KELK
A VPG Brand

ACCUBAND WIDTH GAGE

MODELS C965-A & B

Version 6.1

USER'S MANUAL

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PREVENTING ELECTROSTATIC DAMAGE

CAUTION. Electrostatic Discharge (ESD) can damage static sensitive components used in this equipment. To prevent ESD, follow the guidelines below when handling, removing, or installing electronic assemblies, boards or components.

1. Handle boards as little as possible.
2. Store and transport boards only in static shielding bags or containers.
3. Boards should only be removed from their static protective packaging by personnel wearing a grounded wrist strap.
4. When boards have been removed from the equipment or their protective packaging, do not place them on any surface other than a properly grounded static dissipative mat.
5. Before installing or removing any boards, make sure that the equipment is properly grounded.
6. Personnel installing or removing boards from the equipment should wear a wrist strap which is grounded to the equipment chassis.

Accessibility

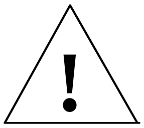
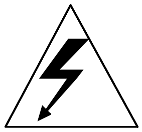
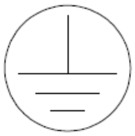
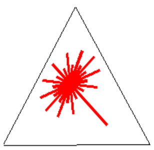
The optional electronics unit is tool accessible and should only be opened by qualified service personnel. Exercise caution while the electronics unit swing-out door is open. It is recommended that the electronics unit access door remain closed while in use to minimize the amount of contaminants allowed to enter the enclosure.

The Accuband width gage scanner power supply with optional calibrator controls, calibrator and backlight are tool accessible and should only be opened by qualified service personnel. Testing the backlight lamps, as described in Part 8 of this manual, is the only permissible user service where live voltage connections are exposed. For all other services always disconnect the power source before opening or removing covers. Do not reconnect power until closed and secured.

The maximum exposed voltage inside the scanner is 24 VDC.

Intended Use

Accuband Width Gages, Models C965-A and B, Version 6.0 are intended for the measurement of strip width in metals rolling and processing applications. Do not use an Accuband Width Gage in a manner not expressly described in this manual or approved by authorized KELK personnel or their agents. The outputs and the alarms will be unpredictable and both Accuband and the equipment to which it is connected may be damaged.

	Caution: Risk of injury or death
	Caution: Risk of electric shock
	Protective Conductor Terminal
	Caution: Risk of exposure to laser beam. Do not look directly into the laser. Due to its low power, accidental exposure is unlikely to cause injury to skin or eye tissue. Failure to comply with this warning may result in eye damage. MAXIMUM POWER OUTPUT=10mW
	Electrostatic discharge (ESD) can damage static sensitive components used in Accuband Width Gages. To prevent ESD, follow the guidelines given in Part 8, Maintenance, when handling, removing and installing sensitive components.

Technical Assistance

For Technical assistance on any KELK product, contact KELK at

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PART 1

ABOUT THIS MANUAL

1.1 Applicability

This manual describes the operation, maintenance and calibration of the ACCUBAND-6 series of strip width gages:

- Model C965A (Infrared)
- Model C965B (Backlight)

The sketches, drawings, and values used in this manual are for the information of the reader and not intended for procedures which are not specifically set forth.

The information provided is for operating and servicing the basic configurations of Accuband Width Gages, Models C965-A and B, Version 6.0, when used for the measurement of strip width in metal rolling and processing applications.

The basic systems may be augmented by additional features, such as an Operator's Interface or a Discrete I/O Kit. They may also be combined with a strip velocity measuring system, such as Accuspeed, for strip head and tail end profiling in an Accuband Crop Shear System. Although the Discrete I/O Kit is described in this manual, usage and operation of these additional features can be found in their corresponding User's Manuals.

If additional technical assistance is required, contact our designated agent or KELK at the address given on the title page.

PART 2

GENERAL DESCRIPTION

2.1 Principal Assemblies

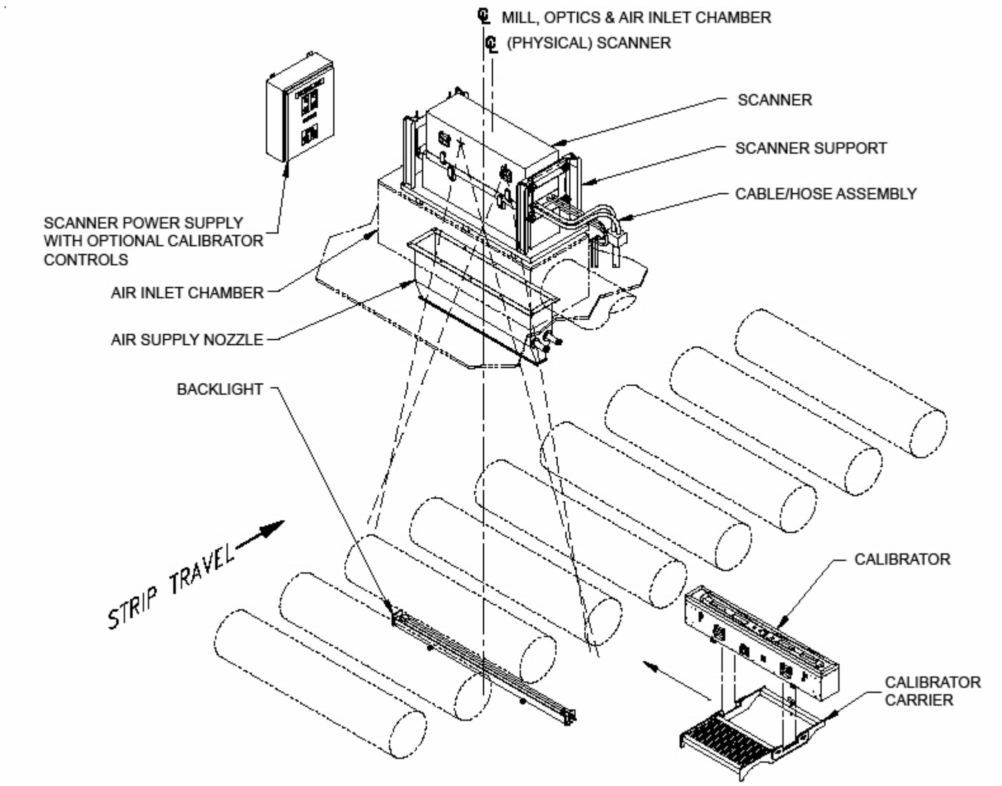


Figure 2.1 Accuband Width Gage

Accuband Width Gages, Models C965-A and B, Version 6 (Figure 2.1) employ precision optics, linear CCD array technology and stereoscopic imaging to provide fast and accurate measurement of strip width. They feature:

- Strip width, centerline deviation, and edge height measurement.
- Compensation for thermal expansion of the strip, allowing for cold width readings.
- Fieldbus I/O compatible with Windows OPC technology. An optional Discrete I/O Kit is available to users.
- On-site calibration.
- Verification of measurement accuracy with dynamic strip simulation.
- Continuous self-monitoring with software status indications.
- Diagnostics for rapid troubleshooting with optional on-line connection to KELK for technical assistance.
- Modular construction for easy maintenance.
- Rugged construction for operation in the demanding environment of hot metal rolling mills.

2.2 Theory of Operation

The Accuband width gage is designed to measure the strip accurately regardless of changes in strip position above the roll table due to hop or tilt. To accomplish this, the two cameras are offset by 22 inches (559 mm) and focused at a single point on the roll table (Fig 2.2) providing binocular vision. Each edge of the strip is scanned by both cameras, and the exact vertical and horizontal location calculated by triangulation. Since the readings are instantaneous, taken at 0.8 to 8 ms intervals, they are first filtered to prevent atypical measurements.

Edge determination, triangulation, and filtering constitute the three central functions that allow the gage to "see" and measure strip accurately.

2.2.1 Edge Determination

A hot metal strip (600 °C to 1300 °C) emits infrared radiation visible to the cameras, while cold strip (to 600 °C) can be backlight to create a silhouette. Either way, the point at which light levels jump from low intensity to high intensity indicates an edge.

To detect these transitions, the cameras scan a narrow 1 x 2048 pixel line across the path of the metal strip, generating closely spaced analog light readings-one per pixel[1]. After performing advanced processing techniques, adjacent pixels are analyzed for changes in magnitude (Fig 2.2). The gage determines an edge to be present where most of the pixels on one side of the change are "light", and most on the other side are "dark".

Rather than a sharp and unambiguous high/low intensity boundary, an edge is seen by the circuitry as a band several pixels wide of intermediate "gray" light values. Conditions external to the gage--the metal strip itself and the mill floor environment--create optical noise that reduces the edge resolution. Metal scales, reflections, jagged edges, lateral drift, strip temperature gradients, and steam can all contribute to misleading light intensity data causing an edge to smear.

The edge circuitry first isolates the edge regions calculating two "rough" edges (a left and a right) per camera, a total of four edges. With each edge located to the nearest pixel, the location is interpolated to the closest 1/32 pixel. These four interpolated edge locations are then used for triangulation and calculation of width, width deviation, and centerline deviation.

[1]A pixel is a single photosensitive element on the camera's light sensitive surface, the charge coupled device (CCD).

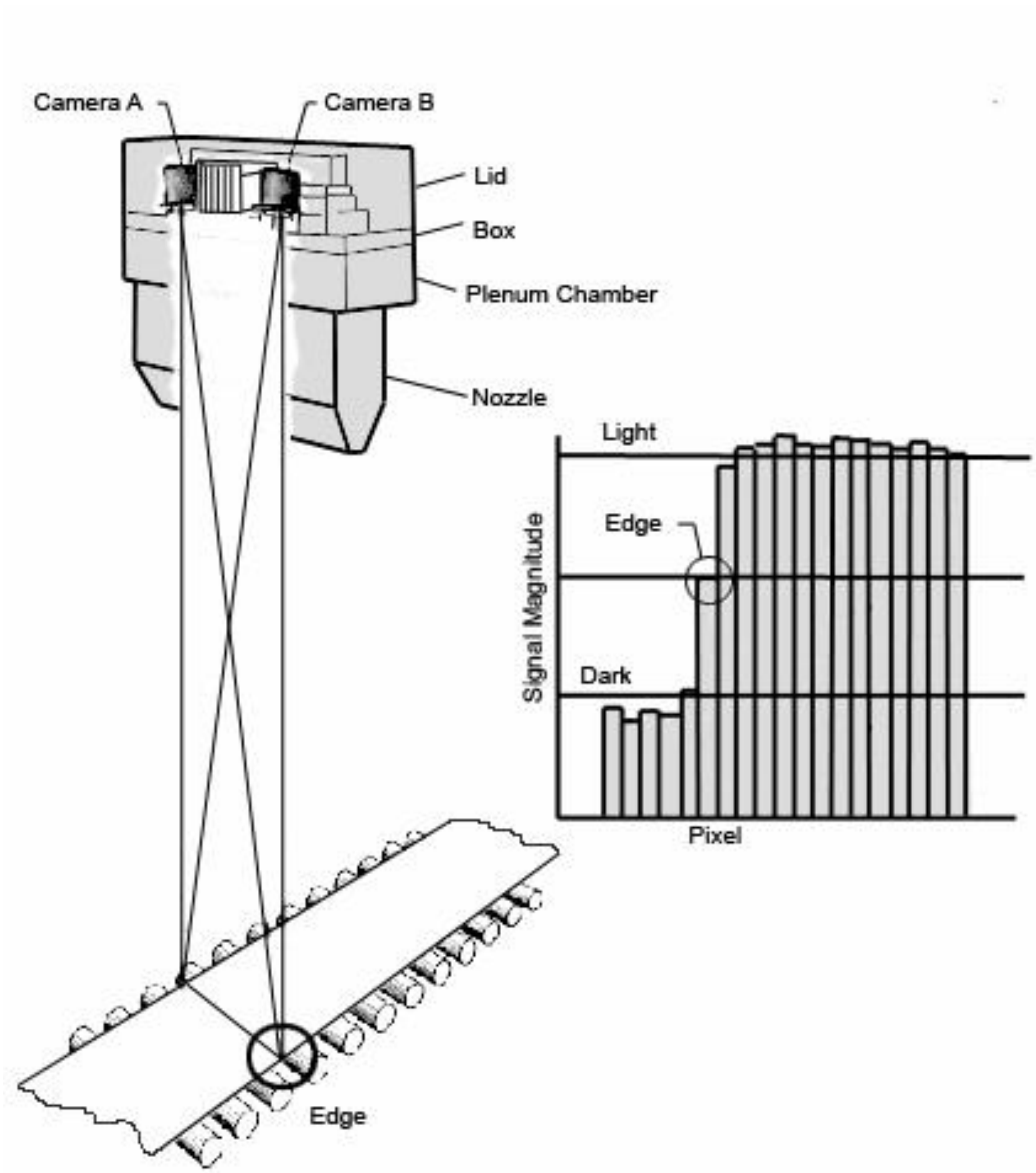


Figure 2.2 Edge Determination

2.2.2 Triangulation

The Accuband's ability to tolerate strip tilt, hop and drift from centerline depends upon the use of a two-camera scanner.

A one-camera system sees the strip as a flat two-dimensional "photo" where nearby objects seem larger, and those farther away seem smaller. A one-camera system has no way of knowing if a strip is getting wider, or is merely bouncing closer to the camera.

The use of two cameras avoids this source of width error by providing additional information. An edge is seen by two cameras from different angles; its distance from the scanner can be calculated precisely by simple triangulation, and the apparent edge position corrected accordingly (Fig 2.3).

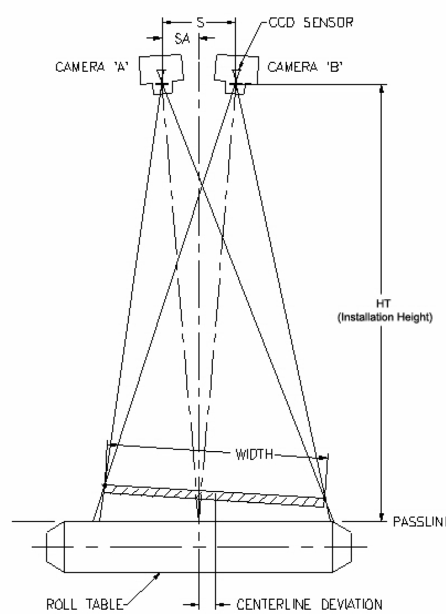


Figure 2.3 Triangulation

The straight line between two such strip edges is defined by the gage as the "width". A bowed or warped strip, of course, will appear narrower than it really is. This, however, is not the normal case and is preventable through control of the finishing roll train.

Centerline deviation is then calculated by adding the two edge positions (recorded by the gage on a common grid), and dividing by two. This averaging provides the center position of the strip. The difference between this center position to the actual mill pass line (determined through calibration) is reported as "centerline deviation."

2.2.3 Output Filtering

The width and centerline measurements are not suitable for use by the mill computer as soon as they are calculated because they are snapshots of the strip at one instant in its passage. A scan of the field of view takes about 800 μs and this instantaneous record of the strip width may be an unrepresentative view. To ensure the gage output is representative, the measurements are compared with the results of preceding scans to eliminate anomalous measurements and only then sent by the scanner to the mill's computer.

2.3 Major Components Physical Description

The basic Accuband Width Gage (Figure 2.1) comprises:

- Scanner
- Plenum Chamber
- Nozzle
- Scanner Power Supply with optional Calibrator Controls
- Backlight (Model C965-B only)
- Calibrator and Calibrator Carrier
- Operator's Interface

The scanner, sitting on the scanner support and air nozzle, is mounted 3 to 5 meters (10 to 16 feet) above the roll table. It houses two line scan cameras, which view a narrow path across the table (i.e., a line at 90° to the mill centerline), and the signal processing capability to determine strip width, centerline deviation and edge height. These measurements are accessible to the user through an Ethernet connection that implements the MODBUS TCP/IP protocol.

2.3.1 Scanner

The scanner contains two electronic cameras and all data processing electronics (Figures 2.4 and 2.5) mounted in fixed positions on a horizontal beam which is shock-mounted within a sealed metal enclosure. It is equipped with a water-cooled heat exchanger and two electric fans, and is mounted above the strip at a height sufficient to give the required field of view (typically between 4 and 5 meters for a 2000 mm width strip). A LASER is mounted on the beam to assist in scanner alignment.

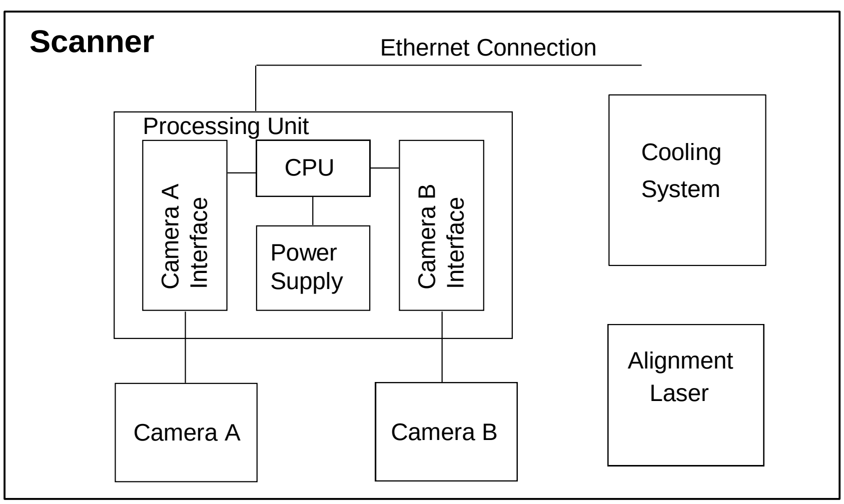


Figure 2.4 Scanner - Block Diagram

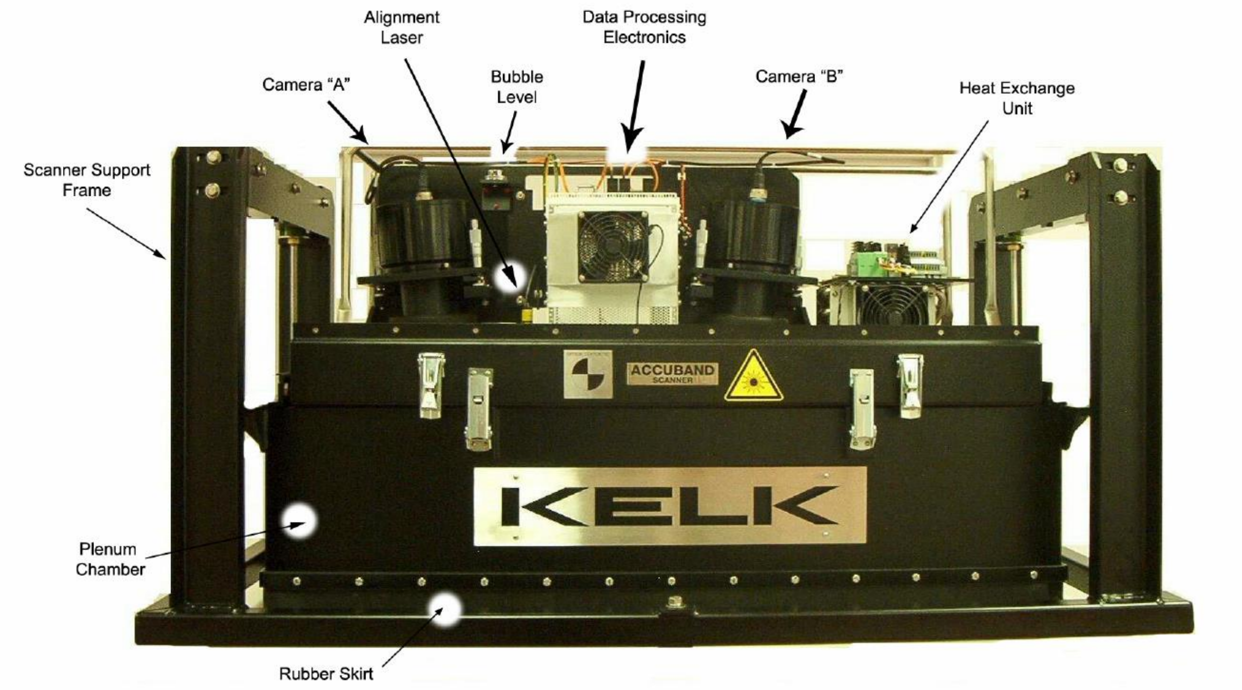


Figure 2.5 Scanner - Layout

2.3.2 Cameras

Each camera is composed of a high quality optical lens, 1 x 2048 pixel line scan CCD array, analog gain control, digitization, and signal processing electronics to determine the locations of the strip's edge on the CCD arrays. Both cameras are mounted on adjustable platforms on a rigid support beam. They are sealed from the surrounding environment and contain no user serviceable parts.

2.3.3 Processing Unit

The Processing Unit receives the edge image data from the cameras and calculates width, centerline deviation and edge height. Based on an industrial PC, it is comprised of the following items:

- Two camera interface modules that connect to the cameras via a Fiber-optic links.
- A 4 slot card cage.
- A Central Processing Unit (CPU), based on a 3U Compact PCI Industrial PC incorporating an X86 processor, solid state disc drive, and QNX RTOS operating system.
- Two ethernet ports, one for communication with the mill control computer, and the other for the optional Discrete I/O Kit.
- A power supply to regulate the 24 V DC power received from the Scanner Power Supply. Four LEDs indicate the healthy status of the power supply. Voltage outputs are +5 V, +3.3 V, +12 V, -12 V

2.3.4 Cooling System

The cooling system is comprised of an air-to-water heat exchanger. Two fans circulate the cool air through the heat exchanger, processing unit, and within the scanner enclosure. The water running through the heat exchanger is supplied by the mill and should service approximately 10 liters per minute (2.7 USGPM) at about 40 °C (104 °F). A high temperature digital output alarm warns if the internal scanner temperature exceeds 60 °C (140 °F) and will automatically shut down the gage if it approaches the level at which the cameras and/or the Processing Unit could be damaged (70 °C, 158 °F). The scanner will not turn on until the internal temperature falls below the factory preset value.

2.3.5 Scanner Laser

Camera alignment is facilitated by a CDRH Class 2, 10 mW, 635 nm solid state laser cross hair generator, mounted on the camera support beam. The laser projects a line parallel to the camera support beam, across the roll table. The cross hair has an offset to the scanner optics centerline of about 108 mm (4.25”). An LED indicator on the back of the laser is illuminated while it is operating.
The alignment laser is activated by a switch found on the scanner power supply and is indicated to be on with an amber pilot light. The switch is equipped with a lockable cover that may be secured with a padlock if required by local regulations. Relay contacts accessible in the scanner power supply can be used to control a remote user supplied and installed “Laser On” warning lamp.

2.3.6 Plenum Chamber & Scanner Support

The scanner rests on a metal plenum chamber fastened with hinges so that the scanner can be tilted upward for cleaning of the camera windows. The purpose of the plenum chamber is to keep dust from settling on the lens cover glass by providing a region/zone of clear still air. Both the scanner and the plenum chamber are supported by a heavy duty suspension system tuned to protect the scanner from shock and vibration.

Figure 2.6 Scanner Suspension

2.3.7 Nozzle

High pressure compressed air supplied by the mill is directed through a nozzle fitted below the plenum chamber to keep the camera windows clean by providing a continuous downward airflow. This also helps keep the optical path between the cameras and the strip clear of excessive fog. See Figure 2.1 for nozzle mounting location.

2.3.8 Scanner Power Supply with optional Calibration Control

The scanner power supply is contained in a NEMA 4 wall-mountable, lockable cabinet normally located in an accessible position within 10 meters (33 feet) of the scanner. It supplies regulated 24 V DC power to the scanner. Customers have the option of purchasing a scanner power supply with built-in calibrator controls, thereby saving on the need to have a separate control cabinet.

The Scanner Power Supply with Calibrator Controls (optional):

- Provides 24 V DC power to the Scanner.
- Incorporates connection points for power input/output, calibrator control and communication interface.
- Is equipped with a power switch with a green pilot light and a laser switch with an amber pilot light.
- Two selector switches are provided for the calibrator remote control: Light control switch (Low/High) and Motor control switch (Jog/Run).

2.3.9 Backlight

A backlight is supplied with model C965B gages only. If the strip temperature is 600 °C (1110 °F) or less, a backlight (Figure 2.6) is placed below the roll table to create a silhouette of the strip. It is a heavy gage metal light-box placed below the roll table to illuminate the strip edges above. It has a window along its length illuminated by two or four diffused fluorescent tube lamps behind a translucent diffuser and polycarbonate (Lexan) window, in a rugged, hermetically sealed enclosure.

The window is kept clean and cooled by a laminar flow of water from a built-in manifold, connected to the mill supply. A positive internal pressure is maintained by a connection to a mill instrument air or nitrogen supply through fittings located on the endplate.

Backlights are equipped with wheels for track mounting for easy removal to an off-line position for cleaning and maintenance.

Power is supplied to the backlight through a backlight cable and hose assembly attached to a remote junction box. The junction box is a dust-free, splash-proof enclosure; it is located away from the roll table area and is connected to the mill power supply. In typical installations, the backlight junction box can be mounted 65 ft (20 m) from the backlight.

Figure 2.7 Backlight

2.3.10 Calibrator & Carrier

The gage is calibrated, and its accuracy verified, using a calibrator (Figure 2.8) designed to simulate strip motion throughout the field of view. Calibrators are illuminated by IR emitting lamps and covered by a mask with cutouts to simulate strips of accurately known width-a total of eight edges.

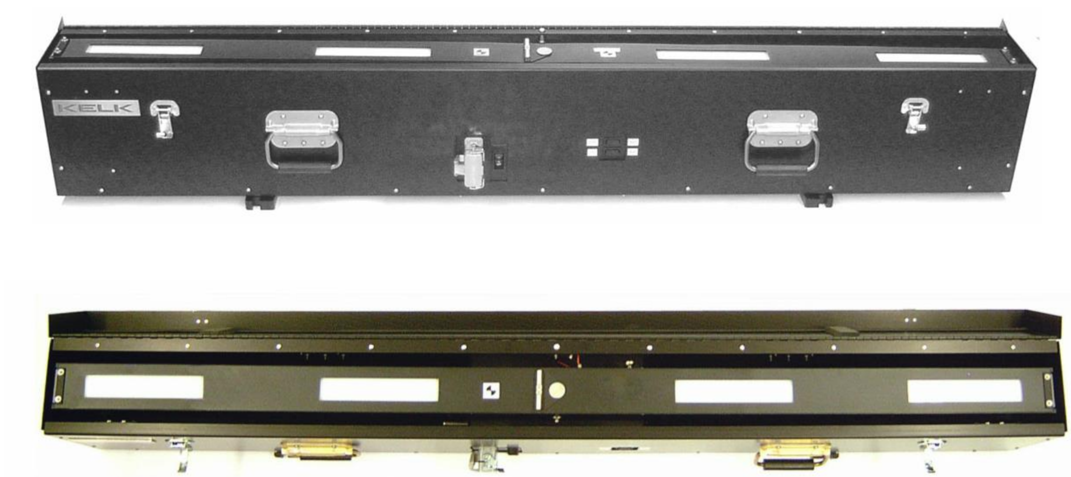


Figure 2.8 Calibrator

The calibrator is comprised of a motorized rocking beam supporting a certified mask with eight edges (formed by four rectangular slots) to simulate strips of known width. Incandescent lamps behind a translucent diffuser are mounted beneath the mask.

The mask is manufactured from Invar to minimize the effects of thermal expansion. It is supplied with a certificate of accuracy traceable to NIST.

The calibrator sits in a custom designed carrier which mounts on the roll table at the measurement site such that the mask is centered on, and its centerline is at 90° to the mill centerline.

Power for the calibrator is provided directly by the mill. Three switches are located on the calibrator for controlling its operation. A power switch (On/Off) applies power to the calibrator while the two momentary SPDT rocker switches; motor(Jog/Run) and light(Low/High) are used to adjust beam position and the light intensity of the calibrator respectively. These controls can also be accessed through a supplied calibrator control junction box or power supply.

For more information and/or procedures for calibrating the scanner, please see Part 6 of this manual.

2.3.11 Operator’s Interface

The operator's station components consist of an industrial PC, keyboard, mouse, and an LCD.

- The keyboard is for entry of nominal width and temperature correction curve number.
- The LCD monitor is for display of width and shrinkage settings, gage readings, status messages, time, and date.

PART 3

SCANNER FUNCTIONALITY

3.1 Introduction

This section of the manual describes the basic principle of gage operation and signal flow: from strip image formation on the camera's CCD arrays through to gage output. Setup and maintenance procedures are found in Parts 6, 7, 8 and 9.

3.2 Overview

The Accuband's ability to tolerate strip tilt, hop, and drift from centerline depends primarily upon the use of a two-camera scanner.

A one-camera system sees the strip as a flat two-dimensional "photo" where nearby objects seem larger, and those farther away seem smaller. Such a system has no way of determining if a strip is getting wider, or is merely bouncing closer to the camera.

By employing two cameras, Accuband 6 overcomes this problem. The cameras are mounted on adjustable platforms on a rigid support beam and are aligned at a slight angle towards each other. The cameras locate the strip edges by detecting the difference between the strip and the background. Each strip edge is seen by both cameras, offset by 22 inches (559 mm), and its position (horizontal and vertical coordinates) is calculated precisely by triangulation (Fig 2.3). The distance between the edges is the width of the strip.

