ACCUCROP CLOSED LOOP
CROP SHEAR CONTROLLER
MODEL ACP1X1-CBE V3.0

USER'S MANUAL

Manual # 90466
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This manual is provided solely as a convenient guide to the operation and maintenance principles of the accompanying KELK instrumentation device and software.

For purposes of explanation, the text and illustrations have been simplified or represent typical installations and, therefore, do not represent nor replace the approved engineering drawings and documentation that accompany each unit.

All operation and maintenance must be with reference to the approved engineering drawings and documents.

George Kelk Corporation assumes no responsibility for errors or omissions in this manual or their consequences.

WARNING SUMMARY

Intended Use

Accucrop Closed Loop Crop Shear Controller, Model ACP 1X1-CBE, Version 3.0 is intended for the measurement of Strip width, Crop Imaging, Crop Cut length determination, and dynamic control of the shear motion so that the shear blades will crop the transfer bar very close to the determined crop line. Accucrop controller system is intended to be used in metals rolling and processing applications. Do not use an Accucrop System 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 Accucrop and the equipment to which it is connected may be damaged.

Accessibility

The Accucrop Closed Loop Crop Shear Controller System comprises of the following main components: Accuband Crop Image, Accuspeed Laser Velocimeter, Accuscan HMD 2048 and Accucrop controller. Please consult the Warning paragraphs from the User's Manuals of these components for Accessibility details, cautions and recommendations.

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

Technical Assistance

For Technical assistance on any KELK product, contact George Kelk Corporation at:

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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.

PART 1 ABOUT THIS MANUAL

1.1 Applicability

This manual describes the operation of the Accucrop closed loop crop shear controller system, Model ACP 1X1 - CBE (Coil Box Entry), version 3.0 for a crop shear entry configuration. The Accucrop controller system is part of a more complex system - Accuband closed loop crop optimization system (crop shear entry configuration) so this manual must be used in conjunction with the Accuband width gage, Accuband crop imaging, and Accuspeed laser velocimeter.

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

Information is provided for operation, setup and configuration of the Accucrop closed loop crop shear controller system, Model ACP 1X1 - CBE, Version 3.0 when used for the shear motion dynamic control in metals rolling and processing applications.

Accucrop controller regulates the shear mechanism so that the shear blades will crop the transfer bar very close to the theoretical crop line set by the Accuband crop imaging system. For information regarding operation, setup and configuration of the Accucrop system components, please see their corresponding user's manuals.

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

PART 2 GENERAL DESCRIPTION

2.1 Introduction

The Accuband closed loop crop optimization system (crop shear entry configuration) is made up of two main parts:

- Accuband crop imaging system at the coilbox entry location.
- Accucrop closed loop crop shear controller system.

2.2 Scope

This chapter includes important terminology that the user will find helpful in understanding the Accuband closed loop crop optimization system. The system main components and how they are combined to create a robust and complex system will be described in this chapter. In addition, details will be provided on the communication, interfaces, and interconnection signals.

This section is necessary for understanding the operating principles which will make troubleshooting and analysing operational results possible. The details discussed are limited to the Accucrop closed loop crop shear controller system. Refer to Accuband width gage, Accuband crop imaging, and the Accuspeed laser velocimeter user's manuals for more details regarding operation and troubleshooting.

2.3 System Configuration

2.3.1 General Description

The Accucrop closed loop crop shear controller system combined with the Accuband crop imaging system forms a more complex system - Accuband closed loop crop optimization system (coilbox entry configuration). To provide an understanding of how these two systems are linked together, below is a brief description of the main components.

The Accuband crop imaging system is comprised of two main components: Accuband imaging gage and Accuspeed laser velocimeter located at the coilbox entry location.

Accuband Width Gage (Coilbox entry location) comprises of:

- **Scanner** - A rugged and thermally insulated sealed enclosure containing two cameras and all data processing electronics. The scanner contains a water cooling system and a laser used for camera alignment.
- **Scanner Support** - Composed of the Plenum chamber (providing a region of still positive air pressure around the cameras) and a suspension system tuned to protect the scanner from shock and vibration.
- **Nozzle** - Provides a continuous downward airflow to assist in keeping dirt away from the camera windows and to ensure that the field of view of the scanner is free of dust and steam.
- **Scanner Power Supply with Calibrator Controls** - Provides 24 VDC power to the scanner and incorporates connection points for the communications interfaces. Additional calibrator controls allow the user to control the calibrator remotely.
- **Cable / Hose assembly** - Provides interconnection cables for power and communication between the scanner and scanner power supply.
- **Calibrator, Calibrator Carrier and Junction Box(with cable**) - Used for calibrating and verification of the scanner.
- **Imaging Discrete I/O Kit** - Provides communication with the gage through analog and logic I/O's.
- **Operator's PC** - Allows manual entry of the set-up data, and monitoring of the system by the mill operator (optionally supplied depending on the mill layout).
- **Accuband & Accucrop Electronics Unit Cabinet** - Houses the imaging discrete I/O kit, Accuspeed electronic unit(s), and connectivity switches.

