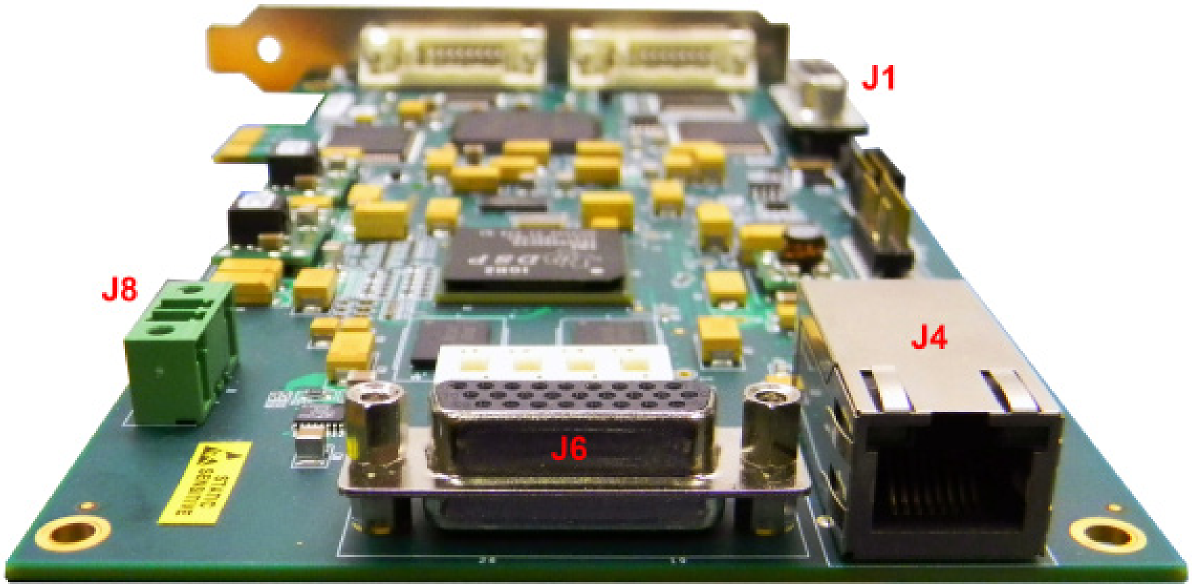

Figure F7.3 Model 7010/7011/7412 Aux Connectors

F7.2.2 Aux Serial Connector

The Aux Serial connector (J6) is a high-density, 26-pin female D connector.

Table F7.3 Aux Serial Connector (J6) - Connection Definitions:

1. UART0 RS-422 (+) TX Out	14. UART1 RS-422 (+) TX Out
2. UART0 RS-422 (+) RX In	15. Ground
3. Ground	16. UART2 RS-422 (-) / RS-232 TX Out
4. UART1 RS-422 (-) / RS-232 RX In	17. UART2 RS-422 (-) / RS-232 RX In
5. UART1 RS-422 (-) / RS-232 TX Out	18. UART3 RS-422 (+) TX Out
6. UART2 RS-422 (+) TX Out	19. Not Used
7. UART2 RS-422 (+) RX In	20. Ground
8. Ground	21. Not Used
9. UART3 RS-422 (-) / RS-232 TX Out	22. Ground
10. Ground	23. Not Used
11. UART0 RS-422 (-) / RS-232 TX Out	24. Not Used
12. UART0 RS-422 (-) / RS-232 RX In	25. UART3 RS-422 (+) RX In
13. UART1 RS-422 (+) RX In	26. UART3 RS-422 (-) / RS-232 RX In

F7.2.3 Ethernet Connector

The Ethernet connector (J4) on the tracker board is a female RJ-45 connector, JK0654219. The mating connector is a male RJ-45 connector.

Table F7.4 Ethernet Connector (J4) - Connection Definitions:

1.	MX0 P
2.	MX0 N
3.	MXI P
4.	MX2 P
5.	MX2 N
6.	MX1 N
7.	MX3 P
8.	MX3 N

F7.2.4 External Power Connector

The External Power connector (J8) can be used to power the board when not connected via the PCI Express connector. The supply voltage is +12VDC.

Note: DO NOT use this connector when the board is plugged into a PCI Express device.
Note: DO NOT use this connector to power external equipment.