The strip is scanned and its width and centerline deviation is calculated in 0.8 to 8 ms intervals. Before being presented to the mill, the data is filtered to remove errors due to any dust, water vapor, or scale coming between the cameras and the strip. Signal flow is shown in Figure 3.1. A function may be performed by a single piece of hardware or software but in many cases it is implemented as a combination of both hardware and software. This is an important concept; to understand the gage, it is necessary to recognize the interactions between the various parts of the system.

Note: In the case of a bowed or warped strip, the width may appear to be narrower than it really is. Although this is not a normal case, yet should it occur, the problem can be remedied through control of the finishing roll train.

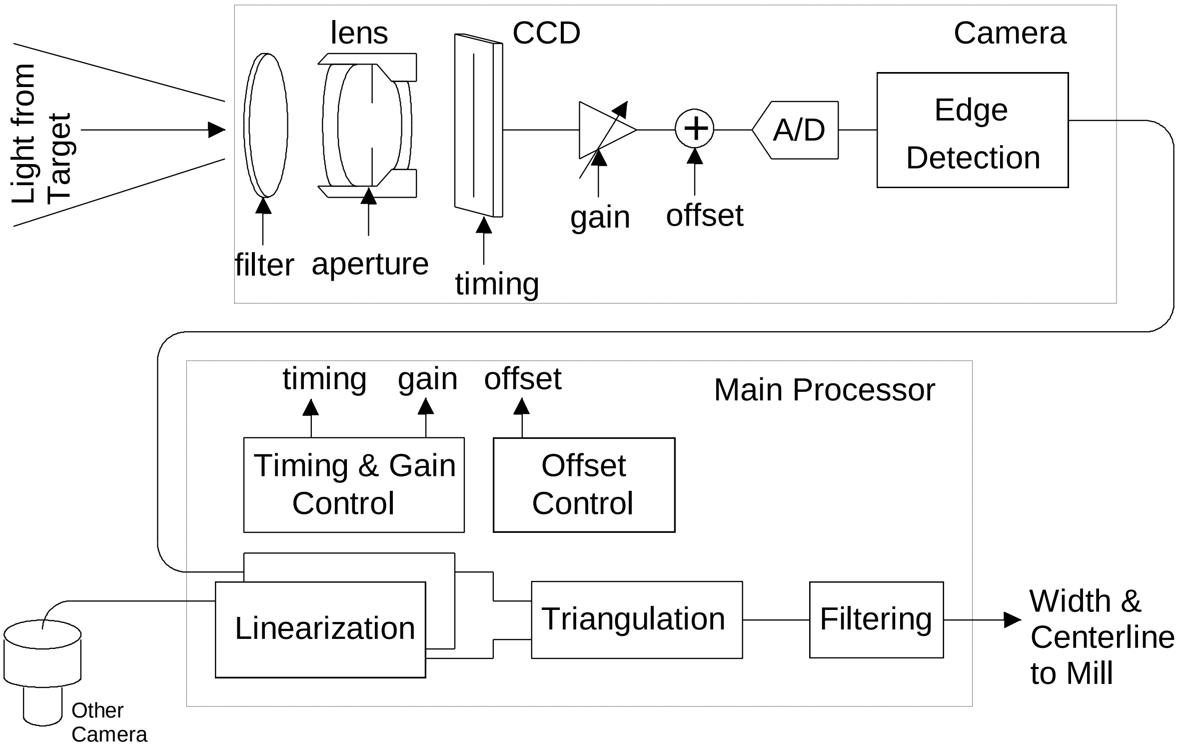


Figure 3.1 Signal Flow

3.3 Imaging

Any imaging performed by the Accuband is solely accomplished by the cameras. The two parts of the camera involved in providing a video signal at a suitable level for further signal processing include an optical component and an electronic component.

The optical component of the camera is comprised of filtering, focussing, and aperture control. The electronic part includes timing, gain, offset control, and digitization.

3.3.1 Optical Filter

Filters mounted in front of the camera lenses block unwanted wavelengths of light to provide maximum contrast between the strip and the background. For IR gages, “black” IR filters block stray visible light, while passing the IR energy from the strip. For backlight gages, “green” filters are used to pass visible light from the backlight, while blocking IR energy from the strip.

3.3.2 Focus

Each of the two lenses is manually focussed during gage setup to obtain a sharp image of the strip on the CCD array. The lenses are of a fixed focal length which is selected by KELK to provide optimum performance for each installation. Determination of the focal length to be used depends primarily on the installation height and the required field of view.

3.3.3 Aperture

Each lens contains an aperture that must be manually set to control the amount of light reaching the CCD array. They are adjusted during gage setup to optimize the range of scan integration times over which the electronic control operates as it automatically adjusts for strip temperature variations. Hotter strips require smaller apertures (i.e., higher f-stop) whereas cooler strips require a larger aperture (i.e., lower f-stop) to allow for more light exposure on the CCD, thereby lowering integration time.

3.3.4 Timing Control

The levels of the output signals from the CCD arrays are a function of light intensity and the integration time during which light is accepted. Based on information for the current scan, the main processor automatically calculates the required integration time and includes it as part of the setup message sent to the cameras for the next scan. Integration time should typically be around 1 or 2 milliseconds but it can range from tens of microseconds up to 8 milliseconds. Hotter strip requires a shorter integration time, cooler strip requires a longer integration time. As noted in section 3.3.3, the camera apertures are adjusted during gage setup to optimize integration time.

3.3.5 Gain Control

The signals from the CCD arrays are amplified to provide the best possible signals to the A/D converters. At high light levels the gain is reduced to prevent saturation and at low light levels it is increased to provide high enough edges for the edge detection system to function properly. Based on the information from the current scan, the main processor calculates the required electronic gain, and at the same time, calculates integration time to obtain an optimum signal from the next scan. The gain settings are sent to the cameras as part of the setup message for the next scan.

3.3.6 Offset Control

The zero reference or black level of the signal is a function of camera temperature and gain. In order to achieve consistent operation and preserve the dynamic range of the cameras, the offset must be adjusted during operation. This is a two part process:

1. The first few pixels in each CCD array are dummy pixels; they function exactly like the real pixels except that they receive no light. Thus, they define the black level for a scan. Their output is automatically subtracted from that of all subsequent pixels by the camera, so that “black” has a digital value of zero. This black level can be seen on the left of the alignment display as a small pedestal.

2. If the black level correction drifts too high, the useable video signal becomes compressed and the dynamic range of the camera suffers. If the black level correction drifts too low, the smaller details near the bottom of the video signal can be clipped off and lost. The camera reports the current value of the black level correction for each scan and the main processor calculates the required electronic offset to maintain a small positive black level correction for the next scan. This is sent to the camera as part of the setup message for the next scan.

3.4 Signal Processing

Signal processing takes place in the cameras (fast, fixed point, pixel-by-pixel operations) and in the main processor (slower, floating point, scan-by-scan operations).

On every scan, each camera passes several pieces of data back to the main processor such as camera status, detected edge positions, light level, and video data. The video data are not normally used by the main processor but are available for display and diagnostics.

Edge determination, linearization, triangulation, and filtering constitute the four principal functions that allow the gage to measure strip width accurately. These will be discussed in the following sections.

3.4.1 Edge Determination

Once the analog video signal has been converted to a stream of digital values by the A/D converter, a camera can perform signal processing to detect and localize the strip edges. An edge is detected where most of the pixels on one side are "light", and most on the other side are "dark" (Figure 3.2). This is true whether the application is IR (light strip, dark background) or Backlight (dark strip, light background).

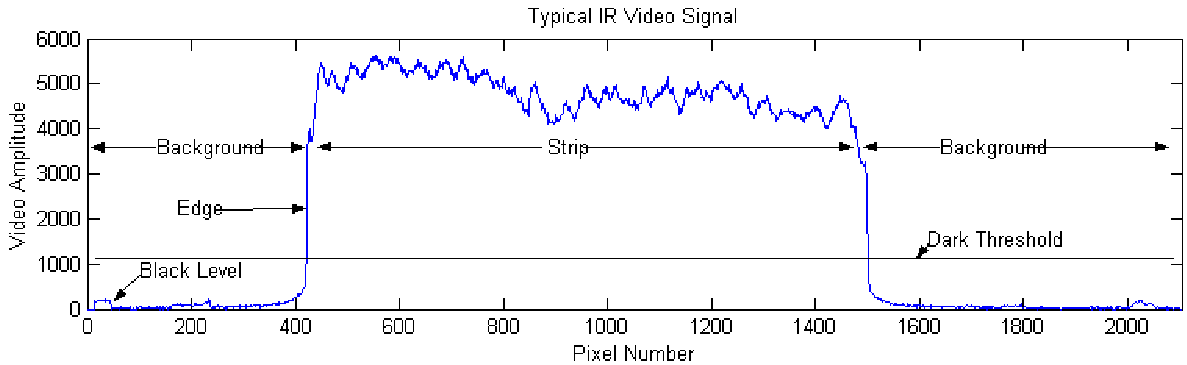


Figure 3.2 Edge Determination

Rather than a sharp and unambiguous high/low intensity boundary, an edge appears as a band, several pixels wide, of intermediate light values. Conditions external to the gage - the metal strip itself and the mill floor environment - create optical noise that reduces edge resolution. Metal scale, reflections, jagged edges, lateral drift, strip temperature gradients, and steam can all contribute to a non-ideal blurred edge. Several criteria are applied to reject invalid transitions and ensure that only real edges are processed. When an edge is detected, further processing first localizes it to a specific pixel. Data on surrounding pixels are then used to determine its position within 1/32 of a pixel. Four edges (two from each camera) are reported to the main processor for triangulation and calculation of width and centerline deviation.

3.4.2 Linearization

The edge positions reported by the cameras are measured in units of 1/32 of a pixel. They are corrected to compensate for optical and geometric distortions in the CCD sensors, the lenses, and due to the angles at which the cameras are viewing the strip. These corrections are then converted into useful physical units of millimeters. This operation is performed by the main processor using an equation incorporating constants determined during the calibration process.

3.4.3 Triangulation

The position (horizontal and vertical coordinates) of each edge, relative to the scanner, is calculated precisely by triangulation (Fig 2.3). The straight line between two such edges is the strip width. Triangulation is performed by an algorithm; defining measurement geometry, and incorporating constants determined during calibration, to achieve the highest possible accuracy. Centerline deviation is then calculated and the horizontal coordinates for the two edges (recorded by the gage on a common grid) are added and the result is divided by two to locate the center of the strip relative to the gage. Through the previous successful calibration, the gage knows the location of the mill centerline. The difference between these two locations is the centerline deviation. Because the gage used the calibrator as its reference when determining the location of the mill centerline, the accuracy of this measurement is dependent on proper positioning of the calibrator during calibration.

3.4.4 Output Filtering

The width and centerline measurements are subject to noise, both from the process being measured (dust, steam, scale, vibration, shimmer from hot air rising off the strip) and the scanner (sensor and electronic noise). A filter, employing a statistical approach is employed to provide the best possible representation of the true values of width and center line deviation, while introducing minimum processing delays. Of particular importance is the filter’s ability to reject transient errors, while accurately and quickly tracking rapidly changing edge positions.

3.5 Temperature Sensing

Three sensors monitor scanner temperatures. Each of the cameras incorporates a sensor to report its temperature as part of the camera status data. These are not precision devices so they may report a difference of several degrees between the two cameras. They do however, provide a sufficiently accurate indication of camera temperature, particularly of temperature changes. The third sensor is a bi-metal thermostat that opens and removes power to the scanner electronics if the temperature inside the scanner enclosure exceeds about 70 °C (158 °F).

3.6 Communications

The primary and preferred means of communication with the gage is through the use of the two built-in ethernet ports. One is designated as the “Host” and is used primarily for connection to the mill automation system. The other is designated for I/O purposes and is used primarily for connection to the optional Discrete I/O kit. For real-time process data (both support the Modbus/TCP protocol), refer to the Communications Protocol reference manual for further details. For maintenance and diagnostics, the Accuband 6.0 scanner supports HTTP, UDP, FTP and TELNET protocols. The optional Discrete I/O kit is controlled by the scanner using a proprietary UDP protocol.

The maintenance interface is a JAVA application that is downloaded from a web server implemented on the main processor. It can be accessed from either ethernet port and requires only a PC with a web browser and JAVA runtime engine. Refer to Part 4 for further details.

PART 4

COMMUNICATIONS

4.1 Introduction

The Accuband 6 scanner incorporates two types of communication interfaces:

- Ethernet (RJ-45) ports
- Logic Outputs

The interfaces are accessed in the scanner power supply and are normally connected to the mill control system by KELK personnel during commissioning. If modifications are subsequently required, see Section 3.6.

4.2 Ethernet Ports

The processing unit contains two ethernet ports capable of operating at 10 or 100 Mbps (See Figure 4.1):

- Primary ethernet port - for communication with the mill automation system and for access to the maintenance interface with a user supplied PC or laptop.
- Secondary ethernet port - for direct communication with the optional discrete I/O kit (Figure 4.2). See section 4.4 for more information.

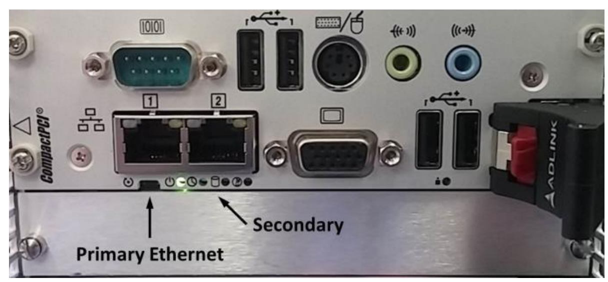


Figure 4.1 Scanner Ethernet Ports

4.2.1 Primary Ethernet Port

The primary ethernet port supports several protocols:

- Modbus/TCP - for basic process data and gage status.
- HTTP - for access to the maintenance interface.
- Telnet - for advanced setup and troubleshooting.
- FTP (File Transfer Protocol) - for advanced setup and troubleshooting.

Although all protocols can be active simultaneously, the total bandwidth is fixed and care should be exercised not to overload the network as this can increase communications latency; particularly if sharing a 10 Mbps network with other users. The Modbus/TCP protocol is described in more detail in the Accuband 6 Programmer’s Reference.

It is possible to access the gage as an OPC server under Windows via several third party Modbus/TCP to OPC translation packages.

4.2.2 Secondary Ethernet Port

The secondary ethernet port can be used to connect to the optional discrete I/O Kit (Figure 4.2). The scanner/gage operates as a master, controlling the WAGO bus coupler through a direct ethernet link.

4.3 Logic Outputs

There are two logic outputs accessible in the scanner power supply. These are as follows:

- **Scanner Power ON** - Indicated by the Form C contacts of a normally open relay and a green power-on lamp on the scanner power supply. If power is turned off, the relay is de-energized and the green power-on lamp is extinguished. If the scanner overheats, a thermostatic switch disconnects power to the processing unit and de-energizes the relay, the green power-on light remains on.

- **Alignment Laser ON** - is indicated by the Form A contacts of a normally open relay and an amber laser-on lamp on the scanner power supply. This lamp turns on whenever the alignment laser is turned on.

4.4 Discrete I/O Kit

An optional discrete I/O kit is available for communicating with the gage through analog and logic I/O's. It incorporates:

4 analog inputs - typical assignments are:

- Strip speed
- Strip temperature
- Spare inputs

4 logic inputs - typical assignments are:

- Display enable
- Metal in roughing mill
- Spare inputs

4 analog outputs - typical assignments are:

- Width deviation
- Strip centerline deviation
- Absolute width

5 logic outputs - typical assignments are:

- Strip-in-view
- Data valid
- Gage healthy
- Analog output saturated (out of range)
- Scanner temperature overheat

The discrete I/O kit may be installed in the scanner power supply cabinet or any other KELK or user supplied enclosure. Customer installation instructions are included with the kit.

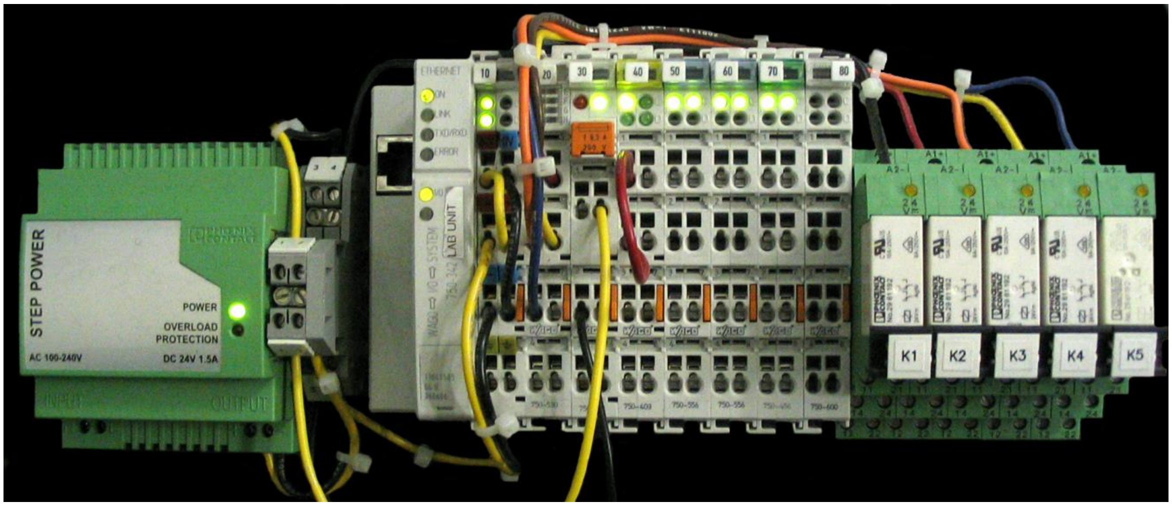


Figure 4.2 Optional Discrete I/O Kit

A typical discrete I/O kit (Figure 4.2) features the following components: power supply, discrete I/O CPU, discrete I/O modules, and dry contact relays. All inputs and outputs are mounted as individual modules that are controlled by a central I/O CPU. Each module is easily replaceable (plug & play) and requires no programming or configuring.

4.5 Wiring

Communications and logic output connection points are located in the scanner power supply (Figure 4.3). See also the corresponding Accuband interconnection diagram supplied with your system.

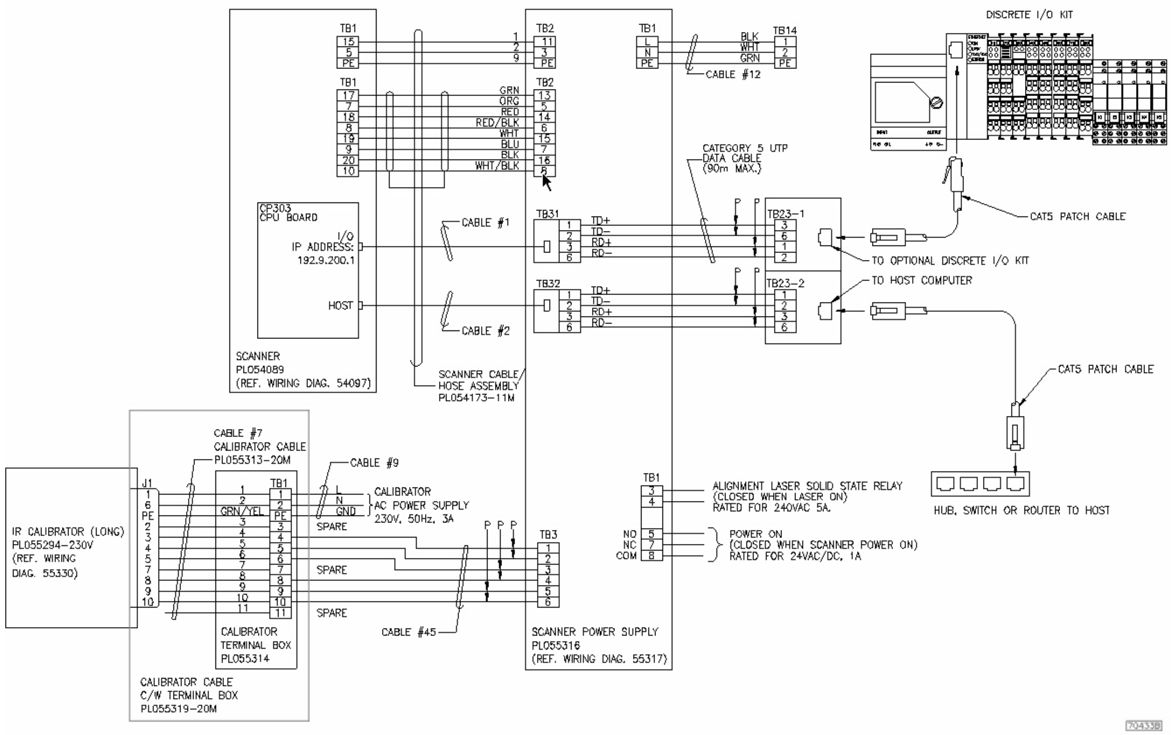


Figure 4.3 Communications and Logic Output Connection Points

All signal wiring connected to the Accuband width gage must be from SELV (Separated Extra Low Voltage) sources in accordance with IEC 61010-1 annex H, safety requirements for electrical equipment for measurement, control, and laboratory use.

Warning

Connecting to sources other than SELV may cause the application of an excessive voltage to the gage if a source malfunctions

4.5.1 Ethernet Port

The ethernet connection on the discrete I/O is a 10/100 BaseT port. RJ-45 terminal blocks are provided in the scanner power supply for direct connection to the scanner ethernet port designated for discrete I/O connection. A good quality Category 5 or 5e unshielded twisted pair data cable should be used for connection to the mill ethernet hub or receiving device. Maximum recommended cable length is 90 meters (295 ft).

4.5.2 Logic Outputs

Note: All wiring must be rated at least 300V.

- **Scanner power on indication**: Contacts TB1-5 and TB1-8 (Figure 4.3) are closed when power is ON, contacts TB1-5 and TB1-6 are closed when power is OFF. Contact rating is 24 VAC/DC, 1A. Refer to the cable list supplied with your system for recommended cable type.

- **Remote laser on indication**: Contacts TB1-3 and TB1-4 (Figure 4.3) are closed when the laser is ON. Contact rating is 240 VAC, 5 A. Refer to the Cable list supplied with your system for recommended cable type.

4.5.3 Discrete I/O

Wiring requirements for connection to the discrete I/O are dependent upon the output assignments. Refer to the instructions supplied with the kit. See also the corresponding Accuband interconnection diagram supplied with your system.

4.5.4 Direct Maintenance Connection

During regular maintenance where calibration is to be verified, it may be more convenient to connect a laptop directly to the scanner. Since the user is stationed close to the scanner, the effects of making small modifications to the scanner/camera alignment can be viewed on the laptop instead of having to commute to the control room. The following procedure will configure a laptop to communicate directly to the scanner.

Windows XP users:

1) Acquire IP address of the scanner (Located on Scanner Configuration Form)

2) Click ‘**Start**’-----▹ ‘**Control Panel**’-----▹ ‘**Network Connections**’

3-5) Refer to Figure 4.4

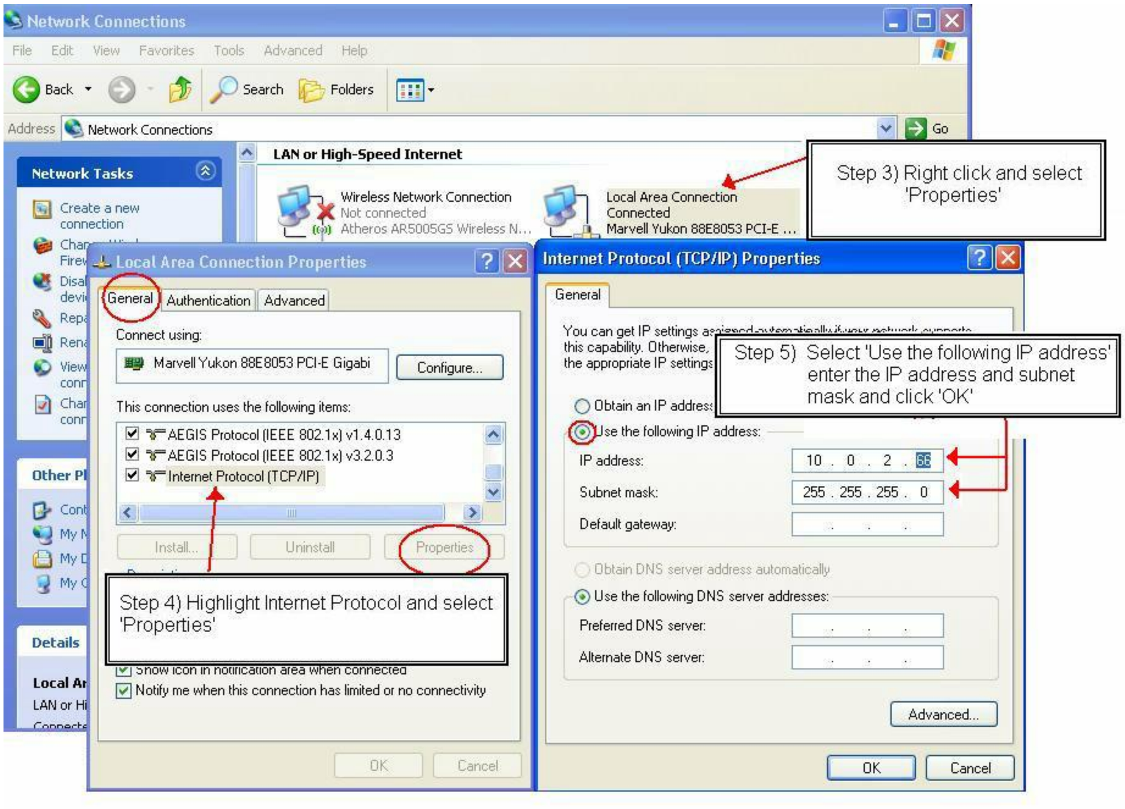


Figure 4.4 IP Modification

6) Select '**Use the following IP address**' and enter a valid IP address and Subnet mask. Select '**OK**' in the '**Internet Protocol Properties**' window and then click close in the '**Local Area Connections**' window.

Windows 2000

1) Click ‘**Start’**-----▹‘**Settings**’-----▹ **‘Network and Dial-up Connections**’

2) Right-click ‘**Local Area Connection**’ and then click **‘Properties**’

3) Click the **‘General**’ tab, and then check that **‘Client for Microsoft Networks**’ and ‘**Internet Protocol (TCP/IP)**’ are visible.

4) Click ‘**Internet Protocol (TCP/IP)**’-----▹'**Properties**’

5) Select ‘**Use the following IP address**’ and enter a valid IP address and Subnet mask. Select ‘**OK**’ in the ‘**Internet Protocol Properties**’ window and then click close in the ‘**Local Area Connections**’ window.

NOTE: In order to be able to utilize the Maintenance Interface a Java Runtime Engine must be installed on the laptop. (See section 5.2 for instructions.)

Once the IP address has been configured properly, open an Internet browser and input the IP address of the scanner in the address field. The Java application will begin to run and a login prompt will appear. Once logged in, the user will be able to view the functionality of the scanner directly on the laptop.

Note

If communication cannot be established, it may be necessary to temporarily disable any software firewall that may be running.

PART 5

MAINTENANCE INTERFACE

5.1 Introduction

The Accuband 6 scanner includes a pre-installed user maintenance software incorporating several windows for use during calibration, setup and maintenance. The maintenance interface runs on a JAVA platform and can be executed from any web browser using Microsoft Windows. The maintenance software user interface is programmed directly into the scanner (recorded on a Compact Flash memory card) and can be executed on any Internet browser on the scanner's network. This is greatly desired as it eliminates the need of installing any proprietary software on each computer.

5.2 Access

The Maintenance Interface is web based and can be accessed by any PC or laptop with a web browser and a JAVA Runtime Engine. The JAVA Runtime Engine can be acquired free at http://www.java.com. Follow the instructions on the web site to install it.

To launch the Maintenance Interface:

- Establish a connection between a PC or laptop and the gage primary Ethernet port, either directly via a RJ-45 cross-over cable (in which case it will be necessary to temporarily disconnect the host communications link) or via a network connection.

- Ensure that your PC's network configuration is appropriately configured to communicate with the scanner. See the **Gage Configuration** form for the scanner's IP address.

- After Launch a Web browser and go to http://<IP-Address>, where <IP-Address> is the primary port assigned to the gage and is given in the Gage Configuration form.

- a short delay, the Maintenance Interface is automatically downloaded from the gage. A login window will appear with *Operational*, *Maintenance* and *Administrative* login options. For differences between the three types of login, see Table 5.1. The Maintenance and Administrative logins are password protected and are provided by KELK to qualified personnel during commissioning. This prevents any unintentional tampering or modifying of scanner parameters that may restrict proper functionality of the Accuband system.