Accuspeed Laser Velocimeter (Cropshear & Coilbox entry locations) comprises of:

- **Optics Head assembly** - generates an optical signal from which the moving material velocity and length is extracted.
- **Head mount** - allows the optics head to be mounted and aligned relative to the moving material.
- **Optics Head extension cable** - High temperature cable that connects the optics head to the junction box.
- **Optics Head cable** - PVC cable that connects the junction box to the electronics unit.
- **Junction Box** - connects the optics head cable with the extension cable.
- **Electronics Unit** - houses the signal processing and the external interfaces.

The Accucrop closed loop crop shear controller system is comprised of the following main components: Accucrop controller and Accuspeed laser velocimeter.

Note: Depending on the mill layout an optional Accuspeed Laser Velocimeter located at the crop shear exit area may be supplied with the system.

Accucrop controller system comprises of:

- **Accucrop Controller** - provides accurate closed loop control of crop-shear position and velocity while maintaining positive torque to the crop shear motor so that the shear blades will crop the transfer bar very close to the theoretical crop line.
- **Accucrop Discrete I/O Kit** - provides communication with the Accucrop controller through analog and logic I/O's.
- **Incremental encoder** - provides the shear motor speed feedback to the Accucrop controller.
- **Absolute Encoder** - provides the shear drum position feedback (shear blades position) to the Accucrop controller.
- **Remote adapter** - converts the Accucrop controller differential analog output (shear drive reference) into single ended analog signal to be fed into the shear drive current regulator.
- **Crop Operator's panel** - provides system and operation mode selectors and manual controls of the Accucrop system to the mill operator.
- **Crop Operator's PC** - allows manual entry of the set-up data, and monitoring of the system by the mill operator.
- **Maintenance PC** - allows maintenance personnel to perform system setup and troubleshooting using the system interfaces. It is also used for system data logging and storage, providing analysing tools for monitoring the performance of the system components.
- **Accuband & Accucrop Crop Shear Controller cabinet** - Houses the Accucrop controller, Accucrop & Accuband discrete I/O kits, Accuspeed electronic unit(s), connectivity switches and power supplies.

See Figure 2.1 for a typical Accuband Closed Loop Crop Optimization System (Coilbox Entry configuration) layout:

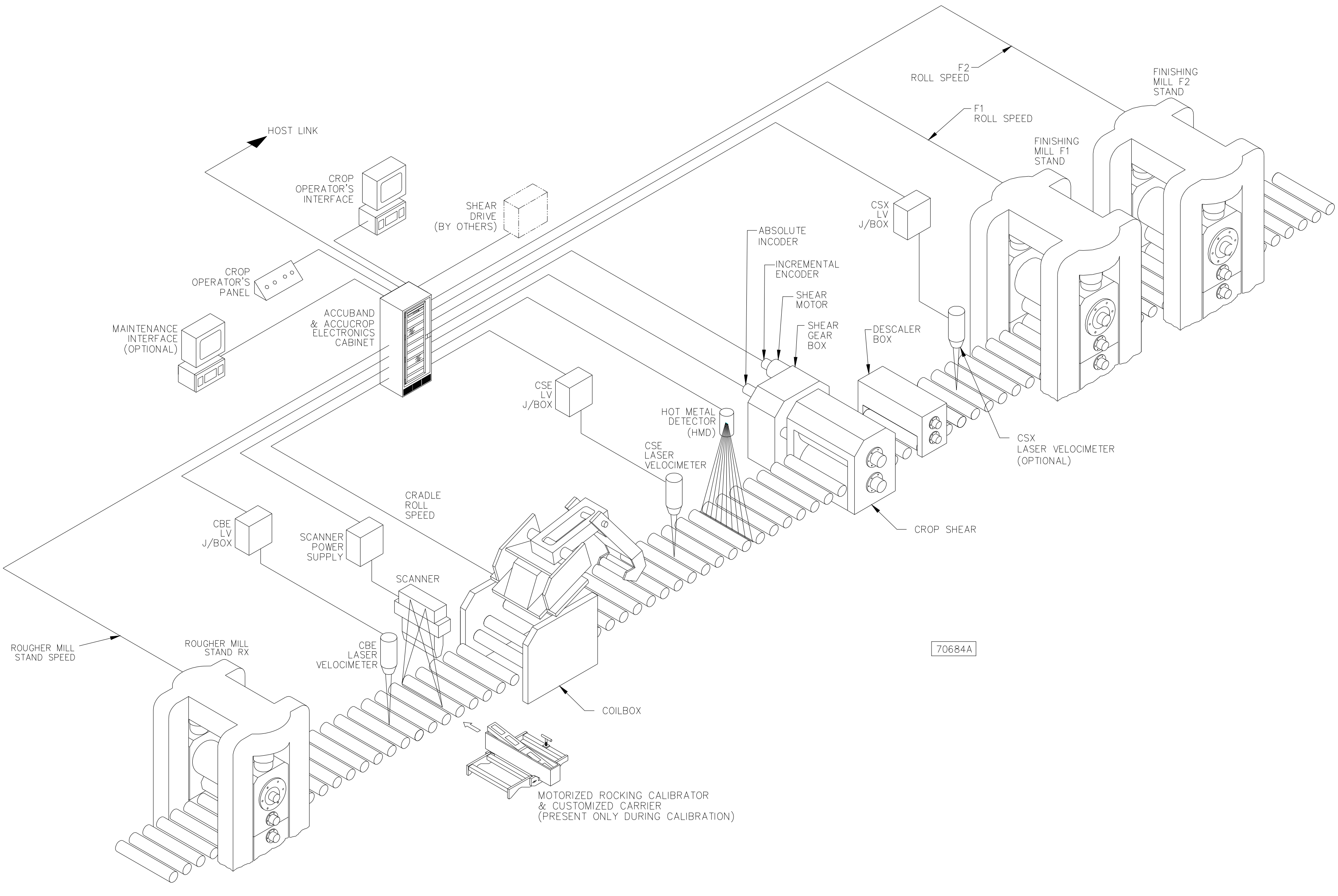


Figure 2.1 Accuband Closed Loop Crop Optimization CBE(Coilbox Entry) System layout

2.3.2a Accucrop Closed Loop System Layout (Coilbox Entry Sensors)

The coilbox entry Accuspeed laser velocimeter optics head is installed on the head mount above the roll table at a specific stand-off height. It is located approximately 1-2 rolls in front of the Accuband scanner (towards the Rougher mill). The Accuspeed junction box, usually 10 m away from the optics head, is installed on one side of the roll table platform or at times on the same platform as the Accuband scanner. The optics head extension cable and the optics head cable connects the optics head to the Accuspeed electronics unit via junction box. Accuspeed generates a very accurate bar speed used for head cut line tracking by the Accucrop controller.

The Accuband imaging width gage is installed at a specific height above the roll table and is located between the Rougher mill and the coilbox and approximately 1 or 2 rolls spacing from the CBE(Coilbox Entry) Accuspeed velocimeter. The Accuband imaging width gage uses two 2048 CCD cameras to measure the width of the bar and produce a head and tail image of the bar. In addition to imaging, the Accuband scanner will also calculate the optimized cut point for each end of the bar and display them to the operator.

Figure 2.2 outlines the description mentioned above.

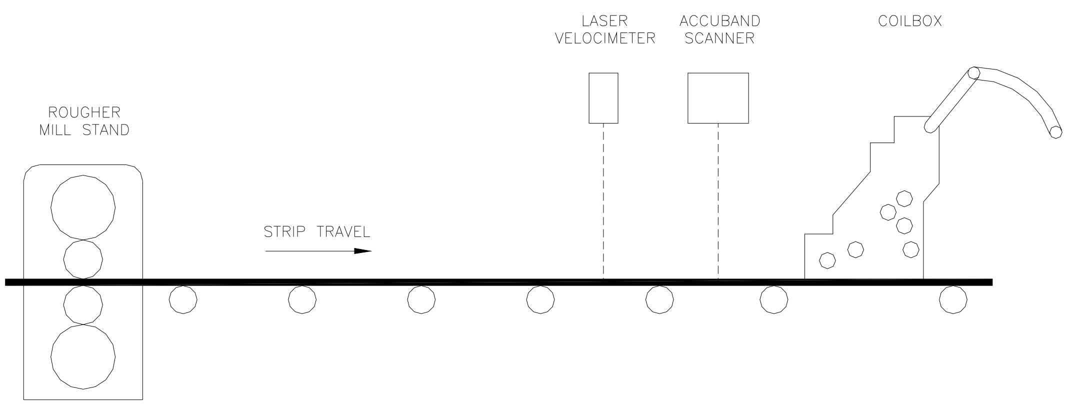


Figure 2.2 Coilbox Entry Sensor Layout

2.3.2b Accucrop Closed Loop System Layout (Crop Shear Entry Sensors)