Table F7.5 External Power Connector (J8) - Connection Definitions:

1.	+12VDC
2.	Ground

F8 Camera Link (CL) Daughter Board I/O Connector Definition

The connectors on the Camera Link Daughter board are described in the following paragraphs.

Note: This daughter card can only be used with Model 7007/7008 and Model 7010/7011 Tracker boards.

F8.1 Camera Link (CL) Daughter Board Rear Panel

The connectors on the rear panel of the Camera Link (CL) Daughter Board are described in the following paragraphs.

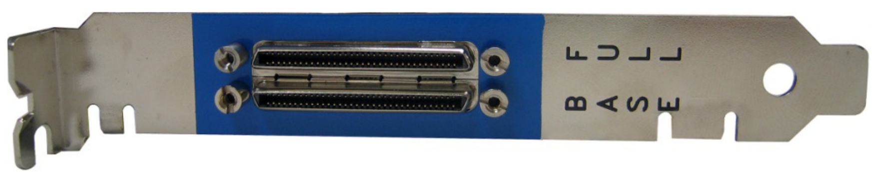

Figure F8.1 Camera Link (CL) Daughter Board Rear Panel

F8.2 VHDCI I/O Connector A/B - Blue

The tracker uses a dual stacked VHDCI connector (J1A and J1B) for all Camera Link I/O. This connector is commonly used in SCSI hard disk storage systems (referred to as SCSI-5). The 68-pin female VHDCI connector is colored blue and is used for camera link digital video base/full I/O.

Table F8.1 VHDCI Camera Link I/O Connector (J1A and J1B) - Connection Definitions:

1.	Digital Ground 1	35.	Digital Ground 8
2.	CL_TXOUT0_N	36.	CL_TXOUT1_N
3.	CL_TXOUT0_P	37.	CL_TXOUT1_P
4.	CL_TXOUT2_N	38.	CL_TXOUTCLK_N
5.	CL_TXOUT2_P	39.	CL_TXOUTCLK_P
6.	CL_TXOUT3_N	40.	CLTXOUT_SerTC_N
7.	CL_TXOUT3_P	41.	CLTXOUT_SerTC_P
8.	CLTXOUT_SerTFG_N	42.	CL_IN_CC1_N
9.	CLTXOUT_SerTFG_P	43.	CL_IN_CC1_P
10.	CL_IN_CC2_N	44.	CL_IN_CC3_N
11.	CL_IN_CC2_P	45.	CL_IN_CC3_P
12.	CL_IN_CC4_N	46.	Digital Ground 7
13.	CL_IN_CC4_P	47.	Not Used
14.	Digital Ground 2	48.	Not Used
15.	Not Used	49.	Not Used
16.	Not Used	50.	Not Used
17.	Not Used	51.	Not Used

18.	Not Used	52.	Not Used
19.	Not Used	53.	Not Used
20.	Not Used	54.	Not Used
21.	Digital Ground 3	55.	Not Used
22.	CL_OUT_CC4_N	56.	Not Used
23.	CL_OUT_CC4_P	57.	Digital Ground 6
24.	CL_OUT_CC2_N	58.	CL_OUT_CC3_N
25.	CL_OUT_CC2_P	59.	CL_OUT_CC3_P
26.	CLRXIN_SerTFG_N	60.	CL_OUT_CC1_N
27.	CLRXIN_SerTFG_P	61.	CL_OUT_CC1_P
28.	CL_RXIN3_N	62.	CLRXIN_SerTC_N
29.	CL_RXIN3_P	63.	CLRXIN_SerTC_P
30.	CL_RXIN2_N	64.	CL_RXINCLK_N
31.	CL_RXIN2_P	65.	CL_RXINCLK_P
32.	CL_RXIN0_N	66.	CL_RXIN1_N
33.	CL_RXIN0_P	67.	CL_RXIN1_P
34.	Digital Ground 4	68.	Digital Ground 5

F8.2.1 VHDCI I/O Cable A/B – Blue

The top/bottom 68-pin female VHDCI connector on the camera link daughter board is colored blue and is used for digital video I/O. The blue I/O Cable A/B connects to the tracker and provides two camera link connectors for base/full digital video to the tracker. These two connectors are described in the following paragraphs.