TAB ID	OPERATIONAL	MAINTENANCE	ADMINISTRATOR
Measurement	X	X	X
Gain Status	X	X	X
Alignment	X	X	X
Width Verification	X	X	X
Communication	X	X	X
System Status	X	X	X
Edges		X	X
Setup		X	X
I/O Scaling		X	X
Temperature Curves		X	X
Calibration		X	X
Logger			X
Filter Parameters			X
Velocity		X	X

Table 5.1 Maintenance Interface Access Levels

5.3 Maintenance Interface Windows

The Maintenance Interface is arranged as a series of windows accessible via tabs across main window. Selecting one of these tabs with the mouse will display various statistics whether they can be read-only values or user configurable.

The following sections of this manual will provide all of the information necessary to understanding the usage and operation of the Maintenance Interface**.** Throughout the following sections, when referencing to text within the interface, ***BOLD ITALIC*** font will be used.

> It is important to note that many parameters in the Maintenance Interface are strictly used for KELK Developers and Application Specialists. Such parameters serve the user no purpose in maintenance and operation of the Accuband scanner and so may be briefly described or omitted from the following sections of this chapter.

All units displayed are metric and displayed in millimeters (mm) unless otherwise noted.

5.3.1 Measurement

The Measurement window (***Measurements***), Figure 5.1, displays measurement results and system status to the operator.

Figure 5.1 Measurement Window

The graphical plot displays measured width and centerline deviation while a strip is in view. In addition, a strip-in-view logic (0- no material present) or (1-material in view) is displayed to represent when material is in view of the cameras. Left clicking on any of the items in the plot legend will auto-scale the y-axis. Left clicking on one of the y-axis scales will rescale the axis back to “full range.”

Strip measurements are displayed numerically (in millimeters) down the left side of the window and are as follows:

Item	Description
Width T.C.	Displays the instantaneous temperature compensated (COLD), width reading.
Width	Instantaneous hot strip width measurement.
CLD	Centerline Deviation.
Edge Height A	This refers to the distance from Camera “A” optics to the closest edge of the strip.
Edge Height B	This refers to the distance from Camera “B” optics to the closest edge of the strip.
Temperature Curve	Reports the number of the alloy expansion curve currently being used to compensate for thermal expansion. A value of 0 indicates that compensation is disabled.
Temperature	Current strip temperature reading. The Accuband scanner does not have any non-contact temperature sensors and so all readings must be done by mill supplied equipment; i.e., pyrometer.
Speed	Displays the speed of the strip under the scanner in meters per second.

Table 5.2 Measurement

System status information is displayed across the bottom of the window. These indicators display the current status/condition for a variety of items and greatly assist in troubleshooting. Each item is highlighted a particular color that represents its current status: Green (Healthy), Yellow (Warning), or Red (Problematic). Status indicators that are red should be attended to as quickly as possible in order to ensure non-interrupted operation.

Table 5.3 lists the status indicators that are present in the Maintenance Interface.

Status Indicator	Description
SIV	Illuminates green when strip is in view of the scanner.
DATA VALID	Indicates when at least two valid edges have been detected for each camera and if camera confidence level is greater than 60%.
HEALTHY	Illuminates green if the scanner is ready to measure and no errors are present on the scanner, camera, I/O, etc…
IO OVERFLOW	A measurement beyond the scaling of the I/O has occurred. Analog output is out of range.
CAMERA OVERHEAT	Illuminates when either scanner camera A or B temperature is too high.
WIDTH	Width measurement out of range. User set limits.
CLD	Centerline deviation measurement out of range. User set limits.
TEMPERATURE	Strip temperature input out of range. User set limits.
VELOCITY	Velocity input out of range. User set limits.
EDGE HEIGHT	Edge height of one of the cameras is out of range. User set limit.
IO_ONLINE	Indicates whether or not the I/O is functioning properly.

Table 5.3 Status Indications

Bar Simulation

In the latest revisions of the software a ***Bar Simulation*** mode has made his apparition, simulating the passage of one or many strips.

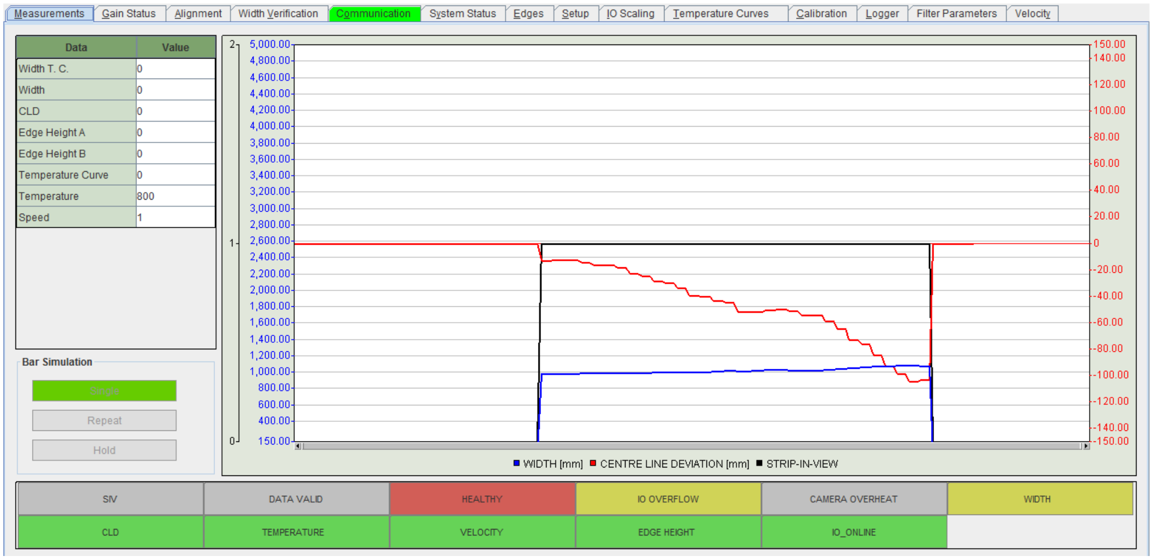


Figure 5.2 Bar Simulation

Boxes	Description
Single	Simulate a single strip
Repeat / Stop	Simulate many strips / Stop the simulation of many strips
Hold / Continue	Hold the current width / Resume the Simulation (Both commands are only available during the simulation of many strips)

Table 5.4 Bar Simulation

WARNING!

Enabling ***Bar Simulation*** mode will place the scanner in an **unhealthy** state. Ensure that you stopped the simulation mode before leaving the tab.

5.3.2 Edges

The Edges window (***Edges***), Figure 5.3, displays the interpolated camera edge positions to 32nds of a pixel (see section 2.2.1 for more information). By interpolating between pixels, high edge position accuracy is attainable. As a result, the 2048 pixels accuracy of the CCD increases to 65536 pixels through the use of software interpolation. Figure 5.3 displays the pixel number (within the 65536 range) of the located edge of each CCD camera. This figure displays the typical number of edges expected when the calibrator is in view. The top windows indicate that eight edges have been detected by each camera. For example, if four edges were detected, then the first top left four boxes will be populated with pixel numbers.

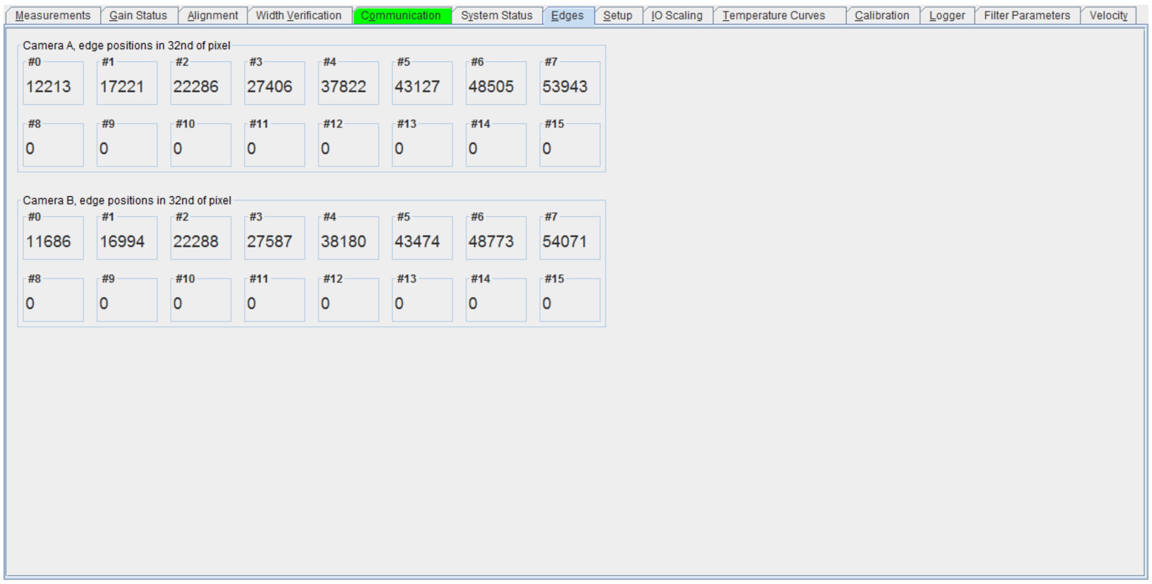


Figure 5.3 Edges Window

5.3.3 Gain Status

The Gain Status window ***(Gain Status)***, Figure 5.4, displays camera scanning statistics temperature, serial number, and revision. This window is useful in monitoring the gain and integration time for each camera over the entire length of the strip. The top half of the window displays camera "A" statistics and the bottom half displays camera "B".

Although many fields in this tab view are for KELK usage, special attention should be given to ***TEMP/ST***. These two fields specify the temperature and software revision of each camera. Since the cameras are enclosed and sealed, they will measure approximately 5 degrees Celsius more than that of the surrounding air inside the scanner.

As discussed in Chapter 3.5, the scanner will warn the user when the temperature approaches its shutdown temperature of about 70 °C (158 °F). The system monitors both camera temperatures and signals an overheat alarm when the highest of the two approaches the shutdown temperature.

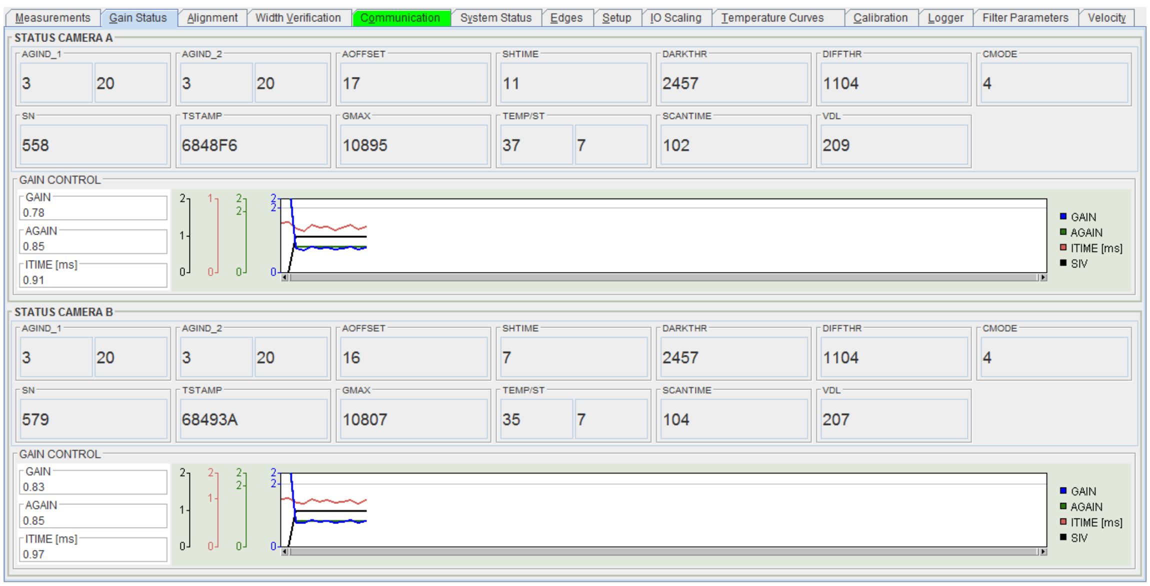


Figure 5.4 Gain Status Window

Item	Name	Description
AGIND_1	Analog Gain 1	Gain to be used during readout of first half of CCD
AGIND_2	Analog Gain 2	Gain to be used during readout of second half of CCD
AOFFSET	Analog Offset	Offset Adjustment for CCD signal processor
SHTIME	Shutter Time	Time electronic shutter on CCD is closed
DARKTHR	Detection Threshold	Level above which video data is considered to be light
DIFFTHR	Step Height	Minimum change in video level required to validate edge position
CMODE	Camera Mode	Transition/edge, normal/test, smoothing on/off
SN	Serial Number	Camera Serial Number
TEMP/ST	Temperature	Camera Temperature / Camera Firmware Revision
SCANTIME	Integration time	Time required for CCD to charge. Inversely proportional to the amount of light falling on the sensor. ***(ITIME (ms) * 100)***
VDL	Video Dark Level	Digital level representing no light
GAIN	Camera Gain	Camera gain as a combination of integration time, analog gain, and shutter time.
AGAIN	Camera Analog Gain	Combined Analog Gain value of ***AGIND_1 & AGIND_2***
ITIME (ms)	Integration Time	Time required for CCD to charge. Inversely proportional to the amount of light falling on the sensor.

Table 5.5 Gain Status

5.3.4 Setup

The Setup window ***(Setup)***, Figure 5.5, displays various camera gains and setup statistics. This window is primarily to be used by KELK personnel to setup and configure the Accuband scanner during commissioning.

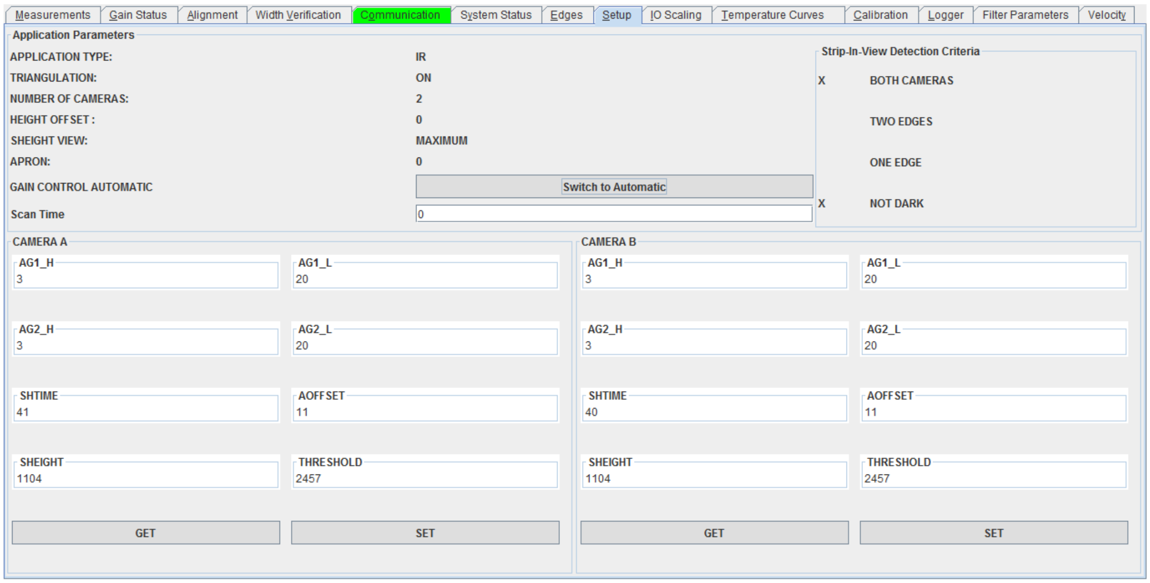


Figure 5.5 Setup Window

The bottom half of Figure 5.5 contains manual gain value settings for the cameras. Since the Accuband scanner primarily operates with an automatic gain control, there is no need to adjust any values. The top half of the window displays mode settings of the scanner with respect to its installation location. Description of the parameters is as follows:

APPLICATION TYPE: Specifies whether or not the scanner is set up to operate in Infrared or Backlight mode.

TRIANGULATION: Whether or not scanner triangulation is enabled.
Default = ON. Turning this option off is not advisable and will cause the scanner not to compensate for any bar hopping.

NUMBER OF CAMERAS: Specifies how many cameras are used for width measurement. Default = 2.

HEIGHT OFFSET: Specifies the height in millimeters between the calibrator mask and the top of the mill rolls. This value is currently not used in the Accuband system.

SHEIGHT VIEW: Specifies the vertical distance from the optical centerline sticker (located on the scanner) to the top of the calibrator mask.

APRON: In Backlight mode, the scanner measures any width that is silhouetted against the backlight. When no material is present, the scanner can easily measure the apron plate and produce an unwanted measurement. By recording the apron plate width, the scanner will avoid any measurements less than or equal to the apron plate value.

GAIN CONTROL AUTOMATIC/MANUAL: Specifies whether the scanner gain control is set to automatic or manual.

SCAN TIME: Allows the user to input an integration time for the cameras when operating in manual mode.

STRIP-IN-VIEW DETECTION CRITERIA: Specifies what criteria is used for detecting when strip is in view. For Backlight applications, it is advisable to have ***"ONE EDGE"*** selected because strip-in-view should enable when either camera detects an edge. For Infrared applications, ***"NOT DARK"*** is used as the criteria to trigger strip-in-view when visible light (from the strip) is detected.

5.3.5 Alignment

The Alignment window (***Alignment***), Figure 5.6, displays the video signals from the cameras, along with information related to camera alignment. This window is used during calibration (Section 6.1).

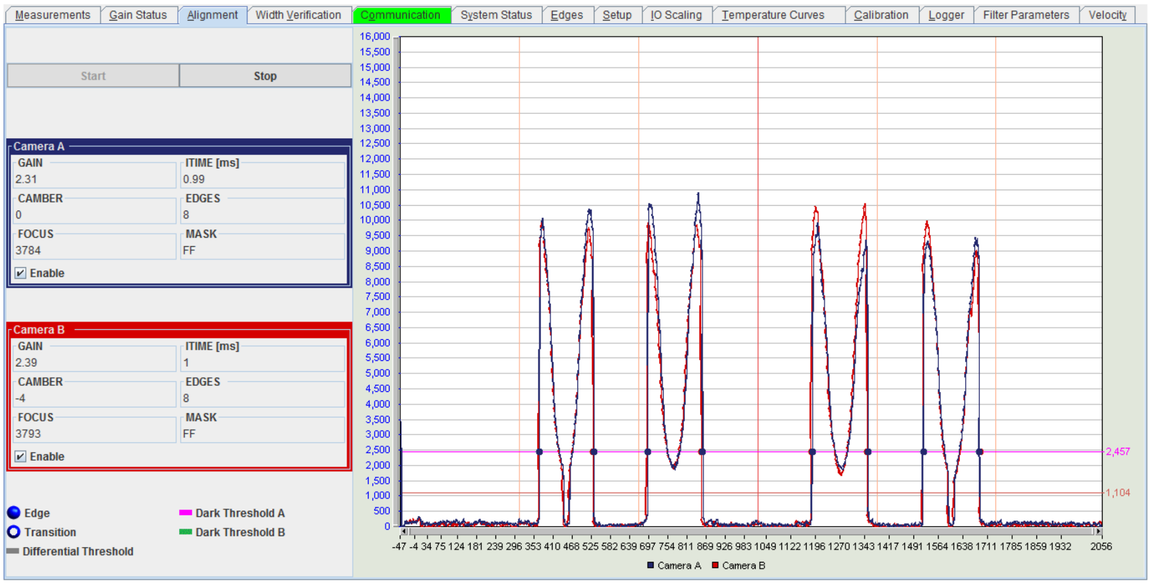


Figure 5.6 Alignment Window

To display the video signals, select the required ***CAMERA A*** and/or ***CAMERA B Enable*** check boxes and press the ***START*** button. As this function requires considerable processor and communication bandwidth, deactivate it by pressing the ***STOP*** button when it is not needed. To adjust the display:

- Double click on the pan bar at the bottom of the display to show all edges.
- Zoom the display by dragging inwards the ends of the pan bar.
- Pan the display by dragging the middle of the pan bar.

The x-axis of the plot window displays the video signal located along the 2048 pixel CCD. The y-axis is a representation of the digital count of the Analog to Digital converter.

When an edge is detected in the video signal, the scanner will indicate the signal with a filled circle shape located at the “Dark” threshold line. Transitions are indicated with an empty circle shape and will only be displayed depending on the mode the scanner is in. At times it may be difficult to differentiate between the filled and empty circles shape and may require the user to zoom in for better resolution.

Figure 5.6.1 displays instantaneous camera statistics with respects to the current/present measurement. Description of each is as follows:

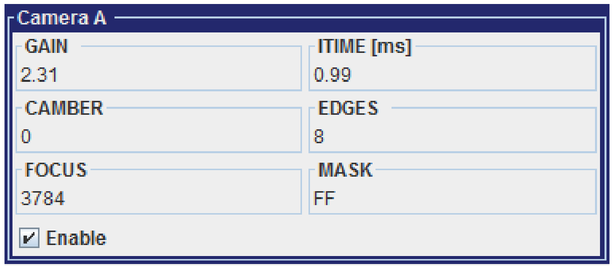


Figure 5.6.1 Alignment - Camera Stats

GAIN: Camera gain as a combination of integration time, analog gain, and shutter time.

ITIME [ms]: CCD integration time.

CAMBER: Displays camera camber alignment. See *Calibration* (Chapter 6) for more information.

EDGES: Indicates the number of edges detected by the camera.

FOCUS: Displays camera focus adjustment. See *Calibration* (Chapter 6) for more information.

MASK: Specifies edge detection criteria for the calibrator mask. This applies when performing calibration and specifies which edges of the mask to avoid and which to detect. FF(hex) in binary represents 11111111. The calibrator mask is composed of 8 edges, each represented by a 1. To instruct the scanner to avoid the outer two edges of the calibrator on both sides, the binary mask must be changed to 00111100, or 3C in hex. By default, the mask is always set to FF.

5.3.6 I/O Scaling & Diagnostics

The I/O scaling window (***IO Scaling***), Figure 5.7, allows the user to fully test and scale the analog and digital input/output of the optional discrete I/O (Section 7.3.2). See Part 4, Communications, for more information on the I/O system.

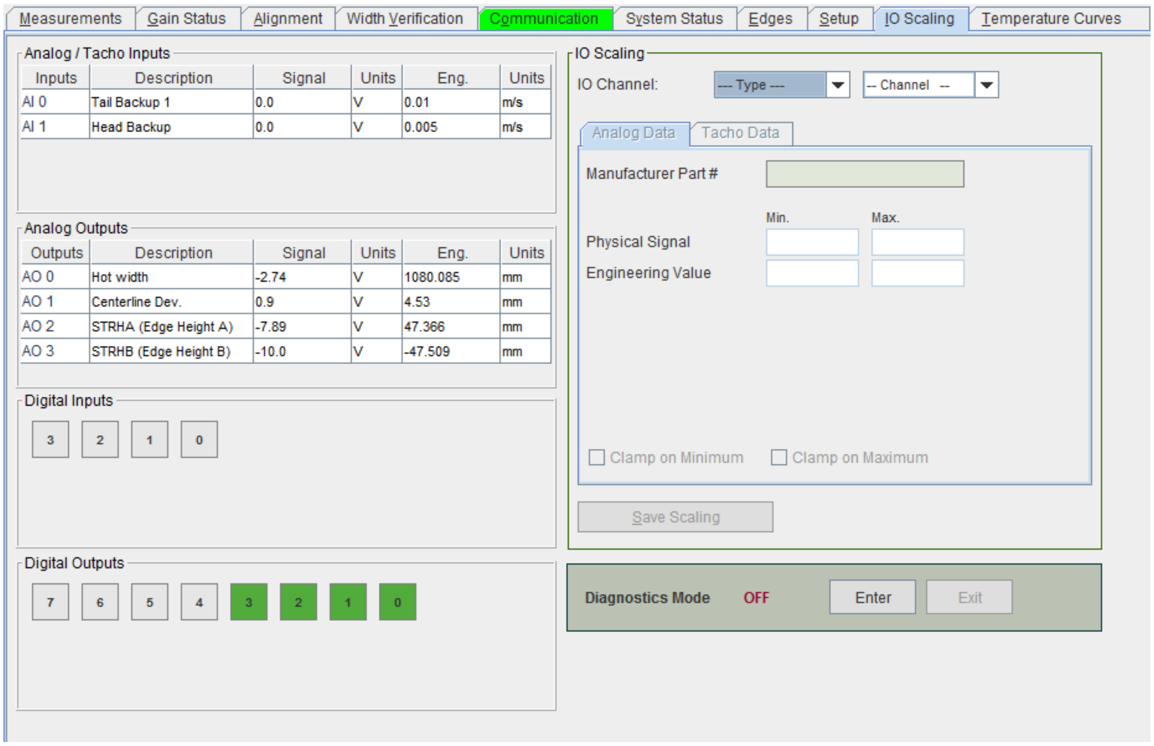


Figure 5.7 Scale Factors Window

The I/O scaling window is divided into two sections; the left side is a view of the Analog and Digital Inputs and Outputs, while the right side is used for the scaling and testing.

Analog Inputs & Outputs

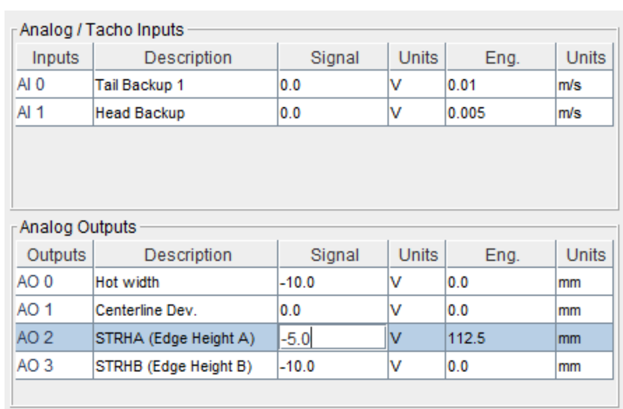


Figure 5.7.1 Analog Inputs & Outputs

This area gives the user a view of the value of the Analog Inputs and Outputs in real time. In testing mode, it is possible to change the ***Signal*** value of the Analog Outputs.

Item	Description
Inputs / Outputs	Number of the Input or Output
Description	Description of the signal
Signal	Analog Value
Units	Unit of the Analog Value
Eng.	Engineering Value
Units	Unit of the Engineering Value

Table 5.6 Analog Inputs/Outputs

Analog outputs are used to provide the customer with data such as Absolute Width, Width Deviation, and Centerline Deviation. Additional outputs can be provided depending on the installation.

Analog Input Scaling Example: If an analog input is configured as a velocity input where velocity ranges from -5 m/s to +5 m/s with a -10 to +10V scaling, then at 2.5 m/s the two fields ***Signal*** and ***Eng.*** in the Analog view area, will respectively display the values **+5** and **2.5**

Digital Inputs & Outputs

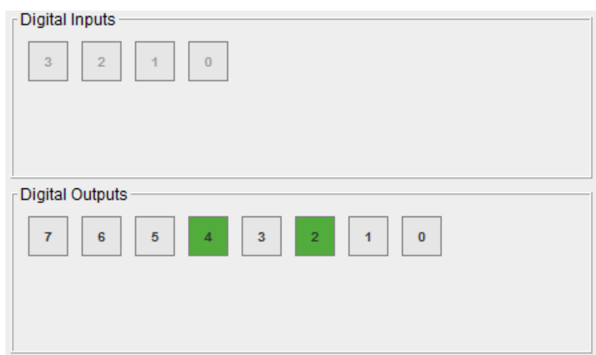


Figure 5.7.2 Digital Inputs & Outputs

This area gives the user the state of the Digital Inputs and Outputs in real time.

Status of digital outputs is indicated by an illuminated *Green* box corresponding to the output (the dry relay contact is enabled). Users can test the digital outputs in diagnostic mode, by clicking on the corresponding digital output channel. It will change from green to grey as it changes from 1 to 0 and vice versa.

IO Scaling

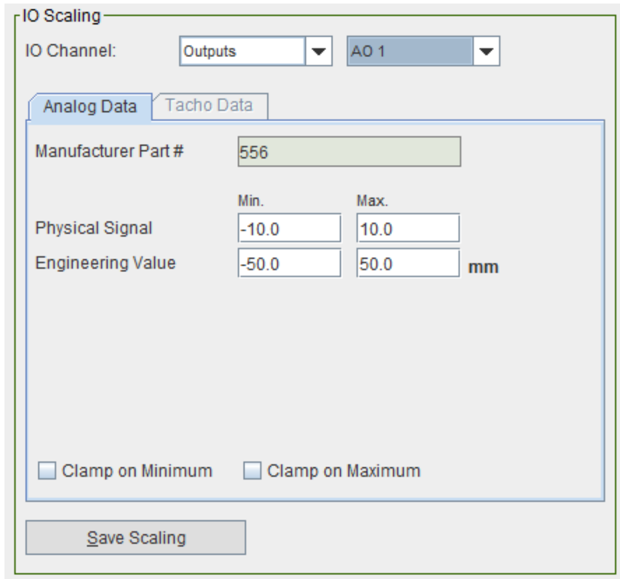


Figure 5.7.3 IO Scaling

This area allows the user to configure the Analog Inputs and Outputs seen in the lefts side of the screen (Figure 5.7.1).