The crop shear entry Accuspeed laser velocimeter optics head is installed on the head mount above the roll table at a specific stand-off height. It is located approximately one roll after the KELK HMD2048 (towards the Finisher mill). The Accuspeed and HMD junction boxes are typically installed about 10 m away from both sensors. The optics head extension cable and the optics head cable connects the optics head to the Accuspeed electronics unit via junction box. Accuspeed generates a very accurate bar speed used for head cut line tracking by the Accucrop controller. The HMD2048 is a high resolution HMD that is used to detect material across the width of the roll table. Since the focus of the HMD lens is performed at KELK, it is very important that the installation of this sensor is done at the specified stand-off height.

Figure 2.3 outlines the description mentioned above.

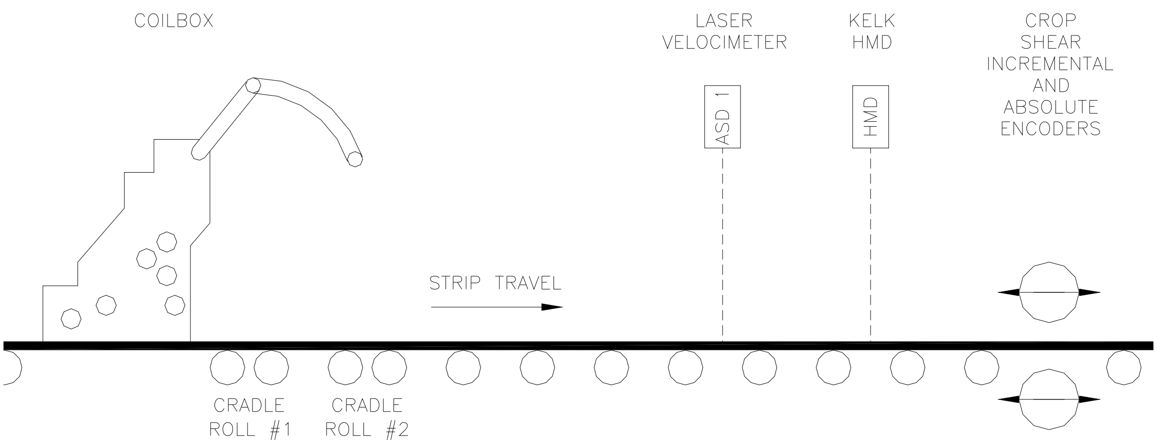


Figure 2.3 Crop Shear Entry Sensor Layout

2.3.2c Accucrop Closed Loop System Layout (Additional)

The Incremental encoder is installed on a mounting bracket and it is connected to the shear motor shaft using a coupling. It provides the shear motor speed feedback to the Accucrop controller.

The Absolute encoder is installed on a mounting bracket and it is connected to the shear motor drum. It provides the shear blades position feedback to the Accucrop controller.

The Remote Adapter is an electronic module usually located in the shear drive control cabinet within 10 m from the Accucrop controller cabinet. It receives the differential analog shear drive reference signal from Accucrop controller and converts it into single ended analog signal to be fed into the Shear drive current regulator.

The Accuband & Accucrop discrete I/O kits are located inside the Accucrop controller cabinet. The Accuband discrete I/O is connected to the Accuband imaging gage via an ethernet cable and provides analog and logic I/O interfaces. The Accucrop discrete I/O provides similar type outputs but is connected between the Accucrop controller and the discrete I/O via and ethernet cable.

The Crop Operator’s panel is located in the Crop Operator’s pulpit and provides Accucrop system controls to the mill operators. It is connected to the Accucrop Discrete I/O Kit.

The Crop Operator's PC is installed in the Operator's pulpit allowing manual entry of the set-up data and monitoring the gage performance by the mill operators. It is typically connected to the gage network.

The maintenance PC is typically installed in the machine room. It allows maintenance personnel to monitor the Accucrop & Accuband system performance, setup, and troubleshoot using the system interfaces. The ibaPDA data logging system is running on this PC which is connected to the same network as Accuband and Accucrop.