F8.2.2 Camera Link - Digital Video Input Connector (P2)

The ***Camera Link – Digital Video Input*** connector (P2) is a standard MDR26 female. The mating connector and cable assembly is a standard Camera Link cable.

Table F8.2 Camera Link - Digital Video Input Connector (P2) - Connection Definitions:

1. Digital Ground 3	14. Digital Ground 6
2. CL_OUT_ CC4_N	15. CL_OUT_CC4_P
3. CL_OUT_CC3_P	16. CL_OUT_CC3_N
4. CL_OUT_CC2_N	17. CL_OUT_CC2_P
5. CL_OUT_CC1_P	18. CL_OUT_CC1_N
6. CLRXIN_SerTFG_P	19. CLRXIN_SerTFG_N
7. CLRXIN_SerTC_N	20. CLRXIN_SerTC_P
8. CL_RXIN3_P	21. CL_RXIN3_N
9. CL_RXINCLK_P	22. CL_RXINCLK_N
10. CL_RXIN2_P	23. CL_RXIN2_N
11. CL_RXIN1_P	24. CL_RXIN1_N

12. CL_RXIN0_P	25. CL_RXIN0_N
13. Digital Ground 4	26. Digital Ground 5

F8.2.3 Camera Link - Digital Video Output Connector (P3)

The ***Camera Link - Digital Video Output*** connector (P3) is a standard MDR26 female. The mating connector and cable assembly is a standard Camera Link cable.

Table F8.3 Camera Link - Digital Video Output Connector (P3) - Connection Definitions:

1. Digital Ground 1	14. Digital Ground 8
2. CL_TXOUT0_N	15. CL_TXOUT0_P
3. CL_TXOUT1_N	16. CL_TXOUT1_P
4. CL_TXOUT2_N	17. CL_TXOUT2_P
5. CL_TXOUTCLK_N	18. CL_TXOUTCLK_P
6. CL_TXOUT3_N	19. CL_TXOUT3_P
7. CLTXOUT_SerTC_P	20. CLTXOUT_SerTC_N
8. CLTXOUT_SerTFG_N	21. CLTXOUT_SerTFG_P
9. CL_IN_CC1_N	22. CL_IN_CC1_P
10. CL_IN_CC2_P	23. CL_IN_CC2_N
11. CL_IN_CC3_N	24. CL_IN_CC3_P
12. CL_IN_CC4_P	25. CL_IN_CC4_N
13. Digital Ground 2	26. Digital Ground 7