At the top of the area you can select the Analog signal you would like to configure, selecting first, if it is an Input or an Output, and then its number.

The Physical and Engineering value of the selected analog signal will then appear below. The Engineering Value is the physical interpretation of the physical analog value

Once you entered the wanted values, just click on the ***Save Scaling*** box, any changes to the analog output / input scaling will take effect immediately. For more information regarding the scaling of the analog inputs and outputs, see Chapter 7 of this manual.

> **Analog Output Scaling Example:** Assume that a centerline deviation (analog output channel 1) of 5 cm in both directions is to be represented by +10 to -10V. In the IO Channels pull down menus, select Outputs, then AO1 (Figure 5.7.3) and enter -10 as Minimum Physical Signal, 10 as Maximum Physical Signal, -50 as Minimum Engineering Value and 50 as Maximum Engineering. Units for centerline deviation are in millimeters.

Diagnostic Mode

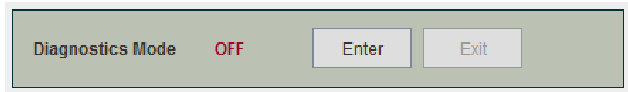


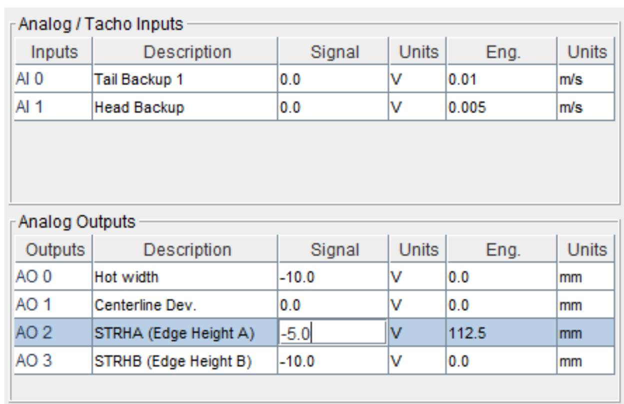
Figure 5.7.4 Diagnostic Mode

This area allows the user to Enter or Exit the Diagnostic Mode. A visual indicator ON/OFF indicates the user if he is or not in Diagnostic Mode

WARNING !

Enabling ***Diagnostics Mode*** will place the scanner in an **unhealthy** state. Ensure that the ***Diagnostics Mode*** is OFF, when testing is complete.

Once you entered in the diagnostic mode, Analog outputs can be tested by entering a count value within the limits of the AO, in the ***Signal*** column (See figure 5.7.5). For example, entering a value of -5 under AO2 will output -5 volts on channel 2, and generate the corresponding engineering value.



Analog / Tacho Inputs

Inputs	Description	Signal	Units	Eng.	Units
AI 0	Tail Backup 1	0.0	V	0.01	m/s
AI 1	Head Backup	0.0	V	0.005	m/s

Analog Outputs

Outputs	Description	Signal	Units	Eng.	Units
AO 0	Hot width	-10.0	V	0.0	mm
AO 1	Centerline Dev.	0.0	V	0.0	mm
AO 2	STRHA (Edge Height A)	-5.0	V	112.5	mm
AO 3	STRHB (Edge Height B)	-10.0	V	0.0	mm

Figure 5.7.5 Analog Output Testing

5.3.7 Temperature Curves

The Temperature Curves window (***Temperature Curves***), Figure 5.8, allows the user to enter and select alloy expansion curves for the compensation of thermal expansion. See sections 7.3.1 and 7.4.2 for more detail and instructions on how to set up correction curves.

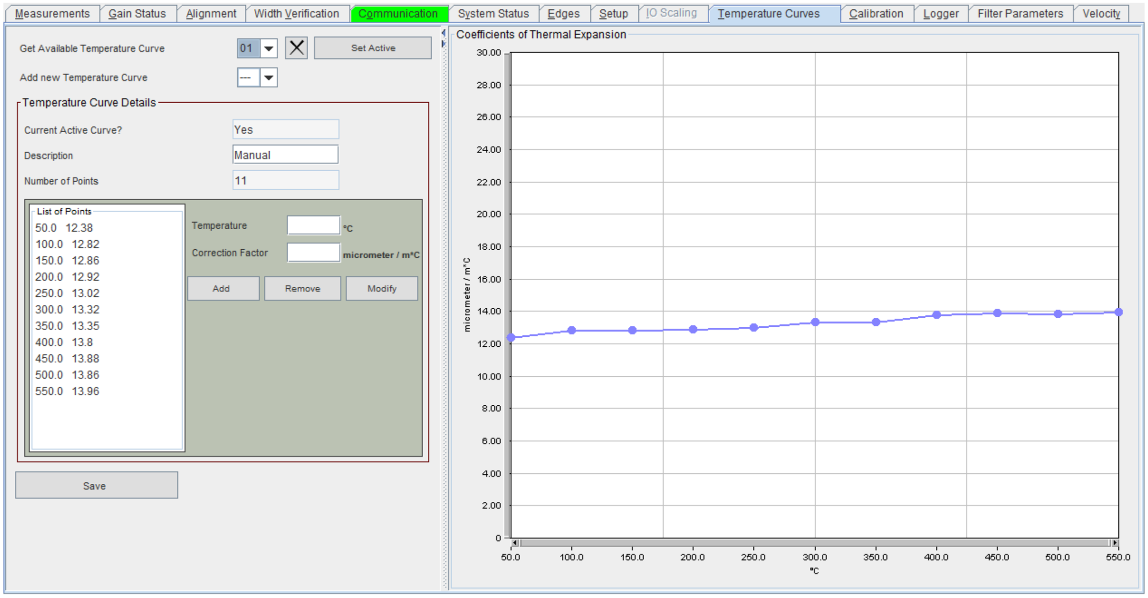


Figure 5.8 Temperature Curves Window

The number of the curve currently displayed will appear either in the first or the second roll menu, at the top left of the page. The curve currently active is the one for which the number is highlighted in green in the ***Get available temperature curve*** roll menu. By default, the curve 00 (no expansion correction) is active, and you can make any curve becoming active just by selecting it in the ***Get available temperature curve*** roll menu and then clicking on the ***SET ACTIVE*** button.

When a curve has been selected using the roll menu, you'll have access to its status (Active, Yes or No), its description, the number of points it is made of and the list of points in the tab below. The ***Temperature*** is displayed in the left column and the ***Correction Factor*** in the right column; their respective limits are 0-3000°C and 5.0-30.0 µm / (m °C).

You can manage the points in the tab by using the checkboxes, Add, Remove and Modify. Selecting an existing point in the list, will allow you to either remove or modify it. You can add a new point; just by filling in the temperature and the correction factor fields and then pressing ***Add***.

Once the curve is set, you can save it, by clicking ***Save***, it will automatically sort by ascending order the points.

5.3.8 Calibration

The Calibration window (***CALIBRATION***), Figure 5.9, is used to perform calibration of the Accuband 6.0 scanner. See Part 6 for a detailed calibration procedure.

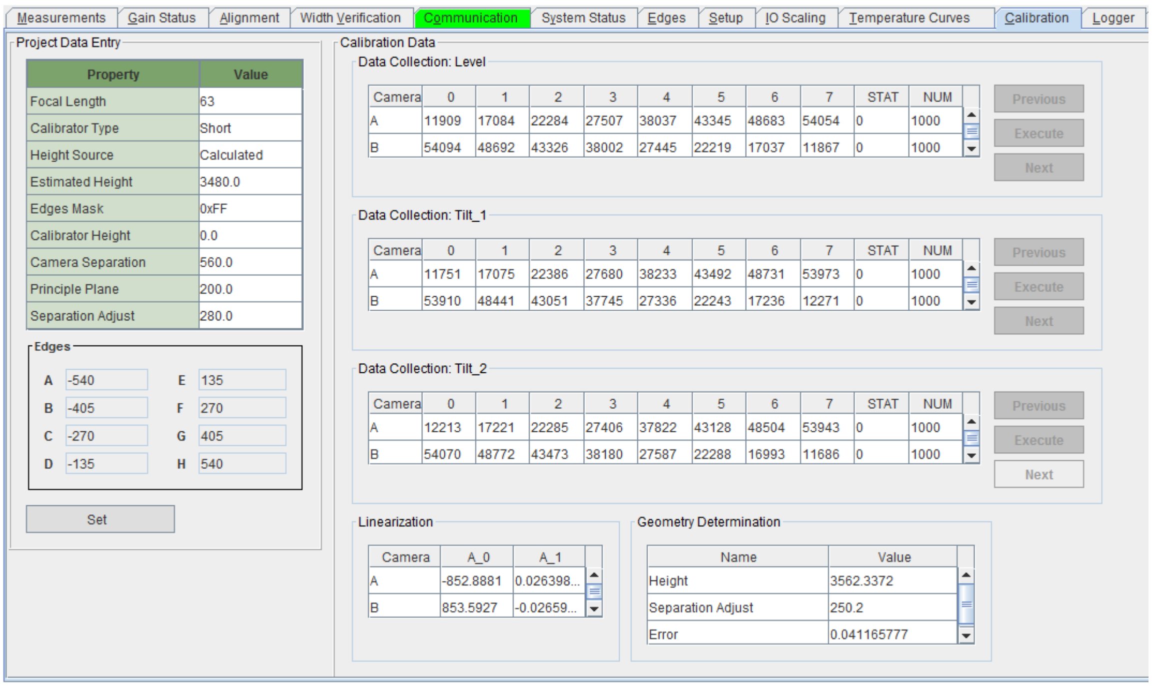


Figure 5.9 Calibration Window

To start the auto calibration routine three user specific parameters must be set in the ***PROJECT DATA ENTRY*** section. These parameters, located in the top left corner of the window include ***FOCAL LENGTH, CALIBRATOR TYPE***, and ***HEIGHT SOURCE***. If the user wishes to manually enter an installation height (distance from camera optics to calibrator mask), this can be done so in ***ESTIMATED HEIGHT.***

EDGES MASK specifies edge detection criteria for the calibrator mask. It sets which edges of the mask to avoid and which to detect. FF(hex) in binary represents 11111111. The calibrator mask is composed of 8 edges, each represented by a 1. As an example, to instruct the scanner to avoid the outer two edges of the calibrator, the binary mask must be changed to 00111100, or 3C in hex. By default, the mask is always set to FF.

Once the calibrator type is selected, the calibrator mask dimensions (distance from calibrator center to each window edge) will automatically appear in boxes *A* to *H*. These dimensions are outlined in Figure 5.9.1.

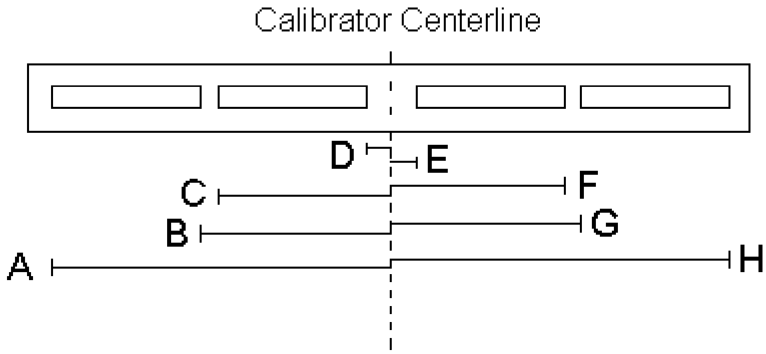
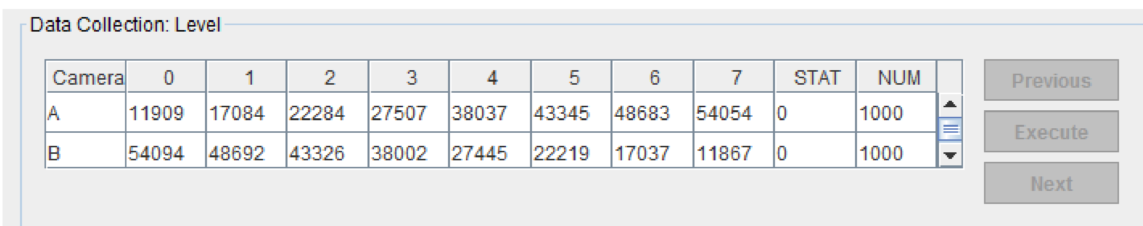


Figure 5.9a Edges' position

Calibration is performed by tilting the calibrator to each extreme position and taking width measurements. Due to triangulation, the scanner will be able to measure the mask width regardless of how much the calibrator tilts. For each tilt/position of the calibrator a series of recorded values are displayed as seen in Figure 5.9.2.



Camera	0	1	2	3	4	5	6	7	STAT	NUM
A	11909	17084	22284	27507	38037	43345	48683	54054	0	1000
B	54094	48692	43326	38002	27445	22219	17037	11867	0	1000

Figure 5.9b Data Collection

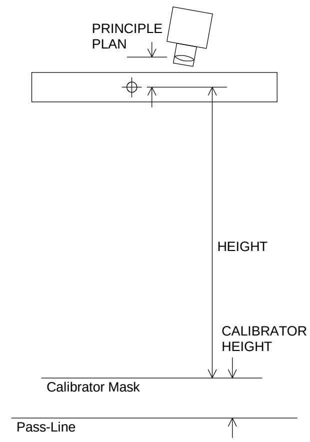
For each camera, the CCD pixel numbers (to the nearest 1/32 pixel) corresponding to the eight edge positions of the calibrator mask will be displayed in the boxes labeled ***0*** through ***7***. Because cameras A and B scan in opposite directions, the edge positions located in boxes ***0,1,*** and ***2*** of ***CAMERA_A,*** for example, will be similar with the edge positions located in boxes ***7,6,*** and ***5*** of ***CAMERA_B,*** respectively. The same applies to boxes 3 to 7.

If ***STAT*** ≠ 0 or ***NUM*** ≠ 1000 the cameras do not see all 8 edges of the calibrator and the results should be declined.

The three buttons located to the right of the ***DATA COLLECTION LEVEL*** window are used to navigate through the calibration. ***EXECUTE*** is used to execute the calibration, ***NEXT*** is used to move on to the next calibrator position (no measurements recorded), and ***PREVIOUS*** is used to go back to the previous calibrator position.

Algorithms inside the scanner automatically calculate linearization constants following the data collection stage. The constants are displayed in the ***LINEARIZATION*** boxes for ***CAMERA_A*** and ***CAMERA_B*** at the bottom of the window (Figure 5.9). The magnitude of the constants should be similar for both cameras although their signs/polarity will be opposite.

In addition to the calculation of the linearization constants, the scanner will determine the geometry of the installation using the collected data and the linearization constants. These values will be displayed under ***HEIGHT*** (scanner height), ***SEPARATION ADJUST*** (horizontal distance from the center of camera A/B to the optical centerline) and ***ERROR*** (error in the widths measured as well as calculated constants). ***CAMERA SEPARATION*** is the distance between the two camera optics and will always be double that of ***SEPARATION ADJUST***. ***PRINCIPLE PLAN*** represents the distance from camera optics to the optical centerline sticker (located on the outside of the scanner). ***CALIBRATOR HEIGHT*** is the vertical distance from the pass-line to the top of the calibrator mask.



5.3.9 Width Verification

The Width Verification window (***WIDTH VERIFICATION***), Figure 5.10, allows the user to perform a statistical analysis on repeated width measurements while the calibrator is continually rocking to both extremes. It is used to verify gage accuracy following calibration (Section 6.2) as required by the mill quality control schedule (Section 8.3). See Part 6 of this manual for usage instructions.

The number of width measurements to be sampled is entered by ***NUMBER OF SAMPLES*** and the ***MEASURE NOW*** button is pressed to initiate measurement and analysis. After a delay, depending on the number of measurements specified, the gage reports the ***MINIMUM, MAXIMUM,*** and ***MEAN WIDTH***, the ***SPREAD*** and the ***STANDARD DEVIATION*** of the resulting width measurements.

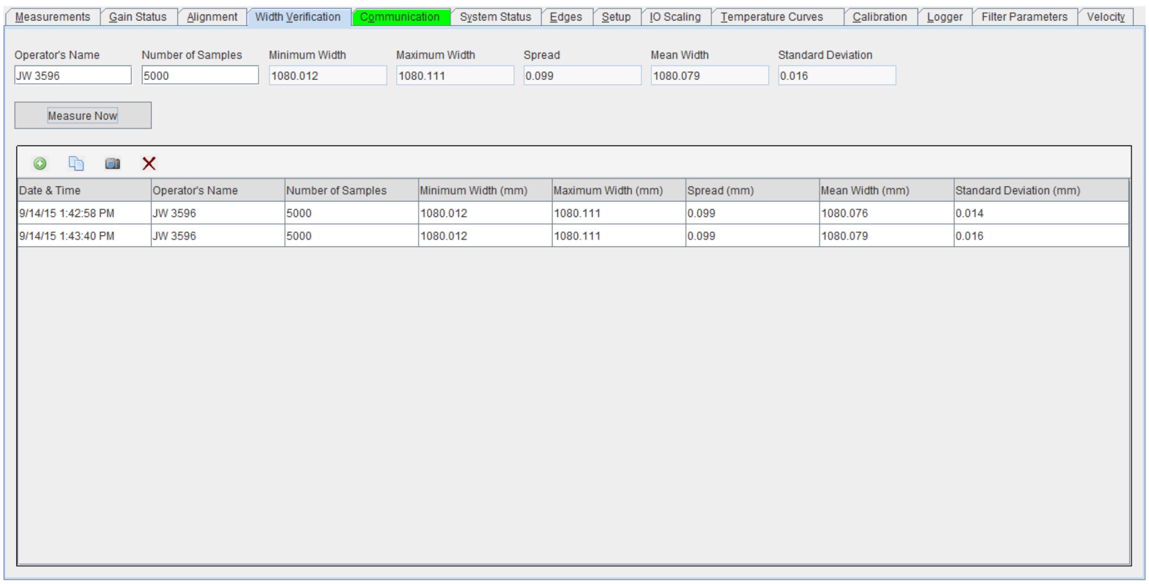


Figure 5.10 Calibration Verification Window

The results of the calibration verification can be managed and exported as a report tab, in the bottom part of the page, using the tools described in the Table 5.7

Item	Description
	Add the displayed measurement to the report tab
	Copy the report tab to the system clipboard
	Copy a snapshot of the report tab to the system clipboard
	Clear the report tab

Table 5.7 Width Verification

5.3.10 Communication

The ***Communication*** Window (Figure 5.11) is mainly used to know the Firmware version, checking that the communication is well established with the scanner and rebooting it, if required.

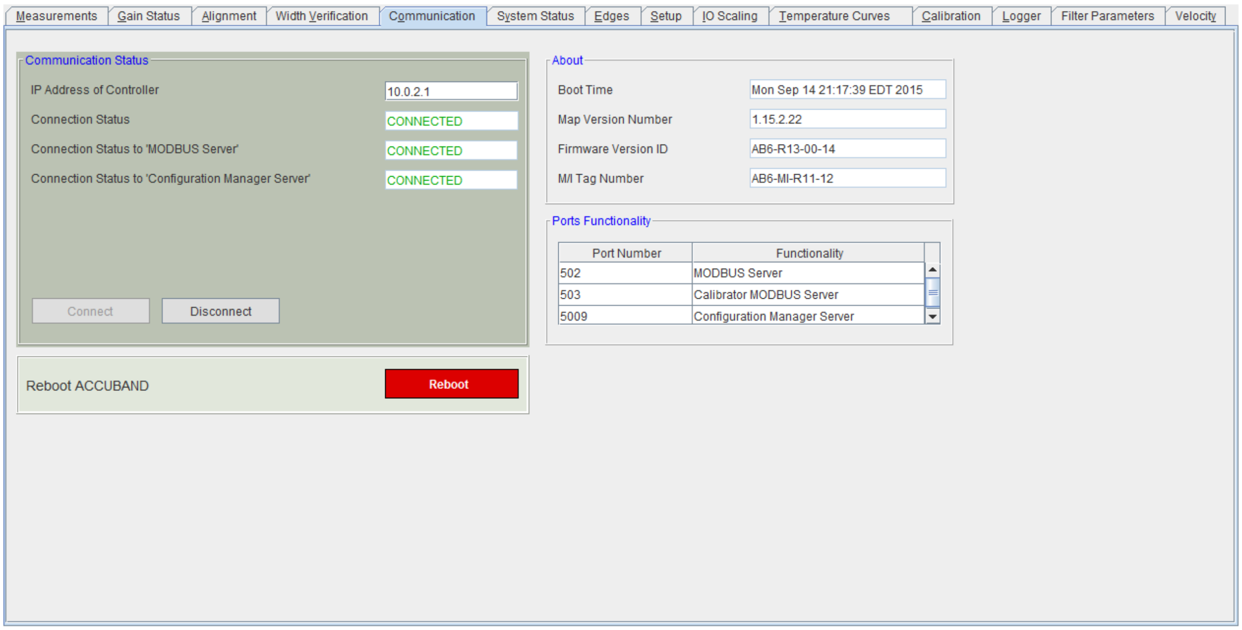


Figure 5.11 Communication Window

Figure 5.11 window is made up of four sections which include:

Section	Description
COMMUNICATION STATUS	1. Displays the host IP address of the scanner connected, as well as the status of the link. 2. Contains ***CONNECT*** and ***DISCONNECT*** tabs to begin or terminate the communications link.
REBOOT ACCUBAND	Contains the ***REBOOT*** tab that enables the user to reboot the scanner (Often required to confirm some parameter changes)
ABOUT	Displays the last time the system was booted as well as the register map revision and the firmware revision currently in use.

Table 5.8 Communication

PART 6

CALIBRATION

6.1 Introduction

Due to curvature, every lens distorts light in a nonlinear fashion. This distortion causes errors in measurements (Figure 6.1). For example, a 1000 mm width would be measured as 1003 mm. To overcome this problem, a calibrator is used to calibrate the Accuband Scanner.

The calibrator has 8 bright edges separated by precisely spaced widths by use of a certified Invar mask. The width separation values of d1, d2, d3 and d4 (Figure 6.2) are always constant and known to the calibration software. During calibration the scanner will measure the width separation d1, d2, d3, and d4 and compare the measured values against the known actual width values. The differences of the measured and actual width values are placed into a mathematical algorithm that will compensate and minimize the error in future measurements. The result of this compensation is a set of calibration coefficients that when used, the equation of the line will linearize the nonlinear lens characterization curve and provide a means for accurately measuring width.

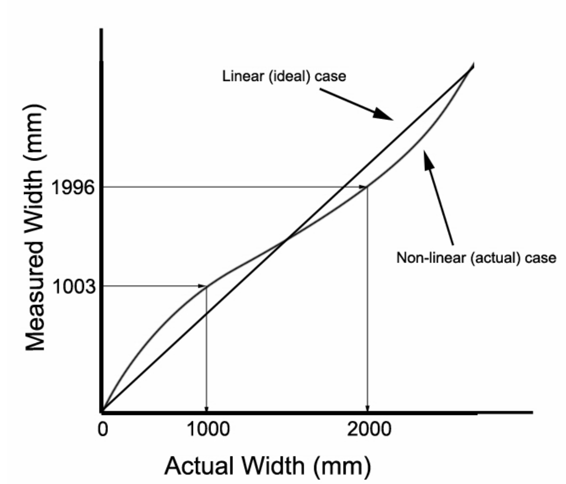


Figure 6.1 Lens Characterization

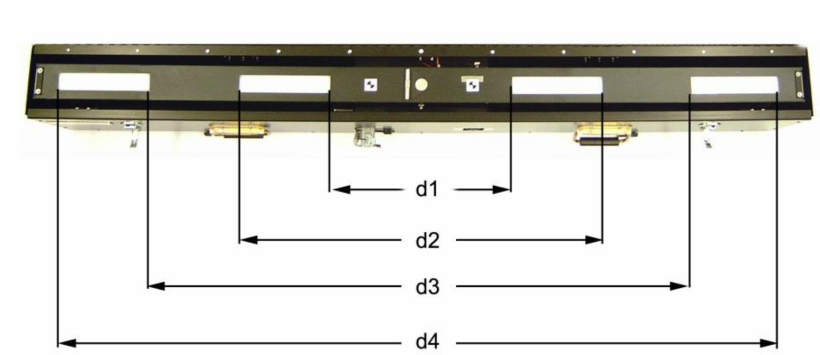


Figure 6.2 Edge Separation Distances

The calibration procedure comprises of 8 stages:

Stage 1 - Positioning the calibrator on the roll table.

Stage 2 - Checking and, if necessary, adjusting scanner level.

Stage 3 - Checking and, if necessary, adjusting scanner alignment.

Stage 4 - Running the auto calibration routine to determine the calibration constants required by the measurement routine. If the resulting measurement accuracy is within specification, calibration is complete at this stage. If not, it is necessary to continue with Stages 5 to 8.

Stage 5 - Checking and, if necessary, adjusting camera focus.

Stage 6 - Checking and, if necessary, adjusting camera rotation and caster.

Stage 7 - Checking and, if necessary, adjusting camera camber.

Stage 8 - Running the auto calibration routine.

The full calibration described above is required only during commissioning, if a camera is replaced, or if the gage is subjected to severe shock. If it becomes necessary to recalibrate the gage, a short calibration, comprising of Stages 1 and 4, is normally sufficient to restore measurement accuracy to specification.

6.2 Procedure

For a short calibration, perform Stages 1 and 4.

For a full calibration, perform Stages 1 to 3, then proceed with Stages 5 to 8. Complete and verify the calibration by performing Stage 4.

Equipment & Consumables:

For short calibration:

- Calibrator, with cable and carrier
- PC or laptop with Ethernet port, Web browser and JAVA Runtime Engine
- 2 m (6 ft.) RJ-45 crossover cable

For full calibration, all of the above, plus:

- 1/2" open end wrench
- 3/32" Allen (hex) head screwdriver (ball type)
- 5/32" Allen (hex) head screwdriver (ball type)
- 1/4" slot head screwdriver
- Texwipe Optics Pads (TX 811)

6.2.1 Stage 1 - Position Calibrator on Roll Table

The calibrator (being the reference against which the gage is calibrated) must be accurately positioned on the roll table. Its center must be perpendicular to roll table centerline, parallel to the rolls.

1) Place the calibrator carrier on the roll table with the "V" notch registering on the key roll (Fig 6.3). The tilt adjustment screw should rest on the adjacent roller.

NOTE

The key roll is normally at right angles to the roll table centerline. If it is disturbed by a mill wreck, or repairs, it must be surveyed and adjusted to 90°, ± 0.5° to the roll table centerline. Should the key roll become grooved or damaged in the areas of contact with the carrier, it must be replaced or repaired.

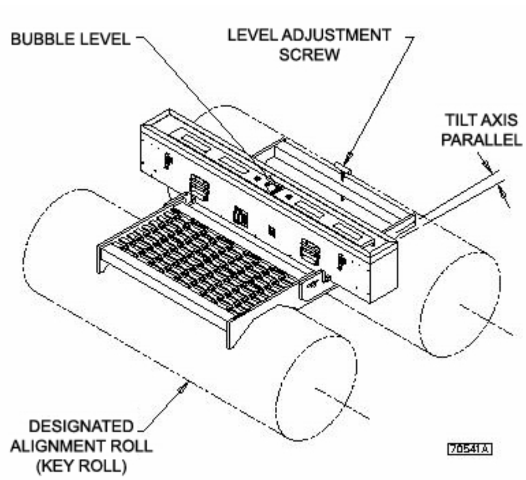


Figure 6.3 Calibrator Placement

2) Place the calibrator in the carrier slot, loosen the cover latches and open the cover.

NOTE

The cover protects the calibrator from dirt and impact damage. It should be closed immediately after using the calibrator.

3) Remove the dust cover from the power cable connector, then connect the cable to the calibrator. Secure the connector with the latch provided.

4) Center the calibrator laterally. The center of the calibrator defines the point from which centerline deviation is measured. Ensure that it is accurately positioned.

5) Adjust the carrier tilt screw until the bubble on the spirit level (located at middle of Calibrator) is centered.

6.2.2 Stage 2 - Level Scanner

The Accuband scanner sits on a plenum chamber and is leveled by adjusting the 4 rods on which the plenum chamber is suspended from the support frame. At one end of the plenum chamber, the rods connect to a pivoted bracket to allow the scanner to be leveled in one axis without affecting the other.

> **NOTE**
>
> Do not lean on the scanner while making level adjustments. Any load applied to the scanner will cause the spirit level to give a false reading.

1) Release the scanner cover latches (Fig 6.2) and remove the scanner cover. If the bubble is in the middle of the spirit level, the scanner is level, proceed to Stage 3.

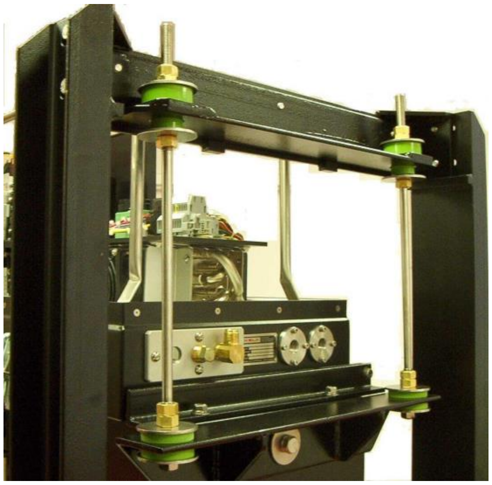
> **NOTE**
>
> Do not release the scanner hold down latches (Figure 6.4) during Stage 2 - Level Scanner. This will cause the spirit level to give a false reading.