The Accucrop closed loop crop shear controller cabinet is usually located in a clean environment (machine room) within 10 m from the shear drive cabinet. It contains the Accucrop controller, Accuspeed Electronics units, Accuband & Accucrop discrete I/O kits, power supplies and connectivity switches.

2.4 System Features

Here are the main features of the Accucrop controller system:

- Receives and displays the crop image, shape classification, statistics and cut length from the Accuband crop imaging system.
- Provides different operating modes to the mill operators (automatic or manual cuts of the transfer bar end).
- Accurate closed loop control of crop-shear position and velocity while maintaining positive torque to the crop shear motor.
- Performs cut line tracking and accurate bar end crop cuts very close to the theoretical crop line.
- Logging and analysing capabilities of crop system parameters
- Friendly and configurable graphical user interface

2.5 Communication

There are two communication interfaces:

- Ethernet ports
- Analog and digital I/O

The interfaces are usually accessed in the controller cabinet and are normally connected to the mill control system by, or with the assistance of KELK personnel during commissioning.

2.5.1 Ethernet Ports

Generally, the Accucrop controller cabinet contains two type of Ethernet ports (switches) - Host and I/O.

- Host Ethernet switch - used for communication to the scanner primary port (Host), Operator's PC, Maintenance PC and Mill automation system (Host PC, etc.)
- I/O Ethernet switch - used for communication to the Accuband and Accucrop discrete I/O kits, and Accuspeed electronic units (coilbox entry, crop shear entry, and optional crop shear exit)

For more details on the scanner, discrete I/O and Accuspeed electronics unit ethernet ports, please consult the corresponding user's manual for each piece of equipment.

2.5.2 Analog and Digital I/O

Available analog and digital I/O:

- Accucrop fast digital inputs - located inside the Accucrop crop shear cabinet
- Accucrop analog outputs - located inside the Accucrop crop shear cabinet
- Accucrop discrete I/O kit - usually located inside the Accucrop crop shear cabinet
- Accuspeed I/O - located inside the Accucrop cabinet

2.6 Accucrop Fast Digital Inputs

There are six fast digital inputs available to the Accucrop controller. They are accessible inside the Accucrop controller cabinet and some of them are reserved only for KELK use. For channel assignment, consult the interconnection diagram supplied for your specific installation.

2.7 Accucrop Analog Outputs

There are four analog outputs from the Accucrop controller available inside the cabinet as follows:

- Shear drive reference, differential (reserved)
- Shear drive reference, differential (reserved)
- Spare
- Spare

2.8 Accucrop Discrete I/O kit

The Accucrop discrete I/O kit is usually located inside the Accucrop controller cabinet, but can also be installed remotely inside the customer's PLC cabinet. It provides communication with the gage through analog and digital I/O. For channel assignment consult the interconnection diagram supplied for your specific installation. Listed below are the default I/Os that are included with the module.

- 4 analog inputs
- 16 logic inputs
- 8 logic outputs

- 3 tachometer inputs (optional)

2.9 Crop Shear Entry Accuspeed I/O

The Accuspeed analog and digital I/Os are connected via a terminal block located inside the Accucrop controller cabinet. The CSX (crop shear exit) Accuspeed is optionally supplied depending on the mill layout.

- 5 digital outputs - Usual assignment: System ready, Head Overheat, Sync. Out (reserved), Data valid, Laser On
- 3 logic inputs - Usual assignment: Direction (reserved), Start acquisition (reserved), Interlock
- 1 analog output - Velocity

2.10 Interconnection diagram

Figure 2.4 outlines a typical interconnection block diagram showing the main ethernet ports and the analog and digital I/O. Always consult the drawing package supplied for your specific installation. Please consult the Accuband width gage and Accuspeed laser velocimeter user's manuals for wiring and safety requirements, warning, and connection details.