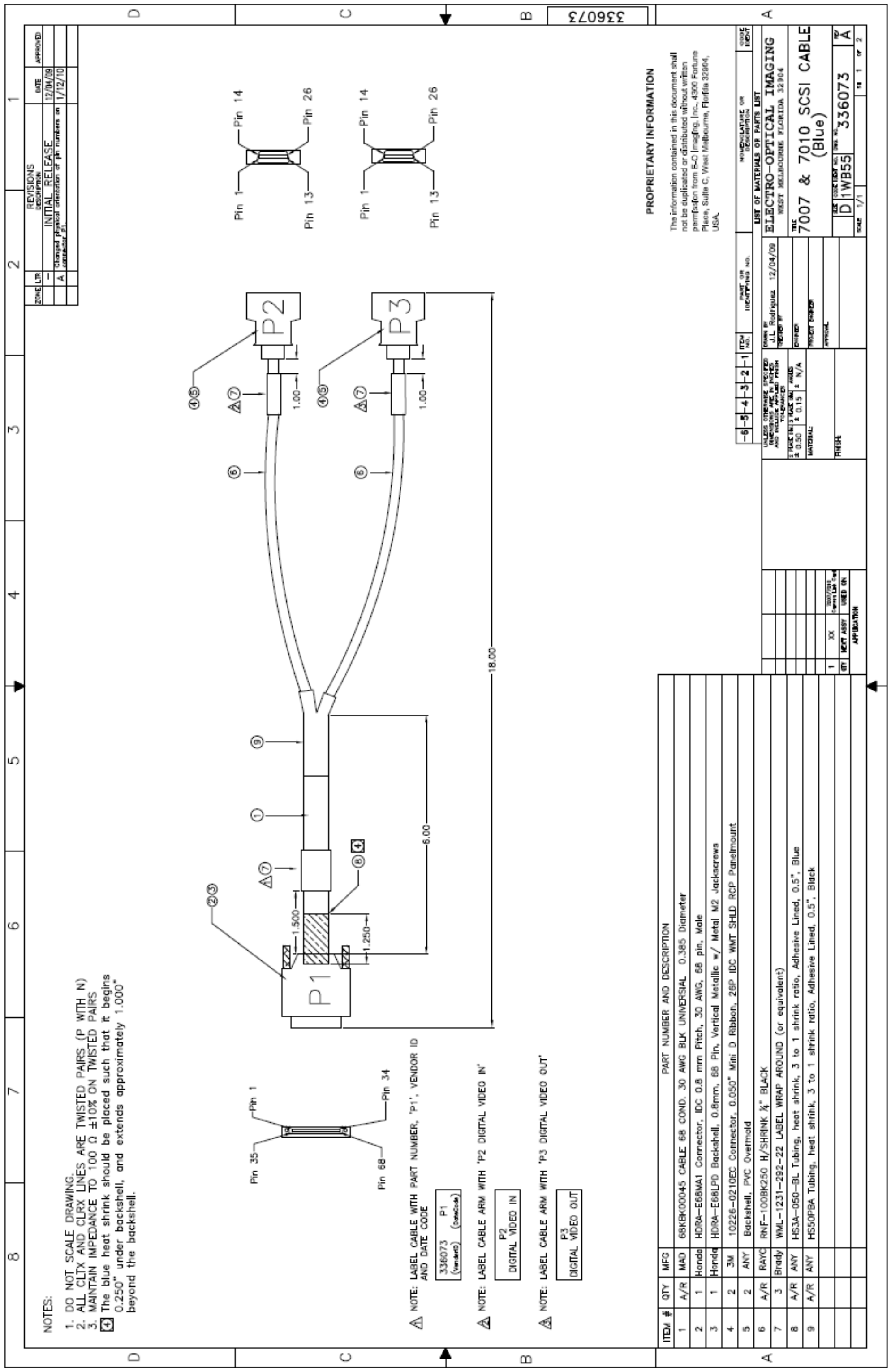

Figure F8.2 Blue Cable Assembly Drawing

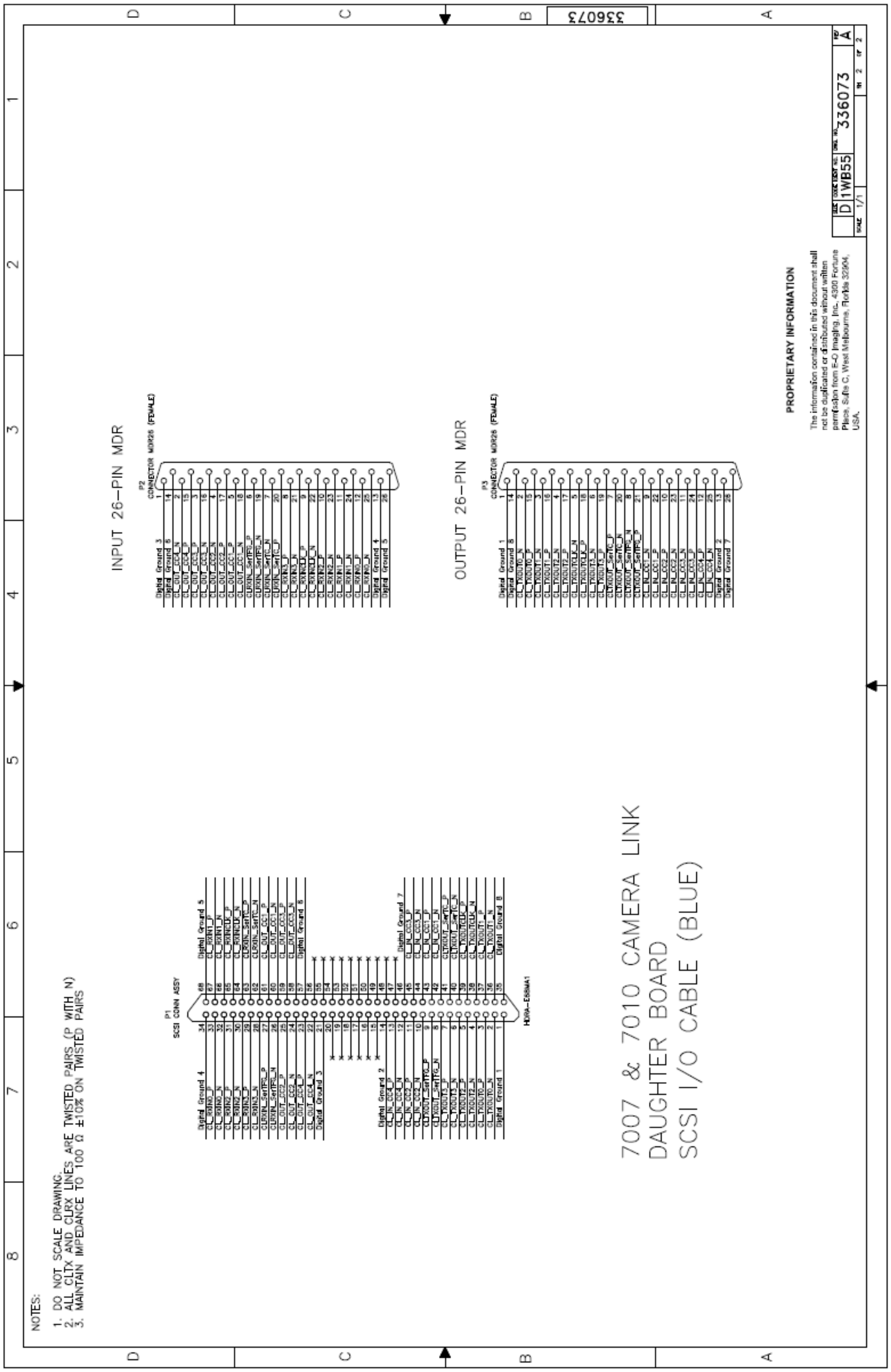

Figure F8.3 Blue Cable Assembly Drawing

F9 HD-SDI Daughter Board I/O Connector Definition

The connectors on the HD-SDI Daughter board are described in the following paragraphs.

***Note: This daughter card can only be used with Model 7007/7008 and Model 7010/7011 Tracker boards*.**

F9.1 HD-SDI Daughter Board Rear Panel

The connectors on the rear panel of the HD-SDI Daughter Board are described in the following paragraphs.

Figure F9.1 HD-SDI Daughter Board Rear Panel

F9.2 Digital Video I/O BNC Connectors

The HD-SDI Daughter Board uses BNC connectors (J1-J4) for HD Digital Video I/O. The HD-SDI daughter board supports two (2) HD-SDI inputs (J1 and J2) and provides two (2) HD-SDI outputs (J3 and J4). All signals follow HD-SDI standard.

Table F9.1 Digital Video I/O BNC Connectors - Connection Definitions:

J1	HD-SDI Input 1	High Definition Digital Video Input
J2	HD-SDI Input 2	High Definition Digital Video Input
J3	HD-SDI Output 1	High Definition Digital Video Output of selected input (unannotated)
J4	HD-SDI Output 2	High Definition Digital Video Output of selected input (annotated)

F10 DVI-D Daughter Board I/O Connector Definition

The connectors on the DVI-D Daughter board are described in the following paragraphs.

Note: This daughter card can only be used with Model 7007/7008 and Model 7010/7011 Tracker boards.

F10.1 DVI-D Daughter Board Rear Panel

The connectors on the rear panel of the DVI-D Daughter Board are described in the following paragraphs.