Figure 6.4 Scanner Cover Removal

2) Loosen the lock nut at each of the 4 lower bushings and tighten the bottom nuts while preventing the suspension rods from turning. Tighten the lock nuts.

3) Loosen the top and bottom lock nuts at each of the 4 upper bushings.

4) Loosen the bottom nuts at the 4 upper bushings (Figure 6.5).



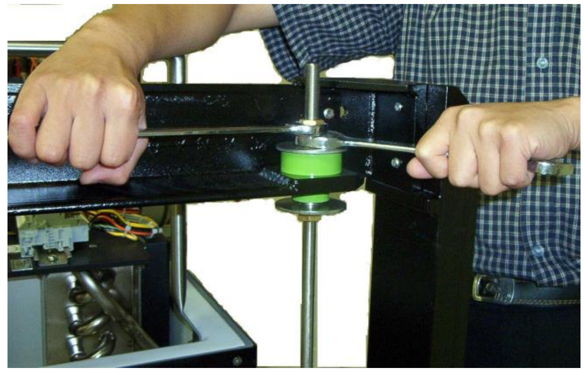


Figure 6.5 Suspension Adjustment

5) Adjust the 4 upper nuts at the upper bushings such that the rubber skirt mounted on the bottom of the plenum chamber barely touches the scanner frame mounting plate on all four sides. The tops of the suspension rods should be at approximately equal heights above the surrounding frame.
6) Adjust the scanner so the bubble is in the middle of the spirit level:

- First, use the suspension rods at the end of the scanner supported on the fixed bracket to level in the longitudinal direction (i.e. parallel with the roll table centerline). The scanner will turn on the pivoted bracket at its other end.
- Then use the suspension rods at the end supported on the pivoted bracket to level in the lateral direction (i.e., across the roll table).

7) Tighten the bottom nut at each upper bushing until it stops compressing the upper bushings. Verify that the scanner is still level; it may be necessary to make a fine adjustment after compressing the upper bushings.

8) Tighten the top and bottom lock nuts.

6.2.3 Stage 3 - Align Scanner

The scanner must be aligned parallel to the calibrator with its center above that of the calibrator.

1) Place the calibrator power switch in the ON position. All four mask cutouts should be illuminated. If they are not, increase the lamp brightness by pressing the Light control switch - HIGH. Replace any of the lamps that do not turn on following the procedures outlined in **Section 8.9.1 - Lamp/Thermostat Replacement.**

WARNING

The rocking beam in the calibrator has the potential to pinch hands or fingers. Keep hands away from the beam when it is moving.

2) Level the calibrator beam using the motor control switch - JOG. Each time the JOG button is pressed, the calibrator central beam will jog between the level position and a maximum tilt. Then place the calibrator power switch in the OFF position. This will allow clear visibility of the scanner alignment laser line against the calibrator.

NOTE

If the calibrator beam is not level, the center of the scanner cannot be accurately positioned over the center of the roll table.

3) Remove the two calibrator alignment masks from their storage slots near the front of the calibrator. Lay them over the two outermost cutouts of the permanent calibrator mask with the triangular cutouts pointing outwards. Ensure that the pemnuts are facing downwards (Figure 6.6). The purpose of the pemnuts is to keep the alignment masks in place of the calibrator mask. Ensure that the calibrator beam remains level.

4) Place the power and laser switches on the scanner power supply in the ON position. Observe the red registration laser line formed on the calibrator. For proper scanner alignment, the laser line should pass through both of the outermost tips of the triangular cutouts on the alignment masks. **The laser line cross hair should intersect the target label on the calibrator masks (Figure 6.7).** When these conditions are satisfied, the scanner is properly aligned. Proceed to Step 6 to start the calibration process. If the laser line is not perfectly within the cutout, then proceed to step 5 for further adjustment.

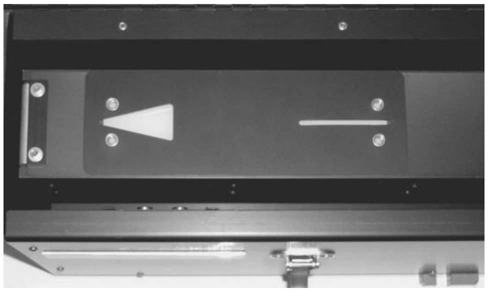
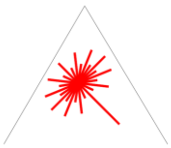


Figure 6.6 Alignment Mask



WARNING

Accidental exposure to the CDRH Class 2 solid state laser used in this procedure is unlikely to cause injury to eye tissue. However, reasonable care is still required. Failure to comply with this warning may result in blindness.

NOTE

The switch on the back of the laser is normally left in the ON position at all times. If the laser does not turn on, check that this switch has not been turned off and that the laser fuse is in good condition (Section 8.4.5).

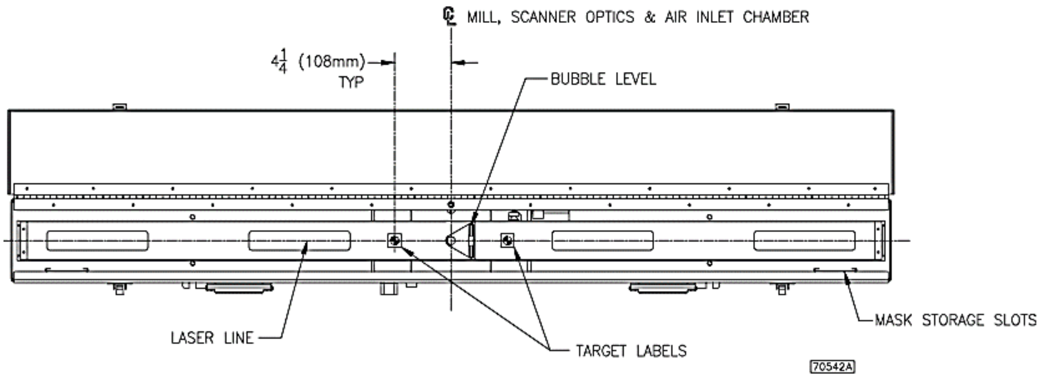


Figure 6.7 Laser line Position

5) There are two sliding plates, one on each side of the carrier, that hold the calibrator in place. For fine adjustments, loosen the 4 bolts that hold them in place and adjust the position of the calibrator until the laser line falls in the middle of the alignment masks. When alignment is complete, tighten the bolts.

   For coarse adjustment, adjust the suspension support brackets (Figure 6.5) at the top of the scanner support assembly. Loosen the three forward-adjustment bolts on each end to allow the suspension to be moved forward or backward in its slots by tapping the frame with a rubber mallet. Loosen the four lateral-adjustment bolts on each end to allow the scanner to be moved sideways in a similar manner. When the laser line passes through the tips of the triangular cutouts as well as the linear cutouts on the alignment masks and the laser line cross hair intersects the proper target labels on the calibrator masks, tighten the bolts. Ensure that the suspension rods are vertical and scanner bubble level is in the middle.

6) Proper leveling of both the calibrator and the scanner can be confirmed by placing the calibrator power in the ON position and holding down the motor control switch - RUN for about 2 seconds to rock the calibrator beam continuously. The laser line should remain within the middle of the calibrator alignment masks for all extreme calibrator tilts. Press the motor control switch - JOG momentarily to stop the calibrator from rocking.

7) Turn the laser OFF and place the calibrator alignment masks in the storage slots before proceeding with the calibration.

6.2.4 Stage 4 - Autocalibration

Autocalibration comprises of 3 phases:

Phase 1 - Project Data Entry - the entry of installation dependent physical dimensions.

Phase 2 - Data Collection - the collection of measured edge data.

Phase 3 - Linearization and Geometry Determination - the determination of constants for the algorithms used to correct for optical distortion and to compute width, strip height and centerline deviation.

Phase 4 - Scanner Calibration Verification

Phase 1 - Project Data Entry

1) Launch the Maintenance Interface as described in Section 5.2. Select the ***Calibration*** window. To start the auto calibration routine three user specific parameters must be set in the ***PROJECT DATA ENTRY*** section. These parameters, located in the top right corner of the window, include ***FOCAL LENGTH, CALIBRATOR TYPE***, and ***HEIGHT SOURCE***.

    - The focal length must be set to the focal length of the lenses installed in the scanner. Available focal lengths include ***40 mm, 52 mm or 63 mm***.

    - The calibrator can be either ***SHORT, LONG***, or ***USER DEFINED*** depending on which calibrator is being used. The long calibrator measures 1549.4 mm (distance between A & H in Figure 6.8a) while the short calibrator measures 1080 mm. By selecting ***SHORT*** or ***LONG***, the calibrator mask dimensions will automatically appear in boxes ***A*** to ***H***. These dimensions (in millimeters) are outlined in Figure 6.8a. Before the selection in this field is made, it is imperative that the user verifies whether there is a label attached to the top of the calibrator as seen in Figure 6.8b. If so, then select ***NOT SELECTED*** from the calibrator type. If the values ***A*** to ***H*** do not match those found on the label, select ***USER DEFINED*** instead and enter the values manually. Any values entered through ***USER DEFINED*** will be stored in memory. The next time calibration is performed and ***NOT SELECTED*** is chosen for calibrator type, the previously entered values through ***USER DEFINED*** will be displayed and will not require reentry. It is still important that these values are verified to those on the calibrator label before proceeding.

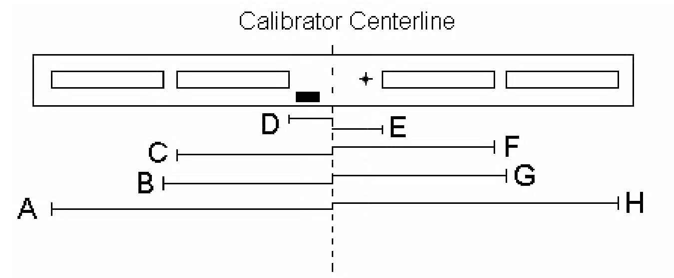


Figure 6.8a Edges' position

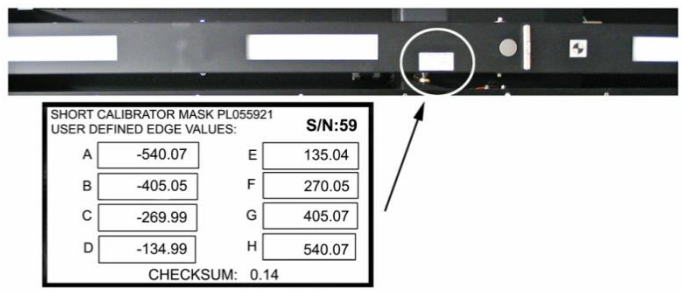


Figure 6.8b Calibrator's label

- Once all eight values have been entered into their corresponding fields, it is important to confirm the checksum value found on the calibrator label with that on the monitor. This checksum value ensures that all the values entered are correct and no entry error was made.

- ***HEIGHTT SOURCE*** - Selects whether the geometry determination routine will use an estimated height value that is ***CALCULATED*** during the linearization phase or a value provided by ***MANUAL*** input in the ***ESTIMATED HEIGHT*** box by the user. In most cases, the ***CALCULATED*** value should be used.

2) Once all specific data has been entered the auto calibration routine may be executed. Press the ***SET*** button at the bottom of the ***PROJECT DATA ENTRY*** Box.

Phase 2 - Data Collection

3) Place the calibrator power switch in the ON position. Ensure that the calibrator is illuminated to a medium-high intensity and the beam is level. Use the light control switch - LOW / HIGH to adjust the lamp brightness.

4) The three tabs labeled ***PREVIOUS, EXECUTE*** and ***NEXT***, located to the right of the ***DATA COLLECTION*** window are used to navigate through the calibration. ***EXECUTE*** is used to execute the calibration, ***NEXT*** is used to move on to the next calibrator position (no measurements made), and ***PREVIOUS*** is used to go back to the previous calibrator position. After each calibration a pop up window will ask whether to ***ACCEPT*** or ***DECLINE***.

   Press the highlighted ***EXECUTE*** button. After a brief interval, edge location data will be displayed for Cameras A and B and a pop-up menu will appear. If **STAT** = 0 and **NUM** = 1000 for both cameras, select **ACCEPT**. If **STAT** ≠ 0 or **NUM** ≠ 1000, this indicates that the cameras do not see all 8 edges of the calibrator. Select **DECLINE** and use the **Alignment** window to help identify the cause of the problem. Possible problems are poor alignment, failed calibrator lamps or obstructions in the field of view. Press the highlighted ***EXECUTE*** button in the **Calibration** window to rerun data collection after the problem has been corrected.

   The CCD's eight pixels corresponding to the eight mask edges will be displayed in the boxes labeled ***0*** through ***7***. Since camera A and B scan in opposite directions, the edge positions located in boxes ***0,1*** and ***2*** of ***CAMERA A*** should be closely similar with the edge positions located in boxes ***7,6*** and ***5*** of ***CAMERA B,*** respectively.

5) Tilt the calibrator beam to one extreme tilt position by pressing the Motor control switch - JOG momentarily, and repeat Step 4 for **DATA COLLECTION TILT_1**.

6) Tilt the calibrator beam to the other extreme tilt position by pressing the Motor control switch - JOG twice, and repeat Step 4 for **DATA COLLECTION TILT_2**.

Phase 3 - Linearization and Geometry Determination:

7) Algorithms inside the scanner automatically calculate linearization constants following the data collection stage. The constants are displayed in the ***LINEARIZATION*** boxes for ***CAMERA A*** and ***CAMERA B*** at the bottom of the window. The magnitude of the constants should be similar for both cameras although the signs will be opposite.

8) Following the calculation of the linearization constants, the scanner will then determine the geometry of the installation using the collected data and the linearization constants. These values will be displayed under ***HEIGHT*** (scanner height), ***SEPARATION ADJUST*** (horizontal distance from the center of camera A to the optical centerline) and ***ERROR*** (error of the widths calculated using collected

data as well as the calculated constants). ***HEIGHT*** should be close to the **GKC REF** value from the installation drawings. ***SEPARATION ADJUST*** will be approximately 280 mm if the scanner and calibrator are perfectly aligned. Small variations from 280 mm will not affect measurement accuracy. The ***ERROR*** value must be less than **0.2** in order to obtain measurements that are within specification.

Phase 4 - Scanner Calibration Verification:

9) Start the calibrator beam rocking by pressing the Motor control switch- RUN for about 2 seconds. This will cause the calibrator beam to rock to both extreme positions continually.

10) Select the ***Width Verification*** Window in the Maintenance Interface. Change the number of width measurements to be sampled in the ***NUMBER OF SAMPLES*** box to 5000.

11) Press the ***MEASURE NOW*** button to initiate the verification. After a few seconds, the result will be displayed in the ***MINIMUM WIDTH, MAXIMUM WIDTH, SPREAD, MEAN WIDTH*** and ***STANDARD DEVIATION*** boxes. Verify results. If unfamiliar with verifying results, see the example below. If the result is acceptable, put the lid on the scanner and secure the latches and repeat Phase 4. If the result is acceptable this concludes calibration. If the result is not acceptable proceed to Stage 6.

Note: with the scanner closed you will have to move your PC to a suitable network connector or use another PC on the network.

Calibration Verification Example

Using Figure 5.9 as an example, the number of samples specified for this verification is 5000. Calibration verification results with the following values:

Min width = 1080.012 mm, Max width = 1080.111 mm, Spread = 0.099, Mean Width = 1080.079 mm, Standard Deviation = 0.016.

Maximum acceptable width error of the Accuband 6 scanner is +/- 0.4 mm. Calibrator mask in this example has a width of 1080.0 mm. Maximum and minimum allowable error would be 1080.4 mm (1080.0 + 0.4) and 1079.6 mm (1080.0 - 0.4). Since the measured Min. and Max values are within the acceptable range, the gage has been properly calibrated and is measuring within specification.

Maximum allowable standard deviation is 0.3: Verification was successful.

6.2.5 Stage 5 - Camera Focus

NOTE

Do not focus the cameras unless absolutely necessary - focusing requires breaking the air tight seal on the lens cover. The cameras (including any spare available at the time) were focused during commissioning and their focusing rings were locked. Unless a camera has been repaired or the distance between the scanner and the roller table has been changed, it should not be refocused. Proceed to Stage 6 if focusing is not required.

1) Remove the alignment masks from the calibrator beam and return them to their storage slots.

2) Ensure that the calibrator power switch is in the ON position. Level the calibrator beam using the motor control switch - JOG. Ensure that the calibrator is illuminated to a medium-high intensity. Use the Light control switch - LOW / HIGH to adjust the lamp brightness.

3) Tilt the scanner by loosening the scanner hold down latches (Figure 6.4). Release the camera port access panel by rotating its two quarter-turn slot head fasteners counterclockwise.

LENS TYPE IDENTITY

The Accuband 6 system support two types of lens manufacturers: Nikon and Schneider. Both lenses have different mounting dimensions so interchanging the two is not possible. Please refer below to the appropriate focus procedure corresponding to the lenses installed.

Nikon Lens

Schneider Lens

4) Remove the lens covers by tilting the scanner and opening the access panel as when cleaning the cover glass during maintenance (Section 8.4). From above, push the beads of the camera port seals out of their retaining grooves and free from the lens covers. Rotate the lens covers counterclockwise to release, and then slide through the seal to remove.

5) Remove the lens covers of both cameras and record the lens f-stop settings (see Figure 6.9). Then open the lens apertures completely (f:4 or f:2.8 for Nikon lenses, Position 1 for Schneider lenses). Close the panel and lower the Scanner.

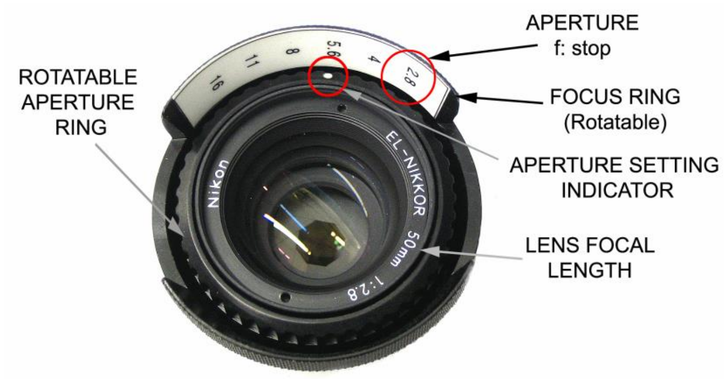


Figure 6.9a Accuband 6 Camera Lens (Nikon)

Figure 6.9b Accuband 6 Camera Lens (Schneider)

Schneider Lens Aperture Conversion Table

Position	**Aperture**
40/50 mm Focal Length	
1	2.8
2	4
3	5.6
4	8
5	11
6	16
60 mm Focal Length	
n/a	2.8
1	4
2	5.6
3	8
4	11
5	16
6	22

6) Launch the Maintenance Interface as described in Section 5.2 and login as "MAINTENANCE". Select the **Alignment** Window.

7) If Camera A is the camera that is to be focused, select the ***CAMERA A*** **Enable** check box and press the **START** button. This will display alignment information and the video waveform for the camera.

8) **Nikon Lens:** Grasp the focus locking ring (Figure 6.10a) of camera A and rotate it counterclockwise sufficiently to release the inner knurled focus ring. **Schneider Lens:** Loosen the focus ring by rotating the focus ring lock counterclockwise (Figure 6.9b, 6.10b) ¼ to ½ turn.

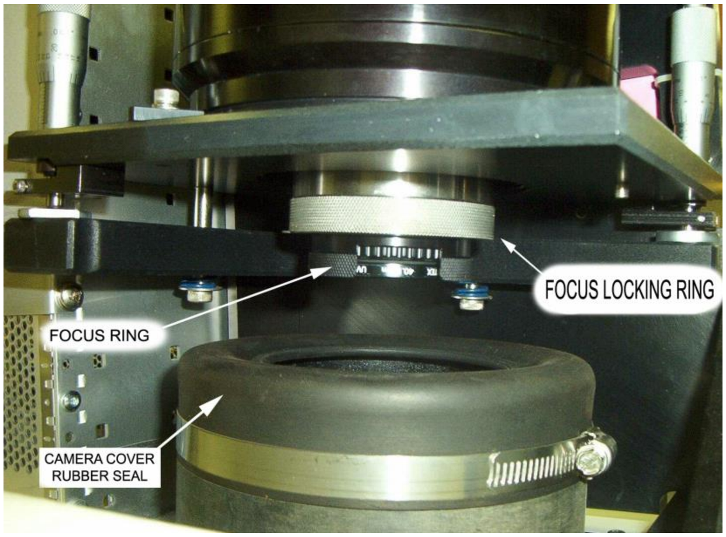


Figure 6.10a Nikon Camera Focusing

9) Screw in the focus ring (turning clockwise) until fully in. Slowly unscrew the focus ring (Nikon: Figure 6.9, Schneider: Figure 6.9b, 6.10b) so that 8 distinct edges are visible in the video display and the edges are as steep as possible. Resultant video signal should be similar to that of Figure 6.11. When an approximate focus has been achieved and 8 edges are visible, make a final focus adjustment to maximize the number in the ***FOCUS*** field, it should be higher than the one in Figure 6.11.

Figure 6.10b Schneider Camera Focusing

10) **Nikon:** Being careful not to rotate the lens barrel, retighten the locking ring, and return the f-stop/aperture to its original setting.

    Schneider: Return the lens aperture back to its original position and re-tighten both the focus and aperture ring locks.

11) Remove and inspect the camera filter. Clean it, if necessary, taking care not to scratch it - use a method suitable for precision coated optics.

12) Repeat Steps 6 to 10 for Camera B.

13) Replace the lens covers by pushing them from the underside of the tilted scanner completely through the camera rubber seals (Figure 6.10a) into position. Then from above, push the rubber seals down the covers until they fall into the cover's retaining grooves. Tighten the covers by rotating clockwise.

14) Close the access panel and lower the scanner.

6.2.6 Stage 6 - Camera Rotation and Caster

1) Ensure that the calibrator power switch is in the ON position. Then level the calibrator beam by pressing the motor control switch - JOG.

> **Caution**
> If the beam is not level, the cameras cannot be accurately aligned.

2) Remove the two calibrator alignment masks from their storage slots near the front of the calibrator. Lay them over the two outermost cutouts of the permanent calibrator mask, with the triangular cutouts on the alignment masks pointing away from the center and the PEM nuts facing downwards (Figure 6.6). Ensure that the beam remains level.

Adjusting Camera A rotation

3) Select the **CAMERA A** ***Enable*** checkbox and press the ***START*** button in the ***Alignment*** window to display its video signal. When the camera is correctly aligned and focused, the **EDGES** field will display **8** for both cameras and the video signal will resemble the display in Figure 6.11.

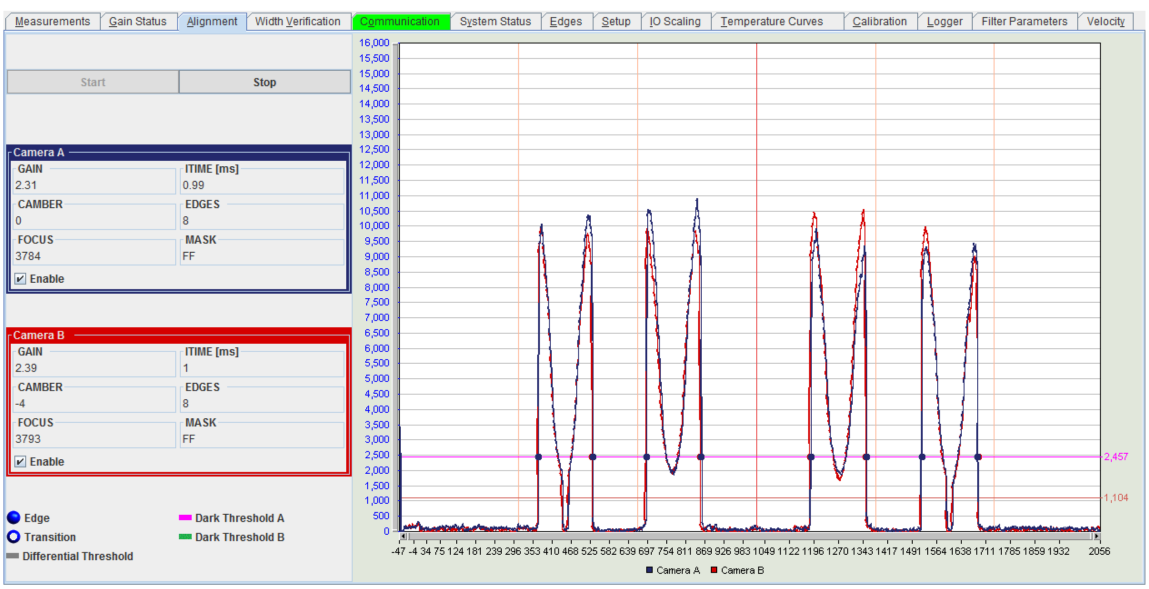


Figure 6.11 Alignment

4) Loosen the caster (forward tilt, Figure 6.13) micrometer lock screw (Figure 6.12) with a 3/32" Allen head screwdriver. Check if the video display contains 8 edges. If not, adjust the caster micrometer until it does. Then, gradually turn the micrometer clockwise until the outer edges in the video display start to disappear. If they start to disappear at the same time, camera rotation is correct, jump to Step 9. If the edges at one end start to disappear before those at the other, continue with Step 5

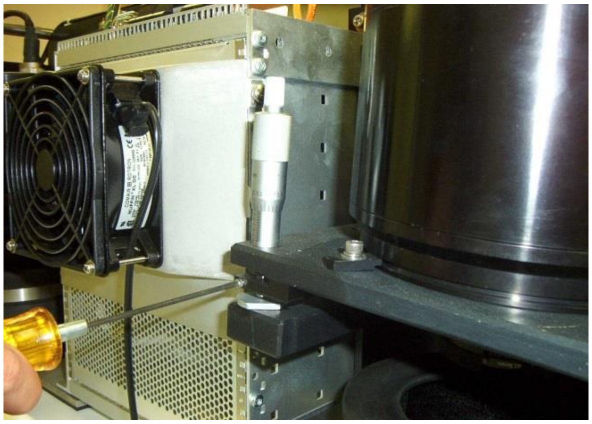


Figure 6.12 Camera Focusing

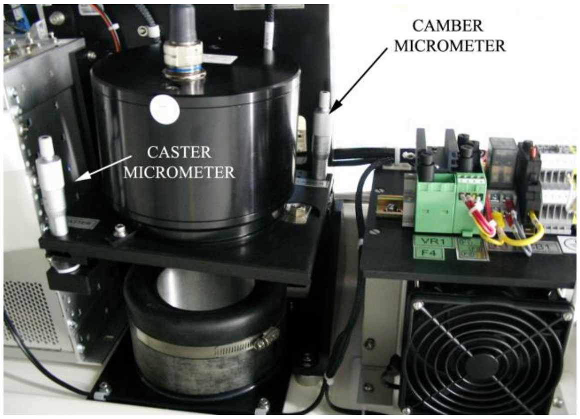


Figure 6.13 Camera Focusing

5) Set the micrometer so that as much of the two opposite edges are seen as possible. Do not worry if one is higher than the other. This will be resolved in the following steps.

5) Using a 5/32" Allen head screw driver, loosen the camera clamps (Figure 6.14) and the alignment disk lock screw (Figure 6.15). Tighten them very lightly to give some light resistance to camera movement.

6)

Figure 6.14 Camera Clamps

Figure 6.15 Camera Alignment Disk

7) Rotate the camera, using a wrench to rotate the alignment disk hex nut (Figure 6.15), until the two outmost peaks in the video display are similar in height. Only a few degrees movement of the wrench is necessary.

8) Retest to ensure that adjusting the caster micrometer causes the outermost 2 edges to disappear from the video display at the same time. Then tighten the camera clamps and alignment disk lock screw.

9) Turn the caster micrometer clockwise until the outer edges begin to disappear. Record the setting from the barrel of the micrometer. Then turn the micrometer counterclockwise until the outer edges begin to disappear again and record that setting. Set the micrometer at the midpoint between the two settings. Tighten the caster micrometer lock screw.

10) Repeat Steps 3 to 9 for Camera B.

6.2.7 Stage 7 - Camera Camber Adjustment

Adjust Camera A camber

1) Ensure that the calibrator beam is level and illuminated. Remove the alignment masks from the calibrator beam and return them to their storage slots.

2) Select the ***CAMERA A Enable*** checkbox in the ***Alignment*** Window.

3) Loosen the camber (inward tilt) micrometer lock screw for camera A with a 3/32" Allen head screw driver. The camber adjustments for both cameras A and B are located farther from the center of the scanner than the caster adjustment screws (Fig. 6.13). Adjust the micrometer to minimize the number in the ***CAMBER*** field. When the value is flickering between +1 and -1, the camera is aligned.