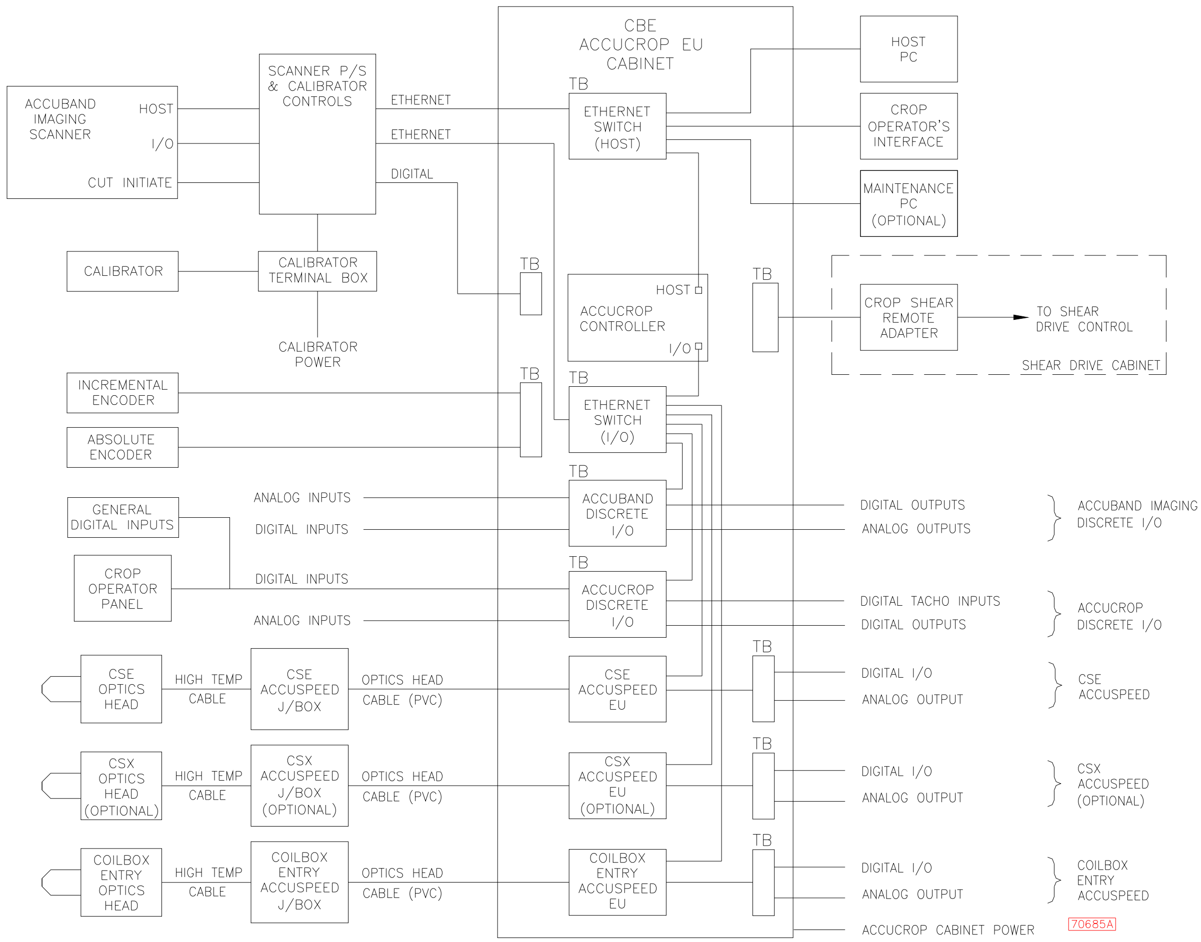


Figure 2.4 Accucrop Controller Interconnection Diagram

PART 3 VELOCITY PROCESSOR

3.1 Introduction

This section will describe the Accucrop Velocity processor basic principle of operation, and to provide useful information for understanding the Accucrop system operation described later in this manual.

It is important to note that the velocity processor is not a physical hardware device, but a software module, responsible for selecting the most stable and accurate speed source(s) for tracking purposes.

3.2 General Description

The velocity processor running on the Accucrop controller system assumes that there are multiple bar speed sources available: Accuspeed laser velocimeter, Measuring roll speed, Bar speed (from Host Computer), Default speed, etc. However, not all of them are accurate. Accucrop velocity processor must select at all times the best and most accurate bar speed source and provide it to the Accucrop controller and other internal processes. Some speed sources require calibration in order to be used.

3.3 Scope

The velocity processor collects speed data from multiple sources and combine them into accurate velocity inputs to the Accucrop controller.

The velocity processor performs the following:

- Depending on the position of the bar and operating status of the various sensors, selects the best speed source.
- Calibrate secondary speed sources to primary source. Most tachometers are subject to errors due to slippage that can change depending on mill and material conditions. In order to maintain the best possible accuracy, these tachometers should be calibrated against the primary speed sensor - Accuspeed.
- Output the following data:

  A) System velocity, velocity source, calibration factor and status
  B) Head velocity, velocity source, calibration factor and status
  C) Tail velocity, velocity source, calibration factor and status

3.4 Speed Sources

3.4.1 Accuspeed Velocimeter

The velocimeter is a non-contact optical sensor and provides the highest possible accuracy. It will always be used as the primary speed source when it is available. It is read via a MODBUS/TCP interface.