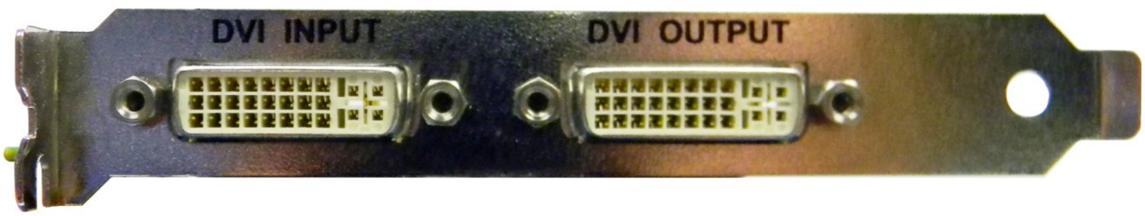

Figure F10.1 DVI-D Daughter Board Rear Panel

F10.2 Digital Video Interface (DVI) Connectors

The daughter board DVI-D input connector (P1) and the DVI-D output connector (P2) are standard Digital Video Interface (DVI) connectors. The pins marked (NC) are not connected to the board. The pins marked (LOOP) are directly connected from the input connector (P1) to the output connector (P2) and are unused on the board. The mating connector and cable assembly is a standard DVI cable.

Table F10.1 Digital Video Interface (DVI) Connectors - Connection Definitions:

1. TMDS Data 2-	14. DDC +5V (LOOP)
2. TMDS Data 2+	15. Ground
3. TMDS Data 2/4 Shield	16. DDC Hot Plug Detect (LOOP)
4. TMDS Data 4- (NC)	17. TMDS Data 0-
5. TMDS Data 4+ (NC)	18. TMDS Data 0+
6. DDC Clock (LOOP)	19. TMDS Data 0/5 Shield
7. DDC Data (LOOP)	20. TMDS Data 5- (NC)
8. Analog Vertical Sync (LOOP)	21 TMDS Data 5+ (NC)
9. TMDS Data 1-	22. TMDS Clock Shield
10. TMDS Data 1+	23. TMDS Clock+
11. TMDS Data 1/3 Shield	24. TMDS Clock-

12. TMDS Data 3- (NC)	
13. TMDS Data 3+ (NC)	C3. Analog Blue (LOOP)
C1. Analog Red (LOOP)	C4. Analog Horizontal Sync (LOOP)
C2. Analog Green (LOOP)	C5. Analog Ground

F11 CLVS Daughter Board I/O Connector Definition

The connectors on the CLVS Daughter board are described in the following paragraphs. For a more complete description of the CLVS Daughter Board refer to the ***CLVS Daughter Card User Manual*** (E-O Imaging P/N 500280).

Note: This daughter card can only be used with Model 7007/7008 and Model 7010/7011 Tracker boards.

F11.1 CLVS Daughter Board Rear Panel

The connectors on the rear panel of the CLVS Daughter Board are described in the following paragraphs.

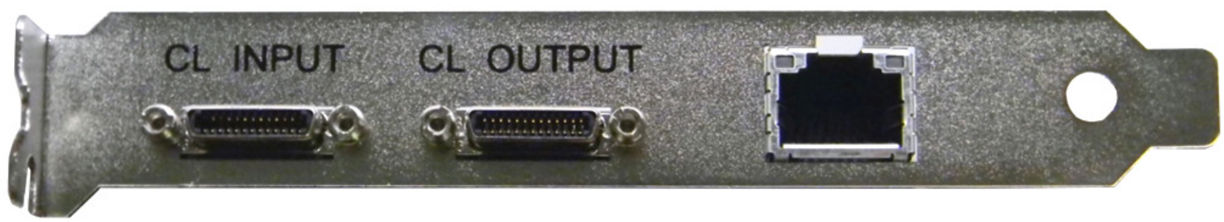

Figure F11.1 CLVS Daughter Board Rear Panel

F11.1.1 Mini Camera Link Connectors

The Mini Camera Link connectors (J1 and J2) on the tracker board are 26-pin MDR female connector, EC26LFDT2. The mating connector is a male 26-pin connector.

Table F11.1 Mini Camera Link Video Connectors (J1-J2) - Connection Definitions:

J1. Camera Link Digital Video In - Base	Base Digital Video Input
J2. Camera Link Digital Video Out - Base	Base Digital Video Output

F11.1.2 Ethernet Connector

The Ethernet connector (J3) on the tracker board is a female RJ-45 connector, JK0654219. The mating connector is a male RJ-45 connector.