4) Tighten the camber micrometer lock screw.

5) Repeat Steps 2 to 4 for camera B.

6.2.8 Stage 8 - Autocalibration

Perform Stage 4 - Autocalibration.

PART 7

SETUP AND OPERATION

7.1 Power-up

Ensure that the power switch on the scanner power supply is in the OFF position. For backlight equipped gages, ensure that the circuit breaker on the backlight junction box is in the OFF position. Restart the gage following these instructions.

Caution

Do not power-up a newly installed gage prior to commissioning by KELK. Service voltages, wiring hookups, and power supply system configuration must all be verified at that time. Failure to comply with this caution could result in equipment damage.

7.1.1 Startup

1) Ensure that the cold water valve to the scanner cooling coil is in the open position. Also, ensure that the cooling water supply is connected to the cooling coil inlet and the drain is connected to the cooling coil outlet. When you look from the piping side the cooling coil inlet is in the middle and the outlet is at the end. Verify water flow by feeling the drain (return) water pipe.

2) **On Backlight equipped gages:**

   Ensure that instrument air or dry nitrogen is available at the backlight pressure reduction valves and that the first pressure gage is reading 25 PSI and the second one (closer to backlight) 1.5 PSI.

   Ensure that the backlight window is clean and free from debris. Open the cold water valve. Ensure that water from the manifold is washing the backlight window evenly and completely.

Caution

Never roll strip without the backlight water flowing. A dry window will be damaged by heat from the metal strip.

Place the circuit breaker in the backlight junction box to the ON position. Visually inspect the backlight for even illumination. Uneven illumination indicates a burned lamp.

3) Place the mill power disconnects to the scanner power supply, calibrator controls, and for backlight equipped gages, the backlight junction box in the ON position.

4) Place the power switch on the scanner power supply in the ON position.

7.1.2 System Operating Check

Confirm that Accuband and its associated communications are functioning correctly:

- Host Communications should show status as Gage Healthy.
- The optional Discrete I/O (if installed) should show status as Healthy.
- If desired, by accessing the Maintenance Interface (Section 5.2).

7.2 System Status Messages

The primary status messages accessible during Accuband operation are listed in Table 7.1. For additional information on these and other status messages, see the references included in the table.

Message	Interface				
	Scanner Power Supply and Calibrator Controls		Host Communica-tions	Maintenance Interface	Optional Discrete I/O Contact
	Indicator Lamp	Relay Contact			
Power On	x	x			
Gage Healthy			x	x	x
Strip in View			x	x	x
Data Valid			x	x	x
Host Communication OK				x	x
Scanner Over Temperature			x	x	x
Alignment Laser On	x	x			
Reference	Section 3.3		(1)	Part 4	

Table 7.1 Primary Operation Status Messages

7.3 Setup

Accuband Width Gages are normally setup by KELK personnel during commissioning. Unless they are moved or measurement conditions have changed, parameters pertaining to the measuring environment and calibration should not be changed - any such changes may adversely affect gage performance.

It is assumed that prior to startup:

- Host communication has been set up in compliance with the host communication protocol provided by KELK. If not, consult KELK.
- If the optional discrete I/O Kit is installed, parameters have been assigned in the gage to its analog and logic I/Os.

The only setup activities to be performed by the user are:

- Entry of alloy expansion curves for the compensation of thermal expansion, if required.
- Scaling of the optional discrete I/Os, if installed.

7.3.1 Alloy Expansion Curves

Expansion data may be entered for up to 63 alloys, each with 64 points of coefficient data. Two pieces of data per point are required. These are temperature and an expansion expressed as micrometer/m/ºC. Refer to the example graph (Figure 7.1).

Caution

Temperatures of the first and last points should be the same as the lower and upper limits of the temperature sensor input. This will ensure that the compensated width will be correct.

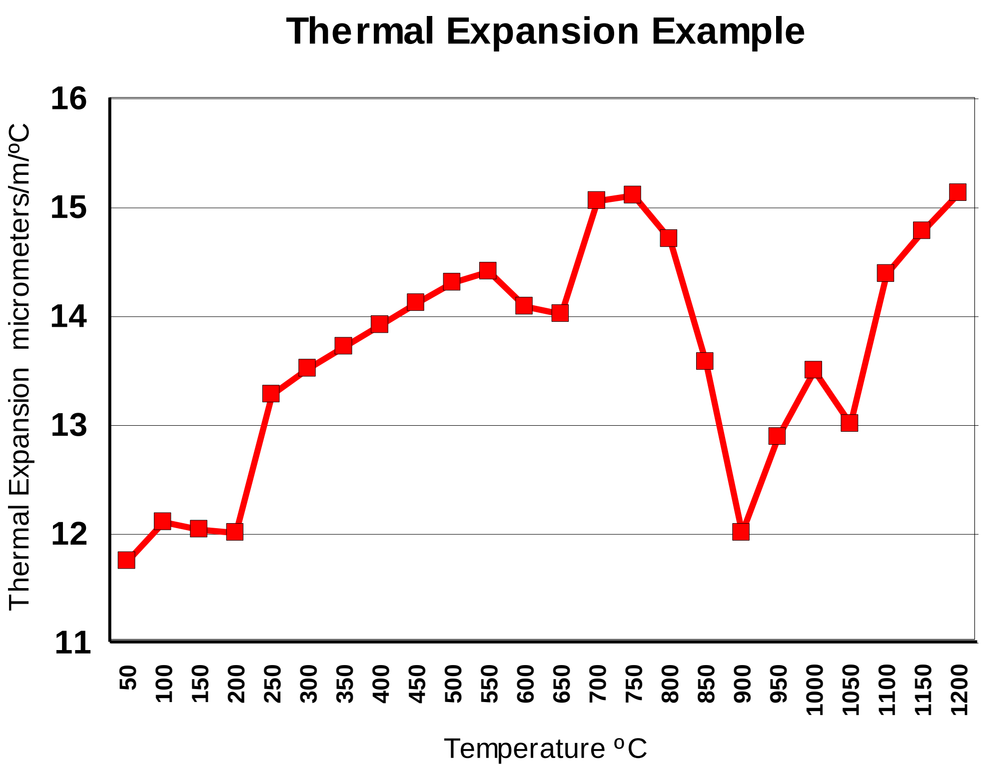


Figure 7.1 Alloy Expansion Curve Example

Caution

All points of the alloy expansion curves must be entered in the same units as the temperature input signal; if they are not, then the compensated width will be incorrect (i.e., do not use ^{0}C for one and ^{0}F for the other).

The following formula is applied in calculating the compensated width:

$$Wc = \frac{1}{1+(T*E*10^{-6})}*W_h$$

$$Wc = Compensated\_Width$$

$$T = Temperature$$

$$E = Expansion\_Coefficient$$

$$W_h = HotWidth$$

The expansion coefficient applied in the above formula is an interpolated value between two entered points.

Medium Carbon				
Temperature Range	(BOH) (0.4% C) Eo8	(AOH) (0.4%) En8	Euteliod (BE) (0.8% C)	Carbon Tool (BOH) (1.7% C)
50	10.72	11.22	10.84	10.3
100	11.21	11.59	11.11	10.6
150	11.69	11.95	11.39	10.9
200	12.14	12.32	11.72	11.25
250	12.6	12.72	12.11	11.68
300	13	13	12.49	12.11
350	13.31	13.45	12.84	12.51
400	13.58	13.71	13.15	12.88
450	13.82	13.95	13.41	13.21
500	14.05	14.18	13.65	13.63
550	14.33	14.43	13.9	13.85
600	14.58	14.67	14.16	14.16
650	14.98	15.11	14.56	14.5
700	14.85	15.08	14.74	14.6
750	13.22	13.66	14.19	14.38
800	11.84	12.5	13.83	14.33
850	12.04	12.86	14.45	15.32
900	12.65	13.56	15.19	16.33
950	13.14	14.03	15.47	16.6
1000	13.59	14.46	15.72	16.84
1050	13.99	14.83	15.95	17.06
1100	14.36	15.18	16.15	17.26
1150	14.69	15.49	16.34	17.44
1200	15	15.78	16.52	17.6

Table 7.2 Carbon Temperature Compensation Points

Table 7.2 displays an example of the type of data that would be entered for temperature compensation. In this case, four temperature curves would be set up for temperatures ranging from 50 to 1200 degrees Celsius.

Follow these steps to enter and save the tabulated data to the scanner via the maintenance interface.

1) Launch the Maintenance Interface as described in Section 5.2. Select the ***Temperature Curves*** Window.

2) Using the roll menu at the right of the ***Add new temperature curve*** line, select the number of the curve to be created. Neither curve 00 nor an already existing curve number will be available. Curve 0 is selected during gage operation to disable compensation for thermal expansion.

3) In the Temperature Curve Details, enter the ***TEMPERATURE*** and corresponding ***CORRECTION FACTOR*** for each point in turn. Click the ***ADD*** button to insert each point, as it is entered, into the table. Points may be entered in any order and will be sorted by temperature when the curve is saved.

4) When all points have been entered, press the ***SAVE*** button to save the table in the memory of the scanner.

Existing points can be changed or deleted with the ***MODIFY*** and ***REMOVE*** buttons. A graphical representation of the table is presented on the right side of the window.

To delete a curve:

Select the curve from the roll menu at the right of the ***Get Available Temperature Curve*** line and then press the X button.

7.3.2 Discrete I/O Scaling

Strip temperature input may be scaled either in ˚C or ˚F; however, the units used must be the same as those used to enter the alloy expansion curves.

Strip speed must be scaled in units of meters per second.

To scale an analog input or output:

1) Launch the maintenance interface as described in Section 5.2. Select the ***IO Scaling*** window.

2) Select the required ***IO Channel*** from the roll menus.

3) Enter the required scaling in the corresponding field (Minimum and Maximum of Physical Signal and Engineering Value).

   Note: The physical signals will be within the +/-10 V or 4-20mA ranges, regarding the type of Input/output installed.

   For example: For a strip width range from 800 to 1200 mm with an output voltage range from 0 V to +10 V, then you must enter:

	Min.	Max.	
Physical Signal	0.0	10.0	
Engineering Value	800.0	1200.0	mm

   If the strip width range is from 600 to 1500 mm with an output voltage range from -5V to +5V, then you must enter:

	Min.	Max.	
Physical Signal	-5.0	5.0	
Engineering Value	600.0	1500.0	mm

4) Press ***SAVE SCALING***

7.4 On-line Inputs

7.4.1 Strip Velocity and Temperature

Strip velocity and temperature can be input:

- By the host computer.
- If the optional discrete I/O is installed, as analog signals from the user's speed sensor and pyrometer. See Section 7.3.2.

7.4.2 Alloy Expansion Curve Selection

The active alloy expansion curve can be selected:

- By the host computer.
- In the Maintenance Interface ***Temperature Curves*** Window:

1) Launch the Maintenance Interface (Section 5.2).
2) Select the ***Temperature Curves*** Window.
3) Select the curve using the ***GET AVAILABLE TEMPERATURE CURVE*** roll menu.
5) Press the ***SET ACTIVE*** button.

The selected curve is:

- Implemented immediately by the gage.
- Displayed in the ***TEMPERATURE CURVE*** box in the Maintenance Interface ***Measurement*** Window.

PART 8

MAINTENANCE

8.1 Introduction

Accuband width gages require little routine maintenance to ensure peak performance, a long service life and minimum down time.

This part of the manual includes:

- The routine maintenance schedule and procedures.
- Repair procedures for all user serviceable components. For assistance with troubleshooting, see part 9 of this manual.

Other service operations required to maintain optimum gage performance will require the services of qualified KELK personnel.

8.2 Schedule

The recommended routine maintenance schedule is given in Table 8.1.

Service		**See Section**	**Service Interval**		
			1 Wk	**4 Wk**	**1 Yr**
Calibration	Check gage accuracy	8.3	As required by mill quality control schedule		
Scanner	Check camera lens covers and laser window and clean if necessary	8.4		x	
Scanner Power Supply	Dust cabinet interior and tighten terminal screws	8.5.1			x
	Inspect pilot lamps	8.5.2		x	
Backlight	Inspect	8.6	x		
Backlight Junction Box	Dust cabinet interior and tighten terminal screws	8.8			x

Table 8.1 Maintenance Schedule

The recommended 1 and 4 week service intervals are recommendations only and will vary depending on mill environment. It is advisable that mill maintenance personnel hold to the maintenance schedule for the first year, observing how often various components of the system require cleaning or replacement depending on the surrounding environment. The maintenance service interval may then be adjusted to provide the gage/scanner with proper maintenance at the right time.

8.3 Accuracy Verification

The maintenance interface calibration verification routine determines gage accuracy by statistical analysis of many width measurements (usually 5000) of a rocking calibrator. There are two stages:

Stage 1 - Positioning the calibrator on the roll table.

Stage 2 - Running the verification routine.

Equipment & Consumables:

- Calibrator with carrier
- PC or laptop with Ethernet port, Web browser and JAVA Runtime Engine
- 2 m (6 ft.) RJ-45 crossover cable

Warning

The rocking beam in the calibrator has the potential to pinch hands or fingers. It is advisable to keep hands away from the beam when it is moving.

8.3.1 Stage 1 - Position Calibrator on Roll Table

Being the reference against which gage accuracy is checked, the calibrator must be accurately positioned on the roll table. It must be perpendicular to, and its center must be on, the roll table centerline.

1) Place the calibrator carrier on the roll table with the "V" notch registering on the key roll (Fig 8.1). The tilt adjustment screw should rest on the adjacent roller.

Note

The key roll is normally at right angles to the roll table centerline. If it is disturbed by a mill wreck, or repairs, it must be surveyed and adjusted to 90° ± 0.5° to the roll table centerline. Should the key roll become grooved or damaged in the areas of contact with the Carrier, it must be replaced or repaired.

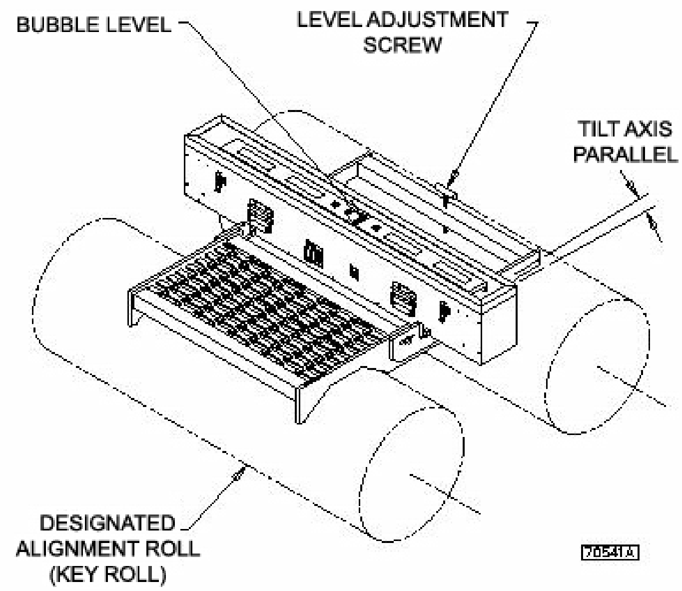


Figure 8.1 Calibrator Placement

2) Place the calibrator in the carrier slot, loosen the cover latches, and swing the cover in the open position.

> **Note**
>
> The cover protects the calibrator from dirt and impact damage. It should only be opened when the calibrator is in use and should be replaced immediately afterwards.

3) Remove the dust cover from the power cable connector, then connect the cable to the calibrator. Secure the connector with the latch provided.

4) Center the calibrator laterally. The center of the calibrator defines the point from which centerline deviation is measured. Ensure that it is accurately positioned.

5) Adjust the carrier tilt screw until the bubble on the spirit level (located at middle of calibrator) is centered.

8.3.2 Stage 2 - Verification

1) Rock the calibrator beam by pressing the motor control switch - RUN momentarily. The calibrator must rock continuously for the calibration verification to succeed. Ensure that the calibrator is illuminated to a medium-high intensity. Use the Light control switch - LOW / HIGH to adjust the lamp brightness.

2) Launch the Maintenance Interface (Section 5.2). Select the ***Width Verification*** Window.

3) Change the number of width measurements to be sampled (default 100) in the ***NUMBER OF SAMPLES*** box to 5000. This will allow enough time to take width samples for all extreme tilts of the calibrator.

4) Press the ***MEASURE NOW*** button to initiate the verification.

5) The result is displayed in the ***MINIMUM WIDTH***, ***MAXIMUM WIDTH***, ***SPREAD***, ***MEAN WIDTH*** and ***STANDARD DEVIATION*** boxes. If acceptable, this concludes accuracy verification. For reference, a short calibrator measures 1080 mm, and a long calibrator measures 1549.4 mm. See section 6.2.4 (Phase 4) verification example for more detail on how to verify if measured results are within specifications.

   If the result is unacceptable, leave the calibrator on the roll table and perform a short calibration, Section 6.2.

8.4 Scanner

8.4.1 Lens and Laser Cover Glass Cleaning

The exterior surfaces of the lens and laser cover glasses are exposed to finely divided oil, moisture and contaminants in the surrounding air; they must be cleaned regularly to ensure problem free gage operation.

Equipment and Consumables:

- Texwipe Optics Pads (TX 811)
- Large ¼" slot head screwdriver

Procedure:

1) Ensure that the Laser switch on the scanner power supply and calibrator controls is OFF and that the Laser-On lamp is OFF.

Warning

Although accidental exposure to the CDRH Class 2 solid state laser used in this procedure is unlikely to cause injury to skin or eye tissue, continuous exposure may result in eye damage or blindness.

2) Release the two latches securing the scanner to the plenum chamber, then tilt the scanner back on its hinges and lock the support arm (Figure 8.2). Be sure to use the optic guard to tilt the scanner - this provides better leverage and protects the scanner components from damage.

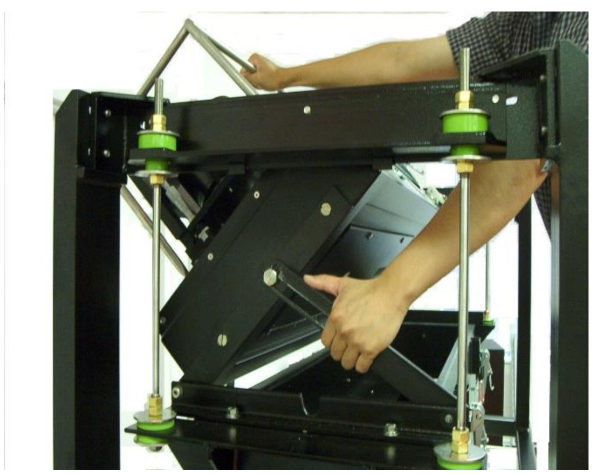


Figure 8.2 Support Arm

3) Release the camera port access panel by rotating its two quarter-turn slot head fasteners counterclockwise (Figure 8.3).

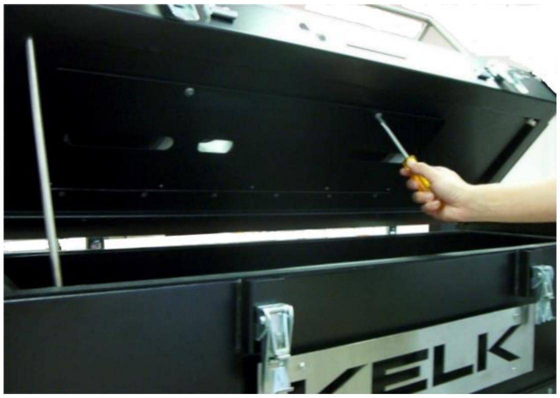


Figure 8.3 Access Panel

4) Remove a pre-moistened optic pad from its sealed pack and open fully.

5) With one half of the pad, wipe the external surface of the camera A lens cover glass free of contaminants. Make sure not to touch the lens or the wiping surface of the pad.

6) Wait until the moisture in the pad evaporates, then, using the clean half of the pad, gently polish the surface of the cover glass with a circular motion.

7) Clean the external surface of the camera B lens cover glass in a similar manner, using a fresh pad.

8) Clean the laser window in a similar manner.

9) Close the access panel and secure it by rotating the quarter-turn fasteners clockwise.

10) Unlock the support arm by supporting the scanner with one hand (grasping the optics guard) and knocking the support arm upwards with the other, disengage the lock notch. Then gently lower the scanner to rest on the plenum chamber, cameras pointing down.

11) Engage and secure the two plenum chamber clamps to the scanner.

8.4.2 Camera Replacement

The cameras contain no user serviceable parts. If one of the two were to malfunction, it must be replaced.

Equipment & Consumables:

- Replacement camera
- 5/32" Allen (hex) head screwdriver (ball type)

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Disconnect the Fiber-optic connector from the camera.

Caution

The Fiber-optic cable is a precision optical device. Do not pull or kink it. Take care to ensure that exposed cable and camera connections do not get dirty. Do not touch the connections!

Figure 8.4 Camera Removal

3) Push downwards along the bead of the camera port seal to disengage it from the lens cover slot.

4) Loosen both camera clamps (Figure 8.4) and lift the Camera from its mounting plate.

5) Position the replacement camera on the mounting plate, ensuring that the positioning pin slips into the alignment disk slot (Figure 8.5).

6) Position the two camera clamps and tighten the retaining screws.

7) Ensure that the bead of the camera seal is sitting in the lens cover slot. If it is necessary to access the underside of the seal via the camera port access panel (Figure 8.6), see Section 8.4.1 for access instructions.

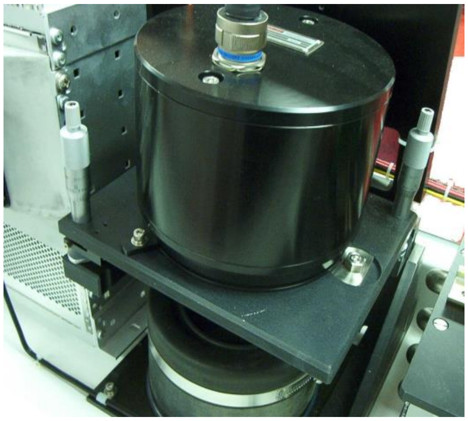


Figure 8.5 Camera Installation

Figure 8.6 Seal Bead Positioning

8) Remove the dust cover from the new camera's optical connector and connect the Fiber-optic cable. Place the dust cover on the defective camera's optical connector.

9) Perform a full calibration (Part 6).

10) Return the defective camera to KELK for inspection and repair.

8.4.3 Processing Unit Module Replacement

The processing unit comprises of one CPU module, two camera interface modules and one power supply module, mounted in a card cage. These modules contain no user serviceable parts. If one fails, it must be replaced.

Equipment & Consumables:

- Replacement module, as applicable
- Small Phillips head screwdriver

Caution

Electrostatic discharge (ESD) can damage static sensitive components used in the gage. To prevent ESD, follow the guidelines given below when handling, removing and installing the modules.

- Handle modules as little as possible.
- Store and transport modules only in static shielding bags or containers.
- Wear a grounded wrist strap when handling modules not in protective packaging.
- Do not place modules on any surface other than a properly grounded static dissipative mat.
- Before installing or removing any module, ensure that the equipment is properly grounded and ground the wrist strap to the equipment chassis.

Procedure:

1) Place the Power switch on the scanner power supply and calibrator controls in the OFF position.

2) Unlatch and remove the scanner lid.

3) To remove the defective module, loosen the two Phillips head screws securing the module. Release the ejector lock and press the ejector down to eject the module.

4) Install the new module. Ensure that the ejector is locked and tighten the Phillips head screws. If a new CPU module is installed, check if the proper Compact Flash card is inserted.

5) Replace the scanner lid ensuring that it is properly seated and latched.

6) Power-up the gage as required. Return the defective module to KELK for inspection and repair.

8.4.4 Fan Replacement

Equipment & Consumables:

- Fan, KELK Part Number *00207
- A short ¼" slot head screw driver

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Unlatch and remove the scanner lid.

3) Remove the defective fan - unplug the power cord by pulling on the connector, then release the four screws holding the fan.

4) Install the new fan, ensuring that the connector is in the same orientation as that on the defective fan. Connect the power cord.

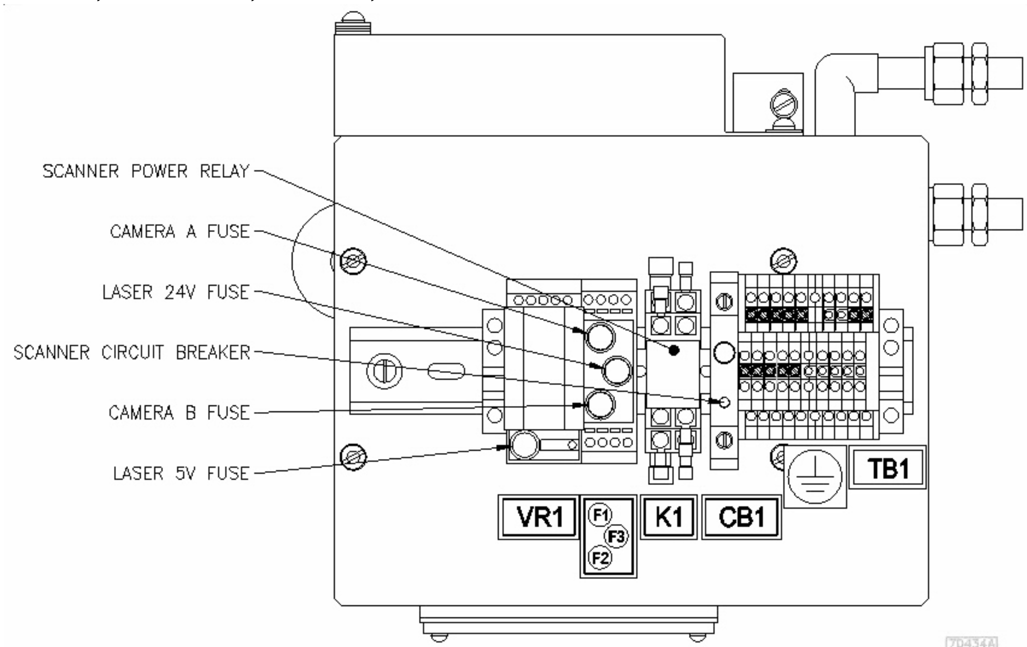
5) Power-up the gage and ensure that the new fan is operating properly.

6) Replace the scanner lid, ensuring that it is properly seated and latched.

8.4.5 Fuse Replacement

Equipment & Consumables:

- Fuse, 5 x 20 mm, 630 mA, KELK Part Number *03253



- **Figure 8.7 Scanner Fuses**

Procedure:

1) Place the Power switch on the Scanner Power Supply in the OFF position.

2) Unlatch and remove the scanner lid.

3) Replace the fuse, see Figure 8.7. The fuse is held in a bayonet cap. To remove the old fuse, turn the cap counterclockwise and withdraw it.

4) Replace the scanner lid, ensuring that it is properly seated and latched.

5) Power-up the gage as required.

8.4.6 Overheat Relay Replacement

Equipment & Consumables:

- Relay, KELK Part Number *06835

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Unlatch and remove the scanner lid.

3) Replace the relay.

4) Replace the scanner lid, ensuring that it is properly seated and latched.

5) Power-up the gage as required.

8.4.7 Thermostat Replacement

Equipment & Consumables:

- Thermostat, KELK Part Number *06878

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Unlatch and remove the scanner lid.

3) The thermostat is soldered to the wires. Unsolder the wires first, replace the thermostat and re-solder the wires to the new thermostat.

4) Replace the scanner lid, ensuring that it is properly seated and latched.

5) Power-up the gage as required.

8.5 Scanner Power Supply

8.5.1 Interior and Terminals

Accumulated dust can cause a short circuit at the power input terminals. Expansion and contraction of the power cable and terminal strip can loosen the terminal screws.

Equipment & Consumables:

- Soft brush or portable vacuum
- 3/16" insulated slot head screwdriver

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Place the mill power disconnect in the OFF position and post a notice at the disconnect that maintenance is being performed.

Warning
Shock hazard. Failure to disconnect electrical power and post a warning notice can result in injury or death.

3) Dust cabinet interior with a soft brush or portable vacuum.

4) Tighten all electrical terminal screws.

5) Place the mill power disconnect in the ON position. Then power-up the gage as required.

8.5.2 Lamp Replacement

Equipment & Consumables:

- 6 W, 24 V incandescent lamp, S6 bayonet mount, KELK Part Number *05482
- Lamp removal tool

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Remove the pilot light lens by rotating the metal lens holder counterclockwise. Do not open the cabinet - the lamps can be changed from the outside.

3) Using the lamp removal tool, push in and rotate the dead lamp one quarter-turn counterclockwise, then withdraw it. Install the replacement lamp.
4) Replace the lens.

5) Power-up the gage as required.

8.5.3 Power Supply Replacement

Equipment & Consumables:

- Power Supply, KELK Part Number *06919
- ¼" slot head screwdriver

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Place the mill power disconnect in the OFF position and post a notice at the disconnect that maintenance is being performed.

Warning

Shock hazard. Failure to disconnect electrical power and post a warning notice can result in injury or death.

3) Disconnect the wiring. Remove the mounting screws. Replace the power supply. Transfer the mounting bars to the new power supply. Mount the new power supply and connect the wiring.