3.4.2 Measure Roll/Cradle Roll

A measure roll or cradle roll contacts the strip and can be used to measure strip speed by determining the rotational velocity of the roll. The circumference of the measure roll must be known to convert rotational velocity to strip velocity. Speeds from from measure rolls tend to be less accurate due to slippage and draft reduction effects between the strip and the roll. These effects change based on the material, size and temperature of the bar. For best results, roll speed inputs should be calibrated against a velocimeter on the current bar before being used.

3.5 Roll Speed Sources

3.5.1 Analog Tachometer

Analog tachometer produces a DC voltage (typically 0-10V) proportional to the rotational velocity. In KELK Accucrop system this voltage will be read with an analog input on the WAGO bus coupler (Discrete I/O). The supplied voltage will be converted into a specific velocity depending on the scaling applied.

3.5.2 Pulse Tachometer

Pulse tachometers produce a specific number of pulses per revolution. By counting the number of pulses in a fixed time interval, the rotational velocity can be determined. In KELK Accucrop system a pulse tachometer can be optionally connected to a WAGO I/O module (Discrete I/O) that can be used to read the frequency of a pulse train. A scaling of the distance per pulses will be applied to convert the digital signal into bar velocity.

3.5.3 PLC Data

It is also possible that the Host computer could provide speed data by writing it to a MODBUS/ TCP input register in the Accucrop. The PLC may also provide logic signals via MODBUS / TCP protocol such as MIM(Metal In Mill) and still provide an analog speed source (optional).

3.5.4 Default Speed

The default speed can be configured to a fixed value. This value can be calibrated against the Accuspeed velocimeter or locked to a specific value. Only one default speed can be defined and calibrated to the primary speed source.

3.6 Roll Speed Calibration

During periods when both roll speed and velocimeter data are stable and measuring the same strip, the roll speed is calibrated to produce the same speed as the velocimeter. A number of pairs of samples from the two speed sources are collected and a calibration factor is calculated. There is a series of checks in order to declare a calibration successful. Once the new calibration factor is available, the roll speed is corrected based on the ratio of the new calibration factor to the old.

3.7 Velocity Processor Outputs

3.7.1 System Speed

The system speed (bar speed) will be provided for display purpose. Depending on the bar position, the velocity processor will decide what speed will be selected as a System speed from the following: Accuspeed velocimeter, other calibrated speed sources(such as measure roll, cradle roll, etc) or calibrated default speed as a last resort.

3.7.2 Head and Tail Speed

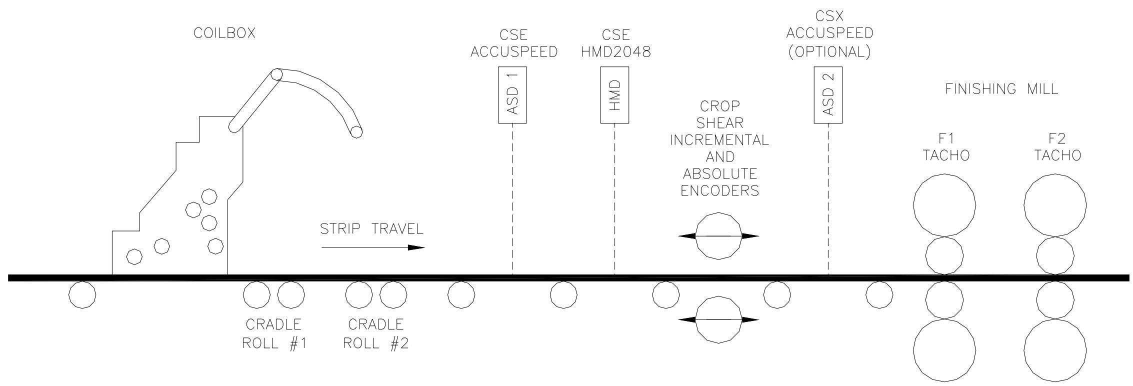
The Head speed provided by the Velocity processor is to be used by the Accucrop controller for Head cut line tracking, and the Tail speed is to be used for the Tail cut line tracking.

3.8 Velocity Processor Operation

See Figure 3.1 for a typical representation of the sensors location and velocity sources available for an Accucrop system located at the coilbox entry area. Normally, the bar moves from left to the right.

The bar first passes over the measuring/cradle roll which will slip initially until it matches the bar speed. In case the Velocity data is not valid from the Accuspeed velocimeter,the cradle roll speed (V4/V6) will be used as a Head back up speed source (HB1).