Table F11.2 Ethernet Connector (J3) - Connection Definitions:

1. MDI P 0
2. MDI N 0
3. MDI P 1
4. MDI P 2
5. MDI N 2

6.	MDI N 1
7.	MDI P 3
8.	MDI N 3

F11.2 CLVS Daughter Board Aux Connectors

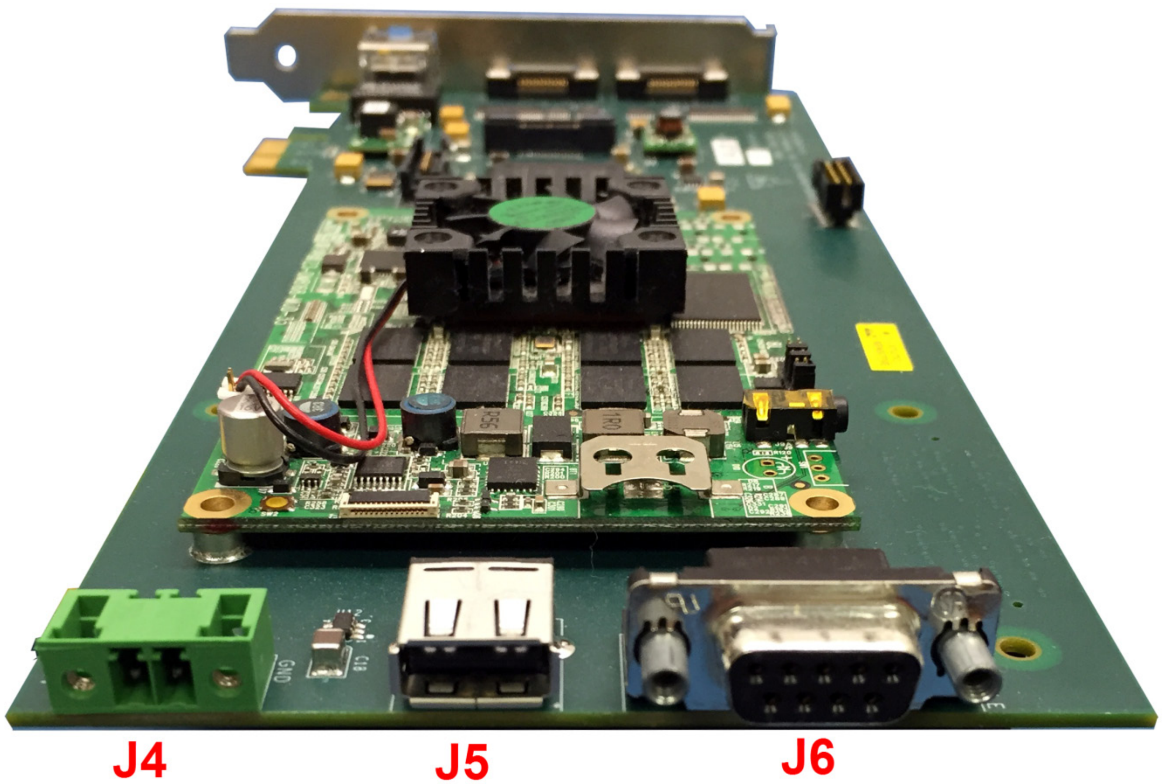

Figure F11.2 CLVS Daughter Board Aux Connectors

F11.2.1 Maintenance Terminal Connector

The Maintenance Terminal connector (J6) is a standard DB9 female used for serial communications (RS-232 only). The wiring is standard for a typical PC computer serial port.

Table F11.3 GUI / UART0 Connector (J1) - Connection Definitions:

1.	Not Used
2.	UART0 RS-232 TX Out
3.	UART0 RS-232 RX In
4.	Not Used
5.	Ground
6.	Not Used

7.	Not Used
8.	Not Used
9.	Not Used

F11.2.2 USB Connector (NOT SUPPORTED)

The USB connector (J5) is not currently supported.

F11.2.3 External Power Connector

The External Power connector (J4) can be used to power the board when the board is not connected via the PCI Express connector. The supply voltage is +12VDC.

Note: The CLVS Daughter board does not receive power from the host tracker board.

Note: DO NOT use this connector when the board is plugged into a PCI Express slot.
Note: DO NOT use this connector to power external equipment.

Table F11.4 External Power Connector (J4) - Connection Definitions:

1.	+12VDC
2.	Ground