4) Place mill power disconnect in the ON position. Then power-up the gage as required.

8.5.4 Relay Replacement

Equipment & Consumables:

- Relay, KELK Part Number *06872

Procedure:

1) Place the power switch on the scanner power supply in the OFF position.

2) Place the mill power disconnect in the OFF position and post a notice at the disconnect that maintenance is being performed.

Warning

Shock hazard. Failure to disconnect electrical power and post a warning notice can result in injury or death.

3) Replace the relay.

4) Place mill power disconnect in the ON position. Power-up the gage as required.

8.6 Backlight Inspection

The backlight will collect oil and debris despite the flow of water across its surface. When the opportunity presents itself, or as experience dictates, the window should be cleared of debris, cleaned, then inspected for damage, marks, condensation and burned lamps.

Equipment & Consumables:

- Warm clean water & bucket
- Two soft cloths
- Tool to adjust pressure regulating valve

Procedure:

1) Place the circuit breaker for the backlight junction box in the OFF position. Close the cold water valve to the backlight manifold.

2) Withdraw the backlight from beneath the roll table.

3) Clear window of debris, and wash with soapy water.

Caution

Do not use alcohol, optical pads, abrasives, or commercial cleaners other than mild detergent to clean the Lexan window. Failure to comply with this caution can cause permanent clouding of the window

4) Dry and polish the window with a soft cloth.

5) Inspect the window for permanent marks or damage. It should be replaced if it is punctured, cracked, gouged, or optically impaired. Stains and marks that cannot be removed with soap and water or a thumbnail and which are read by the gage as an edge classify the window as optically impaired. Abrasions and surface scratches do not weaken the window significantly and, when wet, may become invisible. To check if small stains, marks or abrasions are acceptable:

   a. Ensure that the backlight is in position under the roll table and is being washed with water from the manifold.

   b. Place the circuit breaker on the backlight junction box in the ON position.

   c. Launch the maintenance interface (Section 5.2). Select the ***Alignment*** window. Select ***CAMERA_A*** or ***CAMERA_B Enable*** and press ***START*** to view the video display. If no false edges are indicated, the backlight window is not optically impaired.

   d. Return the circuit breaker to the OFF position.

6) Inspect the window for signs of condensation, which appear as fog or droplets on its interior surface. If condensation is observed, the unit should be cleaned and

resealed according to the instructions in Section 8.7. Leaks may be identified by spraying suspect areas with soapy water and looking for bubbles.

Caution

Do not increase instrument air or nitrogen pressure when searching for leaks. Excessive pressure may damage the window and/or the seals.

7) Energize the backlight by placing the circuit breaker on the backlight junction box to the ON position, then wait until the lamps on the backlight are fully lit before proceeding.

8) To confirm a visual indication of dead or dying lamps:

a. Ensure that the backlight is in position under the roll table with the cooling water turned off.

b. Launch the Maintenance Interface (Section 5.2) and select the **Alignment** Window.

The **GAIN** readouts for **CAMERA_A** and **CAMERA_B** should be approximately the same as those recorded in the maintenance log when the lamps were last replaced. If they have increased significantly, one or more of the lamps is dead or dying. Lamp replacement is described in Section 8.7.

Note

Lamp life is typically six months; however, it is dependent on gage use, vibration and lamp configuration.

9) Adjust the pressure regulating valves on the instrument air or dry nitrogen supply so that first pressure gage is reading 25 PSI and the second one (closer to backlight) 1.5 PSI.

Caution

This value should not be exceeded. Excess pressure may distort Lexan window over time.

10) Before returning the backlight to service, open the cold water valve and ensure that water from the manifold is washing the backlight window evenly and completely.

Caution

Never roll strip without the backlight water flowing. A dry window will be damaged by heat from the metal strip.

8.7 Backlight Service

Backlight service requires:

- Disassembly (Section 8.7.1)
- Cleaning or replacement of the affected component (Sections 8.7.2, 8.7.3 or 8.7.4)
- Reassembly (Section 8.7.5)

Note

Due to the downtime and work involved in replacing a dead or dying lamp, it is recommended that when the backlight is opened for any reason, all lamps should be replaced.

Whenever possible, installation of a new window should be scheduled in advance. Window replacement requires the participation of several people - three for disassembly and four for reassembly. The sealant also requires 72 hours to cure before the backlight can be pressurized and returned to service.

8.7.1 Backlight Disassembly

Equipment & Consumables:

- Soft cloth
- Torque wrench, with 1/2" hex socket
- Table or trolley about waist high, sufficient to support the lamp tray.

Procedure:

1) Place the circuit breaker on the backlight junction box in the OFF position.

2) Place the mill power disconnect in the OFF position and post a notice at the disconnect that maintenance is being performed.

Warning

Shock hazard. Failure to disconnect electrical power and post a warning notice can result in injury or death.

3) Ensure that the cold water valve connected to the backlight manifold is closed.

4) Close the instrument air or dry nitrogen valve connected to the backlight end plate.

5) Withdraw the backlight from its position under the roll table. Dry with a cloth to prevent moisture from entering when opened.

6) Release the six endplate retaining bolts (Figure 8.8). Then, grasping the handle, withdraw the lamp tray carefully so that it does not drop when the far end clears the backlight. Place it on a table or trolley, do not place it on the floor where contaminants can enter and impair its optical quality. One person can normally handle this task; however, for long backlights, two people may be required.

Figure 8.8 Lamp Tray Removal

8.7.2 Lamp Replacement

Equipment & Consumables:

- Lamps. Size dependent on backlight design, see documentation supplied with gage or consult KELK.

Procedure:

Caution

Do not proceed with lamp replacement unless the tray has been fully withdrawn from the backlight housing. The clearance between the lamps and the diffuser retainer is small and any attempt to replace a lamp may result in breakage.

8.7.3 Diffuser Cleaning/Replacement

Equipment & Consumables:

- 3/16" slot head screwdriver
- Warm, clean water and bucket
- Detergent
- Diffusers, as required

Procedure:

1) Remove the diffuser retainer assembly mounting screws and lock washers by rotating in a counter-clockwise direction (Figure 8.10). Keep the spring loaded assembly pressed against the diffuser tracks to make removal easier and prevent it from springing out when the second screw is removed.

2) Grasp both loops of the diffuser removal cable and pull slowly to slide the first plastic diffuser section sufficiently far out of its tracks that it can be grasped and withdrawn by hand. Remove the diffuser, holding it by its edges. Remove the second section in a similar manner.

3) Clean the diffuser sections, washing with warm soapy water and polishing with a clean dry cloth. Replace them if they cannot be properly cleaned.

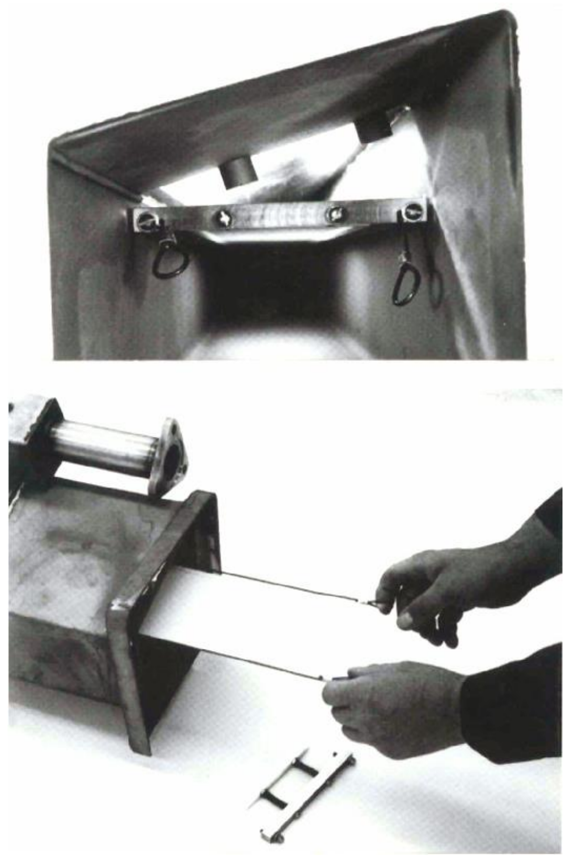


Figure 8.10 Diffuser Removal

> **Note**
>
> Spare diffusers can accumulate dust or other contaminants. Inspect and clean, if necessary.

3) Slide the first diffuser section into the grooves in the track, then push it into the backlight housing until its trailing edge is several inches past the beginning of the track (Figure 8.11). Handle the diffuser by its edges. As it slides along the track, the removal cable will be pulled along. Ensure that the cable feeds evenly down the excess space in the grooves beside the diffuser.

4)

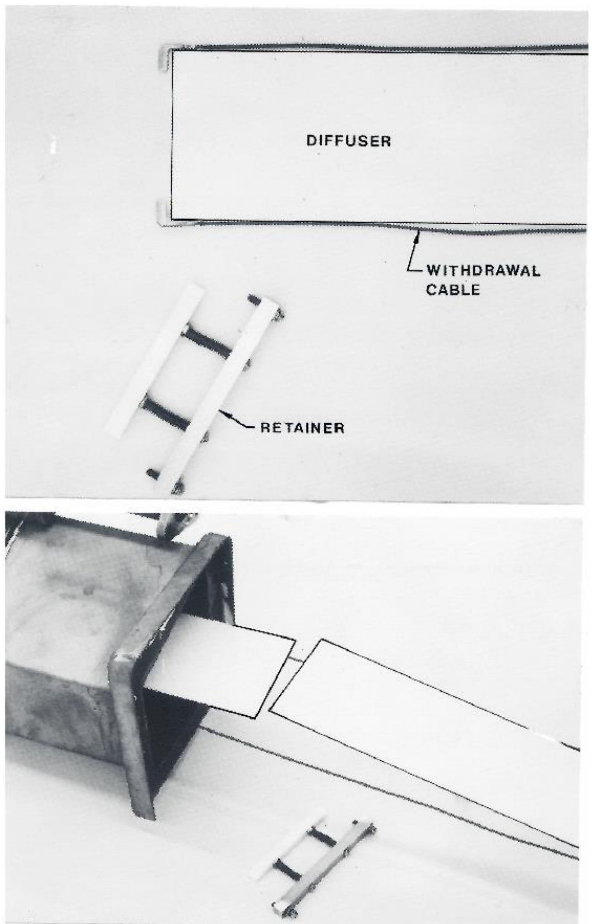


Figure 8.11 Diffuser Replacement

5) Place the second diffuser section in the grooves and carefully slide it all the way into the backlight housing, pushing the first section ahead of it. Ensure that the removal cable feeds properly into position.

6) Slide the front bar of the retainer assembly into the grooves, snug against the diffuser edge. Then push evenly on the retainer, compressing the springs until it sits against the track. Reinstall the retainer mounting screws and lock washers. Ensure that the removal cables are in their slots in the retainer, not bent or pinched between the retainer and the grooves.

8.7.4 Window Replacement

Equipment & Consumables:

- Torque wrench with 1/2" hex socket
- Utility knife
- 0.3 meter (1 ft) length of fine piano wire, with a grip on each end.
- General Electric RTV Silicone adhesive sealant RTV102
- Silicone solvent
- Never-Seez thread compound
- Lexan window

Procedure:

> **Note**
>
> This procedure includes time sensitive operations. All participants must be thoroughly familiar with their duties before embarking on it. Any delays may result in an unsatisfactory seal, requiring that it be repeated.

1) This step requires three people. Loosen the nuts on the manifold retaining bolts (Figure 8.12). Then, with one person supporting each end of the manifold, have a third person remove the nuts, washers, lock washers and retaining bolts. Lift off the manifold and remove the manifold spacer.

Figure 8.12 Manifold Removal

2) Remove the bolts on the long and short clamp strips and lift off the strips.

3) Separate the old window from the backlight housing using a piano wire drawn between the seal and the backlight housing. The wire should be kept taut and forced against the housing, as it is drawn along, so that it cuts the silicone sealant evenly and at the bond.

4) Remove the remaining sealant down to metal with silicone solvent, as directed by the solvent manufacturer. Ensure that the window seat is clean, dry and totally free of solvent.

5) Carefully coat the threads of the retaining bolts with Never-Seez compound.

Caution

Failure to coat the bolts with Never-Seez compound will result in seizing of the stainless steel to stainless steel contact area and may cause permanent damage.

6) Remove the adhesive protective film from both sides of the window and ensure that it is spotless.

Note

The window will be virtually impossible to clean from the inside once it is mounted. Handle it by the edges to keep it spotless during mounting.

7) This step requires three people. Form a 3 mm (1/8") bead of RTV Silicone around each window mounting bolt hole on the backlight housing (Figure 8.13). Then join the holes with a 3 mm (1/8") bead. Leave no gaps. The sealant forms a skin in 10 to 15 minutes, at which time its bonding properties diminish. The sealant must be applied quickly and accurately. Two people, each with a tube of sealant should start at the center and work in opposite directions, encircling the mounting holes. A third person should follow, joining the holes.

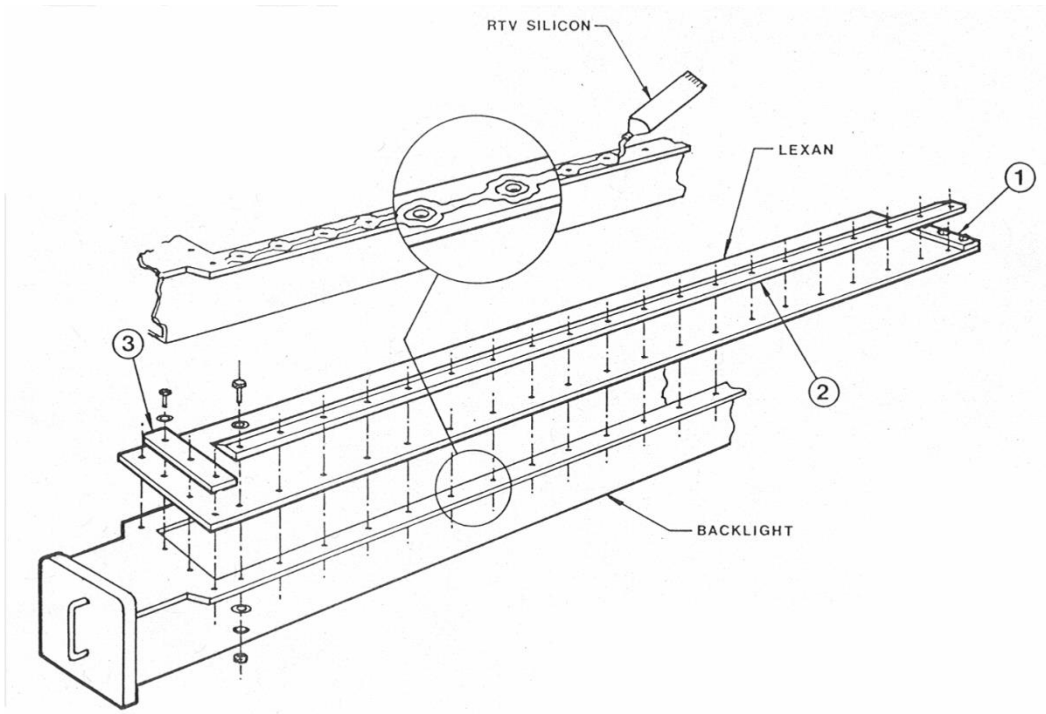


Figure 8.13 Window Installation

8) This step requires two people. Position the window on the housing, aligning the mounting holes in the window with those in the housing - hold the window by the edges and carefully lower it so that it finds the correct position the first time, without smearing the sealant. Then hold it, one person at each end, so that it does not move while others install the clamp strips and manifold, Steps 9 to 12.

9) Lay a short clamp strip on one end of the window and insert a bolt, with washer, in each mounting hole. Add washers, lock washers and hex nuts, fastening only enough to hold them on the bolts - not enough to put pressure on the window (Figure 8.13). Then place the remaining short clamp strip on the other end, followed by the long clamp strip, in a similar manner.

10) Starting at the middle of the long clamp strip, tighten alternate nuts finger tight - middle, third right, third left, fifth right, etc. Then continue on the short strips.

11) This step requires two people. Position the manifold spacer so that its mounting holes align with those on the window. Then lower the manifold on the spacer keeping all three sets of mounting holes - manifold, spacer and window - in alignment (Figure 8.14).

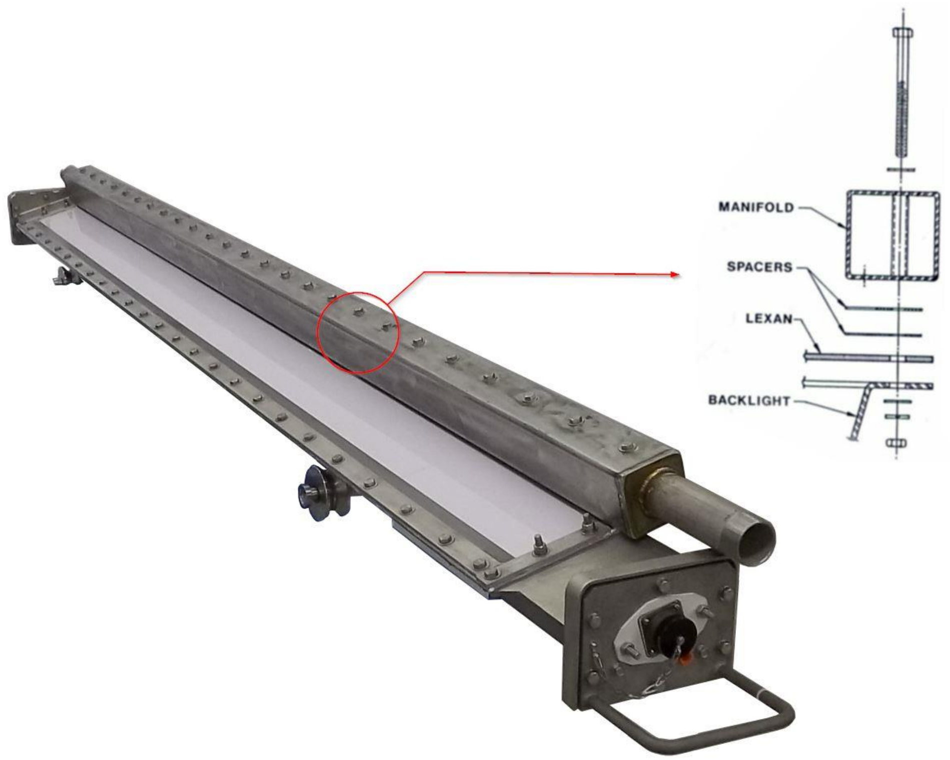


Figure 8.14 Manifold Installation

12) Insert a bolt, with washer, in each manifold mounting hole. Add washers, lock washers and hex nuts, fastening only enough to hold them on the bolts - not enough to put pressure on the window. Then tighten alternate nuts finger tight, left and right from center, as in Step 10. The people holding the ends of the window may now release their grip.

13) Tighten the remaining nuts finger tight, starting at the center of the long clamp strip and working alternatively left and right. Then, with a 1/2" socket wrench, repeat the process - every second left and right bolt, then the remaining left and right bolts - tightening only until resistance is met.

14) Tighten each bolt in a similar pattern to 10 ft. lb. Then, once more, begin at the first bolt and tighten to 20 ft. lb.

8.7.5 Backlight Reassembly

Equipment & Consumables:

- Torque wrench with 1/2" hex socket
- Never-Seez thread compound

Procedure:

1) Slide the lamp tray three quarters of the way into the housing. Inspect the gasket on the interior face of the end plate, ensure that it is both clean and dry.

2) Slide the lamp tray fully in, ensuring that the endplate gasket is tight against the housing.

3) Carefully coat the threads of the retaining bolts with Never-Seez compound.

> **Caution**
>
> Failure to coat the bolts with Never-Seez compound will result in seizing of the stainless steel to stainless steel contact area and may cause permanent damage.

4) Insert the six end plate retaining bolts with associated gaskets, washers, and lock washers - then screw the nuts on finger tight.

5) With a 1/2" socket wrench, tighten the bolts until resistance is met. Then tighten each bolt in turn to 10 ft. lb. Once more, begin at the first bolt and tighten each bolt in turn to 20 ft. lb.

6) If the window has been replaced, allow the Backlight to stand for 24 hours then use a utility knife to remove the excess sealant. Then let it stand for a further 48 hours (for a total of 72 hours) before pressurizing or returning to service.

> **Caution**
>
> The silicone sealant needs 72 hours to fully cure. The earlier application of pressure will dislodge the sealant or create bubbles.

7) Fully open the instrument air or dry nitrogen valve to the end plate, ensuring that the pressure regulators are set properly and the first pressure gage is reading 25 PSI and the second one (closer to backlight) 1.5 PSI.

8) Move the backlight into position under the roll table.

9) Place the mill power disconnect and the circuit breaker on the backlight junction box in their ON positions.

10) It is recommended that, at this stage, system gain be determined and recorded in the maintenance log. This information will be useful when subsequently checking for dead or dying lamps (Section 8.6). Launch the Maintenance Interface (Section 5.2) and select the ***Alignment*** Window. Record:
    - The ***GAIN*** readouts for ***CAMERA_A*** and ***CAMERA_B***
    - The number of lamps replaced at this time.

11) Before returning the backlight to service, open the cold water valve and ensure that water from the manifold is washing the backlight window evenly and completely.

> **Caution**
>
> Never roll strip without the backlight water flowing. A dry window will be damaged by heat from the metal strip.

8.8 Backlight Junction Box

Accumulated dust can cause a short circuit at the power input terminals. Expansion and contraction of the power cable and terminal strip can loosen the terminal screws.

Equipment & Consumables:

- Soft brush or portable vacuum
- 1/8" insulated slot head screwdriver

Procedure:

1) Place the circuit breaker on the backlight junction box in the OFF position.

Warning

Shock hazard. Failure to disconnect electrical power and post a warning notice can result in injury or death.

2) Place the mill power disconnect on the OFF position and post a notice at the disconnect that maintenance is being performed.

3) Loosen the retaining clamps and open the door.

4) Dust the cabinet interior with a soft brush or portable vacuum.

5) Tighten all electrical terminal screws.

6) Close the door and secure the clamps.

7) Place mill power disconnect in the ON position. Then power-up as required.

8.9 Calibrator

8.9.1 Lamp/Thermostat Replacement

Equipment and Consumables:

- 12 W, 12 V, Type T3 incandescent lamps, KELK Part Number *00630
- 250V, 10A, Thermostat, open at 200 ˚F (94 ˚C), KELK Part Number *07441
- 3/32" HEX head screwdriver
- Ohmmeter

Procedure:

1) Ensure that the calibrator is disconnected from the mill power supply.

Warning

Shock hazard. Failure to disconnect electrical power and post a warning notice can result in injury or death.

2) Unlatch and swing the cover in the open position. Tilt the central beam by hand to maximum tilt position. The central beam is mechanically attached to a plunger equipped with a ball locking mechanism which will slip to allow the beam movement when the motor is stopped. Loosen the two thumb screws located under the beam end without removing them completely. Carefully slide out the beam end plate which is attached to the calibrator mask and rest it on top of the beam end. Gently but firmly pull out the lamp tray with the fingers and withdraw it from the housing (Figure 8.15).

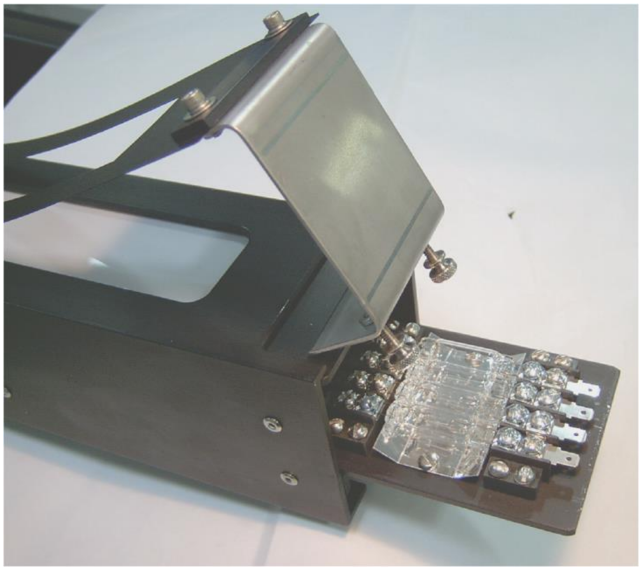


Figure 8.15 Calibrator Lamp Tray Removal

3) Inspect the lamps. A burned lamp is usually slightly darkened.

4) If a burned lamp is not detectable visually, trace it with an ohmmeter.

   Lamps are connected in series in banks of 8. A thermostat is connected in series with each bank. A calibrator contains 4 such banks (2 per side). The input voltage determines how these banks are wired.

   In a 120 V unit, the 4 banks are wired in parallel. If a lamp or a thermostat fails, one half of one side will fail to illuminate.

   In a 240 V unit, the 2 banks on each side are connected in series to form a collection of 16 lamps in total, and the two sides are then wired in parallel. If a lamp or a thermostat fails, one side will fail to illuminate.

   To trace the burned lamp, place one lead of the ohmmeter on the supply terminal for the bank and one on the ground terminal (Figure 8.16). Then, one terminal at a time, move the ground probe back one lamp/thermostat. The burned lamp or thermostat will be the one immediately prior to a continuity indication.

5) Replace the lamp/thermostat, then retest at the supply and ground terminals. Discontinuity indicates a second burned lamp/thermostat. Repeat the test in Steps 3 and 4 until all burned lamps/thermostats have been replaced.

6) Slide the lamp tray back into the housing, carefully attach the beam end plate and tighten the 2 end retaining screws.

7) Gently rock the central beam by hand towards the level position until the plunger ball locking mechanism engages again.

8) Connect the calibrator to the mill power supply and place the calibrator power switch in the ON position. Adjust the lamp brightness by pressing the Light control switch - HIGH/LOW. All the mask cutouts should be illuminated evenly.

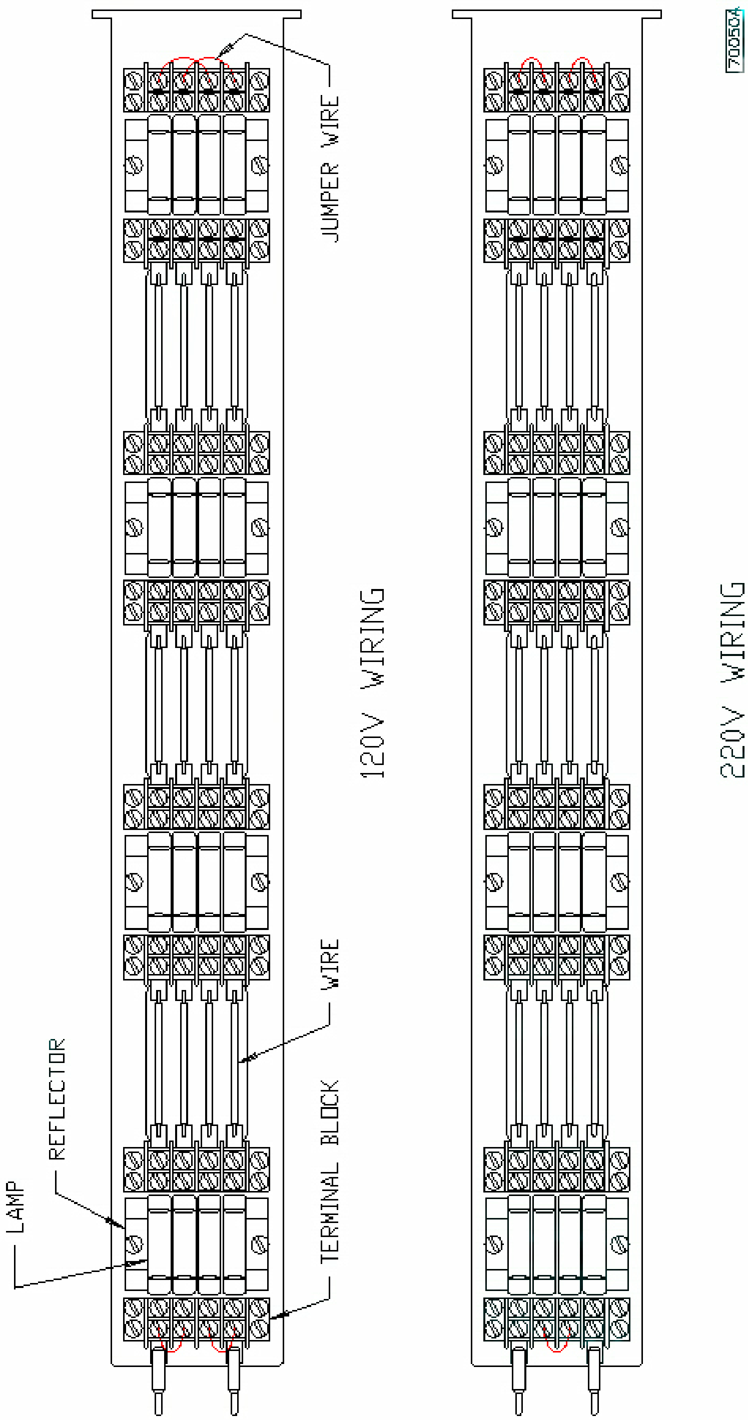


Figure 8.16 Continuity Test Setup

8.9.2 Fan Replacement

Equipment and Consumables:

- 24 VDC, 12CFM, 2.36” SQ, Fan, KELK Part Number *04847
- 9/64” Allen (hex) head screwdriver (ball type)
- 7/64” Allen (hex) head screwdriver (ball type)
- 3/32” Allen (hex) head screwdriver (ball type)

Procedure:

1) Ensure that the calibrator is disconnected from the mill power supply.

Warning

Shock hazard. Failure to disconnect electrical power and post a warning notice can result in injury or death.

2) Remove the cover of the calibrator on the side where the switches are located to gain access to the control box.

3) Unscrew the shaft of the calibrator beam.

4) With the shaft out, remove the calibrator beam to expose the top of the control box.

5) Disconnect the fan connector from the control board.

6) Remove the four screws to remove the fan from the control box.

7) Replace the fan and reconnect the fan connector to the control board. Replace the screws to secure the fan to the control box.

8) Replace the calibrator beam and shaft.

9) Replace the calibrator cover.

10) Power up the calibrator and test as necessary.

PART 9

TROUBLESHOOTING

9.1 Introduction

Troubleshooting assistance is presented in flow chart format, with a separate chart for each of four potential problem areas:

- Gage not working
- Measurement incorrect
- Laser not working
- Laser remote warning lamp not working

Repair procedures are described in Part 8.

9.2 Gage

If the gage is not working and communicating properly with the mill control system, work through gage troubleshooting - Charts A, B and C (Figures 9.1, 9.2 and 9.3), starting in Chart A, to identify the cause.

9.3 Measurement

This section assumes that the gage is running and communicating properly with the mill control system. If this is not the case, refer to Section 8.2. If strip measurement is incorrect, work through the Measurement Troubleshooting Chart, Figure 8.4.

9.4 Alignment Laser and Remote Warning Lamp

If the scanner alignment laser is not working, work through the alignment laser troubleshooting chart, Figure 9.5. If the laser remote warning lamp is not working, work through the laser warning lamp troubleshooting chart, Figure 9.6.

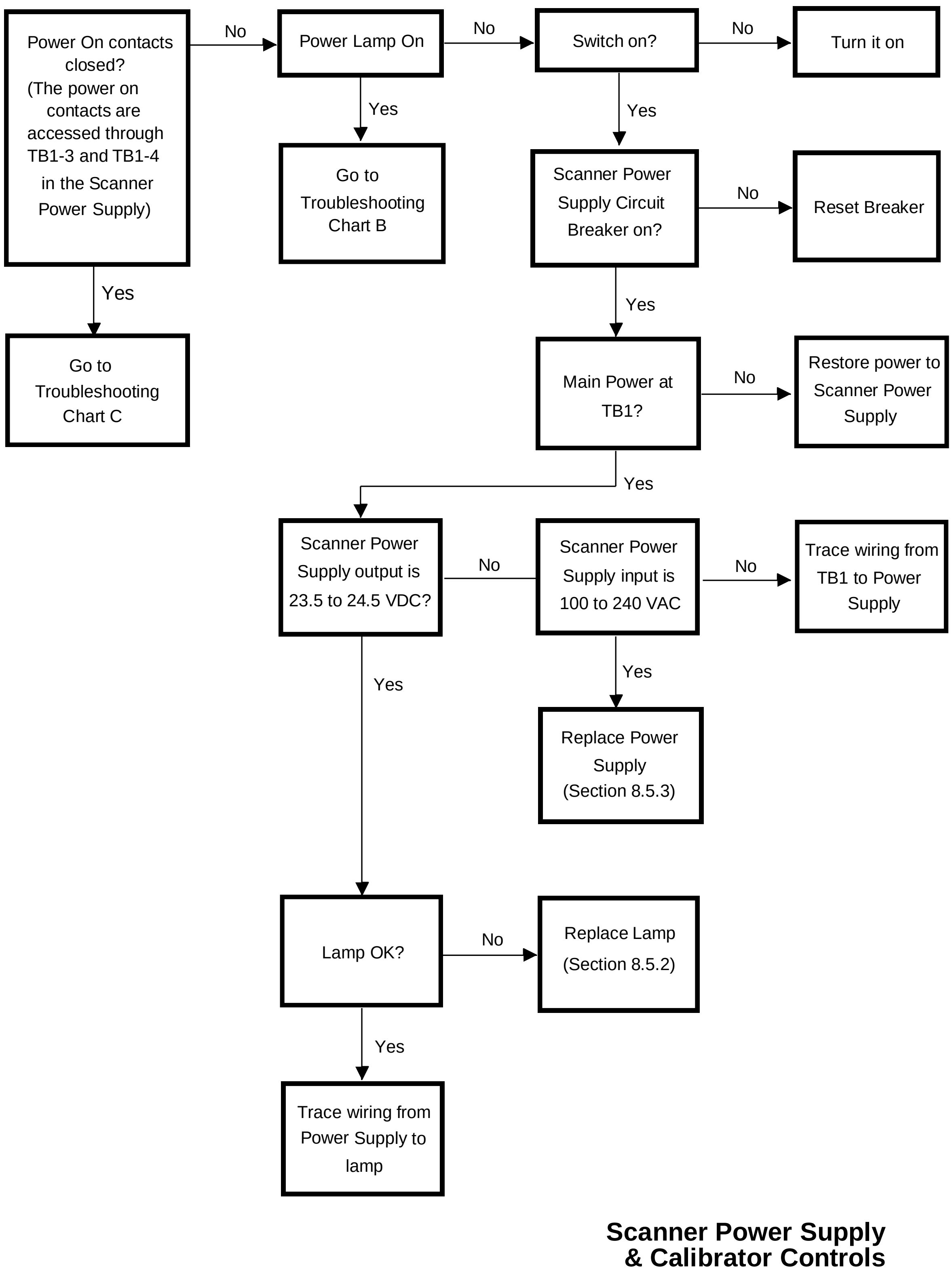


Figure 9.1 Gage Troubleshooting - Chart A

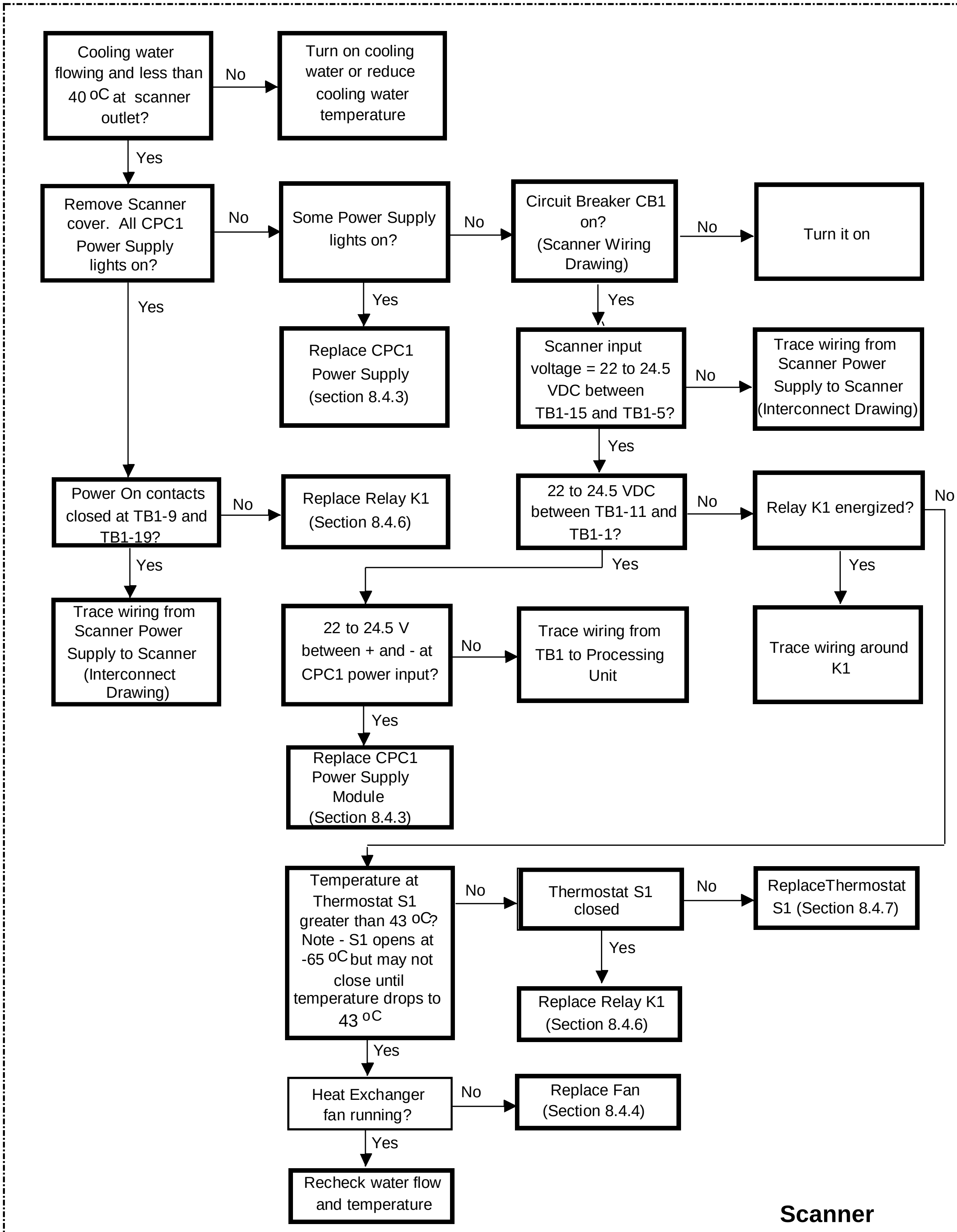


Figure 9.2 Gage Troubleshooting - Chart B

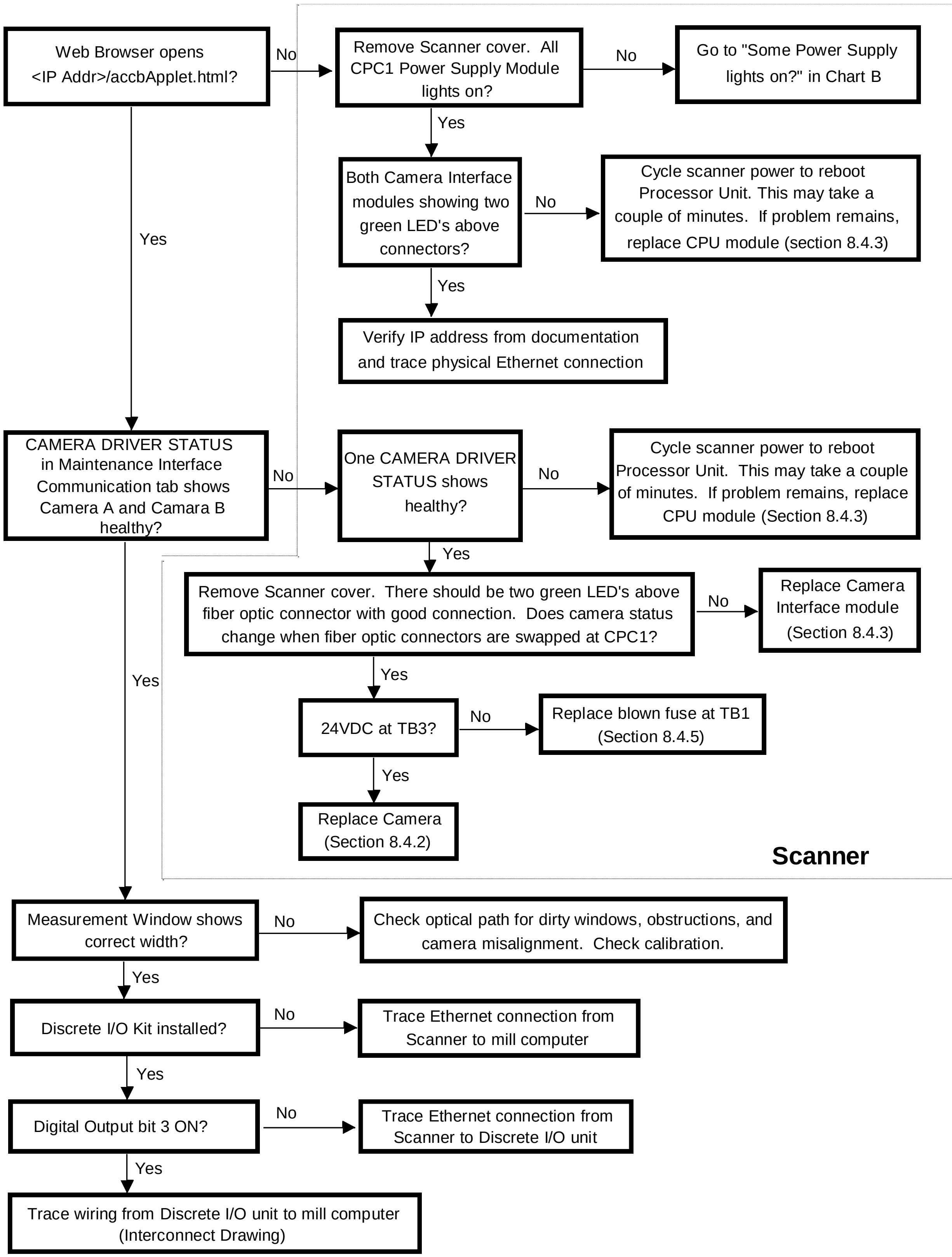


Figure 9.3 Gage Troubleshooting - Chart C

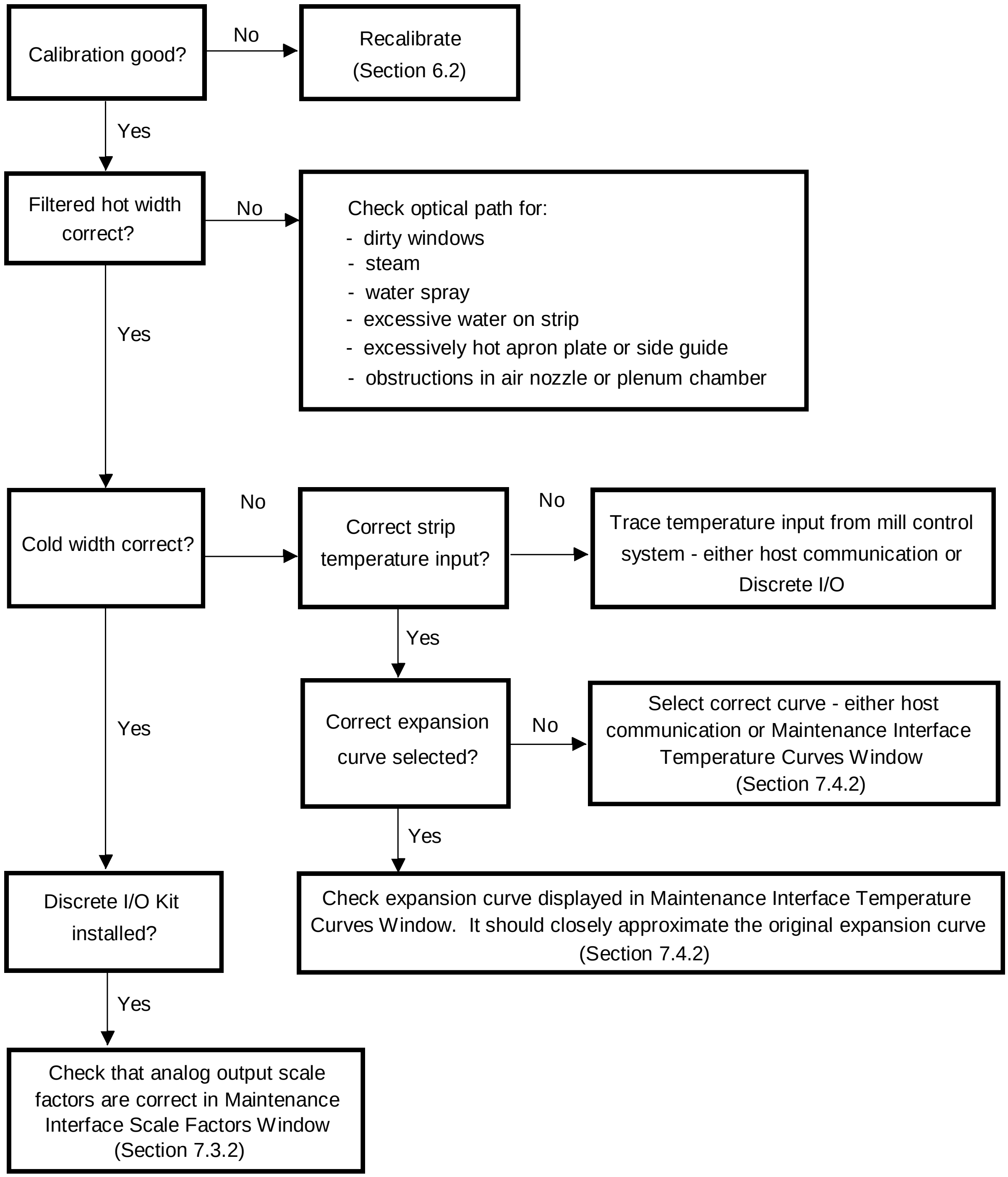


Figure 9.4 Measurement Troubleshooting

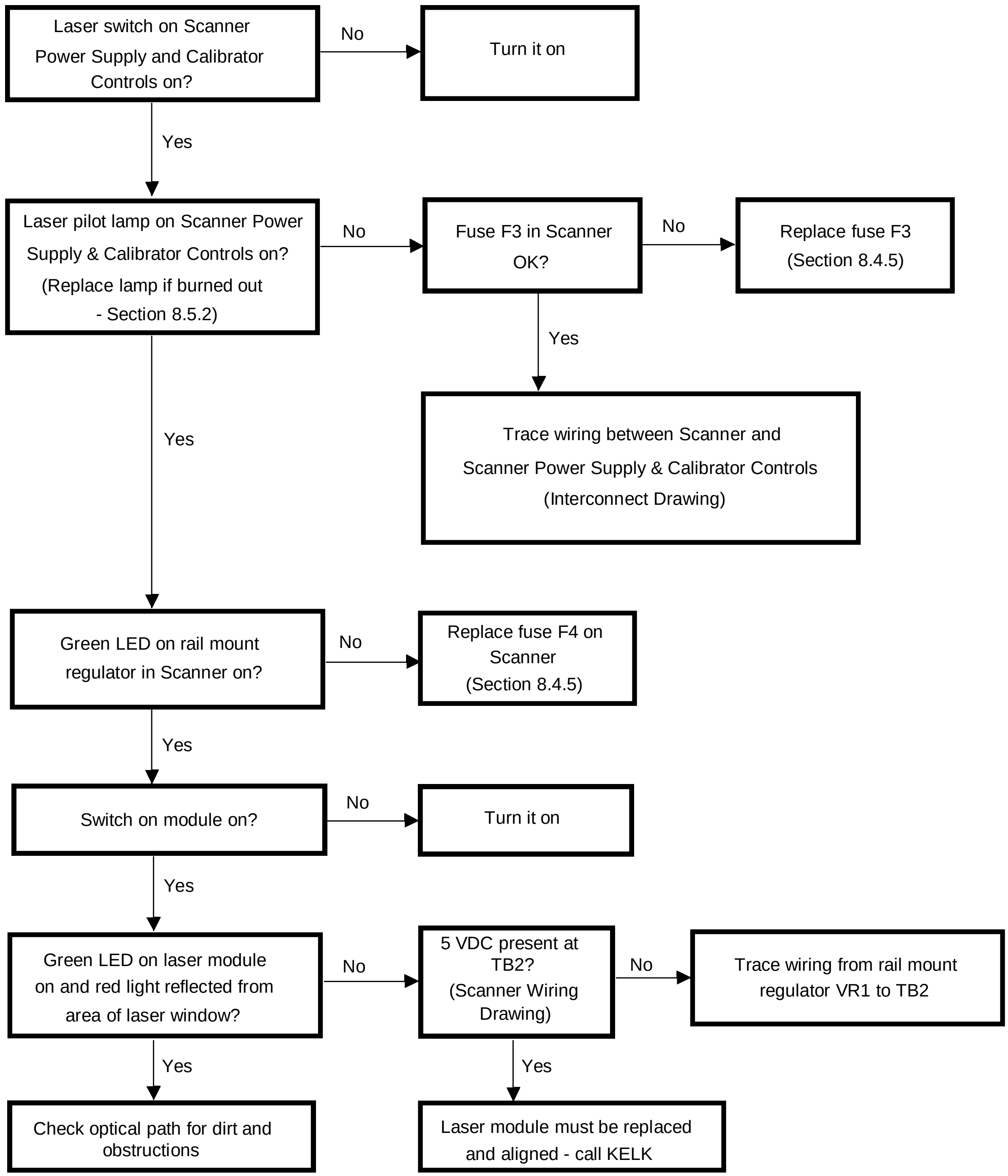


Figure 9.5 Alignment Laser Troubleshooting

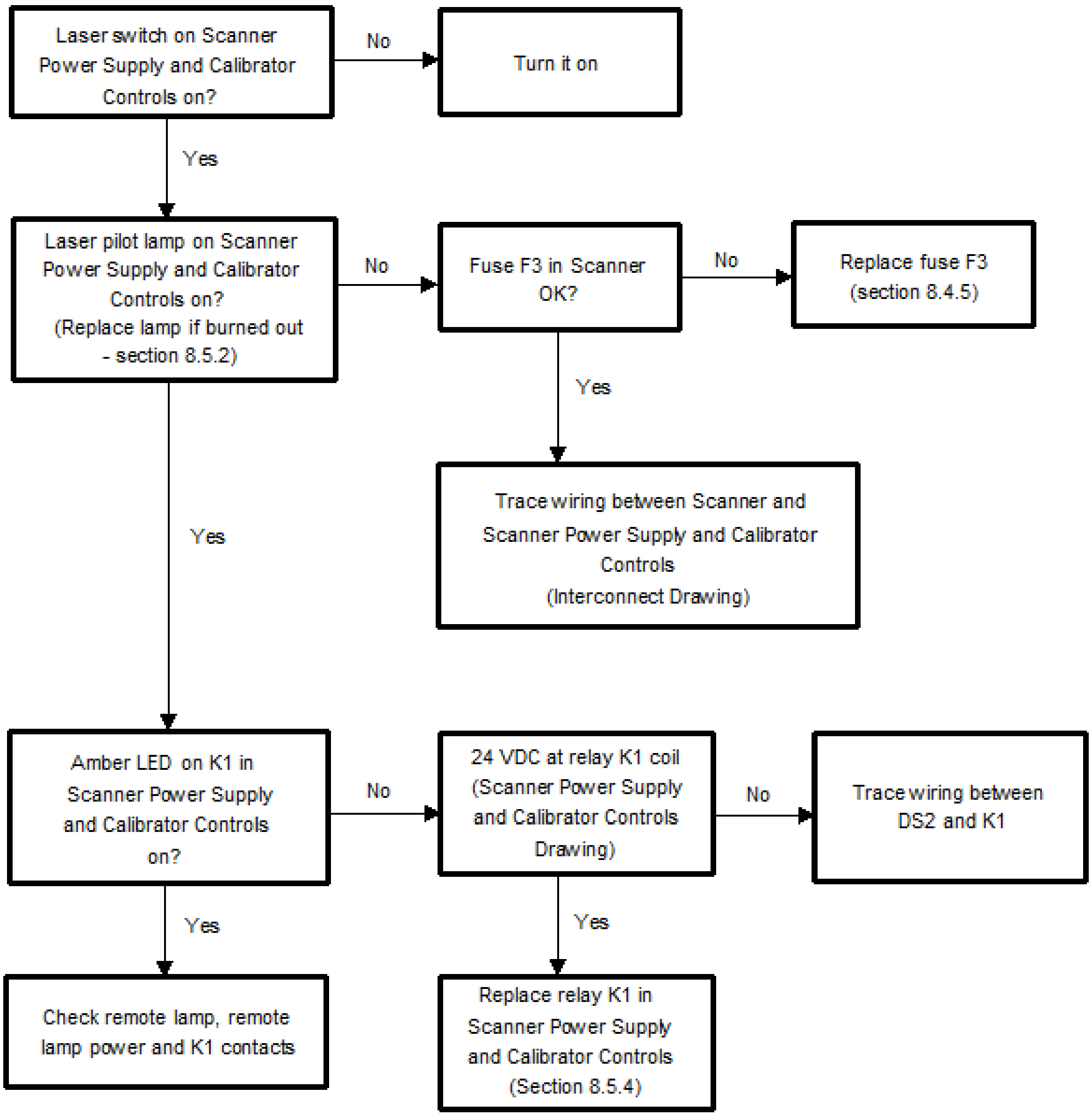


Figure 9.6 Remote Laser Warning Lamp Troubleshooting

PART 10

SPECIFICATION

10.1 Performance

Accuracy	± 0.4 mm (0.016 in.), 2 sigma for field of view up to 1550 mm (82.7 in.) wide
Repeatability (Static)	±0.16 mm (0.012 in.), 2 sigma for field of view up to 1550 mm (82.7 in.) wide
Measurement Frequency	Up to 1250 measurements per second
Head End Response	Less than 4 ms

10.2 Measurement Range

Strip Width	As specified by user
Field of View: Width	Strip width plus allowance for lateral movement, as specified by user
Height	450 mm (1.5 ft)
Strip Temperature:	
Model C965-A (IR)	600 °C to 1300 °C (1110 °F to 2370 °F)
Model C965-B (Backlight)	Cold to 600 °C (1110 °F)
Strip Edge Movement: Hop	Up to 450 mm at 1 m per second (1.5 ft at 3.3 ft per second)
Lateral	Up to 500 mm (1.6 ft) per second, must remain within field of view

10.3 Communications

Fieldbus	Ethernet (Modbus/TCP)
Logic Outputs: Scanner Power On	Contact rating 24 VAC/DC, 1 A
Alignment Laser On	Contact rating 24 VAC/DC, 5 A

10.4 Scanner

Power:	24 VDC, supplied from Scanner Power Supply
Circuit Breaker	10 A
Fuses	630 mA
Alignment Laser	CDRH Class 2, 10 mW, 635 nm solid state laser cross hair generator
Enclosure:	NEMA 4
Operating Environment	
Location	Fixed, indoors
Temperature	70 °C (160 °F) maximum
Humidity	100%, non condensing
Altitude	2000 m (6560 ft)
Pollution Degree	Ref IEC 61010-1
Cooling Water	10 L/min (2.7 USGPM), 40 °C (104 °F) maximum, 690 KPa (100 psig) maximum

10.5 Scanner Power Supply with Calibrator Controls

Power: 120/230 VAC	85 to 264 VAC, 47 to 440 Hz, 320 VA
Installation Overvoltage Category	II. Ref IEC 61010-1
Circuit Breaker	4 A
Operating Environment:	
Location	Fixed, indoors
Temperature	70 °C (160 °F) maximum. Overheat warning at 60 °C (140 °F)
Humidity	10 to 90%, non condensing
Altitude	2000 m (6560 ft)
Pollution Degree	Ref IEC 61010-1

10.6 Backlight

Power: 120 or 240 VAC	± 20%, 50/60 Hz, 500 VA
Overvoltage Category	II. Ref IEC 61010-1
Circuit Breaker (120 VAC)	3.5 A
Circuit Breaker (240 VAC)	2 A
Operating Environment: Location	Fixed, indoors
Temperature	70 °C (160 °F) maximum
Humidity	Wet
Altitude	2000 m (6560 ft)
Pollution Degree	Ref IEC 61010-1
Purge	3.5 Kpa (0.5 psig) instrument air or dry nitrogen, with pressure regulating valve
Cooling Water	120 L/min (31.7 USGPM)

10.7 Calibrator

Power: 120 or 230 VAC	± 20%, 50/60 Hz, 200 VA
Installation Overvoltage Category	II. Ref IEC 61010-1
Operating Environment: Location	Fixed, indoors
Temperature	50 °C (160 °F) maximum
Humidity	10 to 90%, non condensing
Altitude	2000 m (6560 ft)
Pollution Degree	2. Ref IEC 61010-1

10.8 Optional Discrete I/O Kit

Analog Inputs:	Quantity	2
	Performance	12 bits,200 μs conversion time, group isolated
	Range	±10 V, 1 MΩ maximum impedance, self powered
Analog Outputs:	Quantity	4
	Performance	12 bits, group isolated
	Range	±10 V, 5 KΩ minimum load impedance
Logic Inputs:	Quantity	4
	Rating	15 to 30 VDC at 5 mA or dry contacts.
Logic Outputs:	Quantity	5
	Rating	Form C, 240 VAC, 6A
Power:	120/240 VAC	85 to 246 VAC, 0.4 to 0.8 A, 50 to 60 Hz
	Installation Overvoltage Category	II. Ref IEC 61010-1
	Fuse	Internal, 1.25 A
Operating Environment:	Location	Fixed, indoors
	Temperature	40 °C (104 °F) maximum
	Humidity	10 to 90%, non condensing
	Altitude	2000 m (6560 ft) maximum
	Pollution Degree	2. Ref IEC 61010-1