Next, the bar will move under the Accuspeed velocimeter ASD1 (Head primary speed = V1) which asserts Data valid (DV1) while it has a valid speed signal. The Measuring roll speed will be calibrated against the velocimeter speed while DV1 signal is on.



VELOCITY	V4	V6		V1			V5	V2	V3
STATUS				DV1	MIV		DV2	MIM1	MIM2

Figure 3.1 Accucrop Sensors Location and Velocity Sources

The head cut will be made after the KELK HMD triggers and the tracking of the cut line will be performed primarily by the KELK Velocimeter with the measure roll as a backup.

The bar then moves through the first and second Finishing stands (F1 & F2) which provide the Tail backup speeds (V2 & V3). When the Finisher stands are under load, they assert a Metal in mill F1 & F2 (MIM1 & MIM2) signal, and the mill stands F1 and F2 speed can be calibrated against V1 and used. Since the tail of the bar leaves the velocimeter (ASD1/V1) before it reaches the KELK HMD, the F1 speed must be used for Tail cut line tracking. In some cases F1 stand is left open (dummied) in which case no speed is available from F1 and the Velocity processor must use the velocity from F2 stand. In certain installations, the customer may request to install a second KELK Velocimeter (ASD2) after the crop shear to use as an accurate tail cut tracking source. In such cases, F1 & F2 will not calibrate against ASD1 but will use ASD2 instead. F1 & F2 speed sources will then be used only as a backup for trail tracking.

Note: Calibration of all customer supplied speed sources is performed on each and every bar.

In some special cases the bar may be held back by rocking it back and forth on the transfer table before the shear. In this case, it may repeatedly enter and leave the field of view of the velocimeter (ASD1) and HMD 2048. To prevent eratic output from the velocity processor, the mill will assert a Cut inhibit (Bar Rocking) signal that inhibits any recalibration of the Analog speed sources.

The velocity processor can be configured to prevent a recalibration of each analog speed source. A fixed calibration value can be manually entered using the Configuration utility and if the LOCK is turned on, then the Calibration flag will be set to ON, as well indicating that the signal is OK to be used. The calibration factor will be applied right away.

The Accucrop controller will use the speed provided by the velocity processor for bar tracking and automatic head and tail cuts. In case the Accucrop controller is to perform a manual cut and the user has selected a fix velocity, the Accucrop controller will not use any velocity source from the velocity processor.

The velocity processor defines three speeds: Head speed, Tail speed and System speed. As the bar proceeds through the mill, the velocity processor must select the best speed source based on a priority list. The lists below display the precidence that Accucrop will give each speed source, ie.the higher up the item in the list, the higher the priority.

Head speed

- Head primary speed ASD1 (V1) if data is valid.
- Measuring/cradle roll speed = Head backup #1 speed (V4) if calibrated and ASD 1 data is not valid.
- Head default speed = Head backup 2 speed (V6) if calibrated and no other Head speed is valid.

Measuring roll speed (V4) and Head default speed (V6) will be calibrated against the Accuspeed Laser velocimeter ASD 1 (V1) when certain conditions are met. When a calibration is successful, the calibration factors is applied right away.

Tail speed

- Tail primary speed ASD 2 (V5) if available and data is valid.
- F1 stand speed = Tail backup 1 speed (V2) if MIM F1 is on, speed is calibrated and ASD 2 data is not valid.
- F2 stand speed = Tail backup 2 speed (V3) if MIM F2 is on and MIM F1 is off, speed is calibrated and ASD 2 data is not valid
- Tail default speed = Tail backup 2 speed if calibrated and no other Tail speed is valid.

F1 stand speed (V2) and F2 stand speed (V3) and Tail default speed will be calibrated against the Accuspeed Laser velocimeter ASD1 (V1) or ASD 2 (V5) if available when certain conditions are met. When a calibration is successful, the calibration factors are applied right away.

System speed

- Head speed can be ASD 1 (V1) or Measuring/cradle roll (V4/V6) or Head default depending on Data valid, calibration success and priority.
- Tail speed can be ASD 2 speed (V5) or F1 stand speed (V2) or F2 stand speed (V3) or Tail default speed depending on Data valid, calibration success and priority.

The System speed will be used for display.

3.9 Velocity Processor Interface

The Accucrop controller incorporates a Maintenance Interface containing a number of windows for use during setup and maintenance. Refer to the Accucrop interfaces part in this manual to learn how to get access to the Maintenance interface. Once the Maintenance interface is connected to the Accucrop controller, select the Velocity tab. The image should be similar to the one in Figure 3.2.

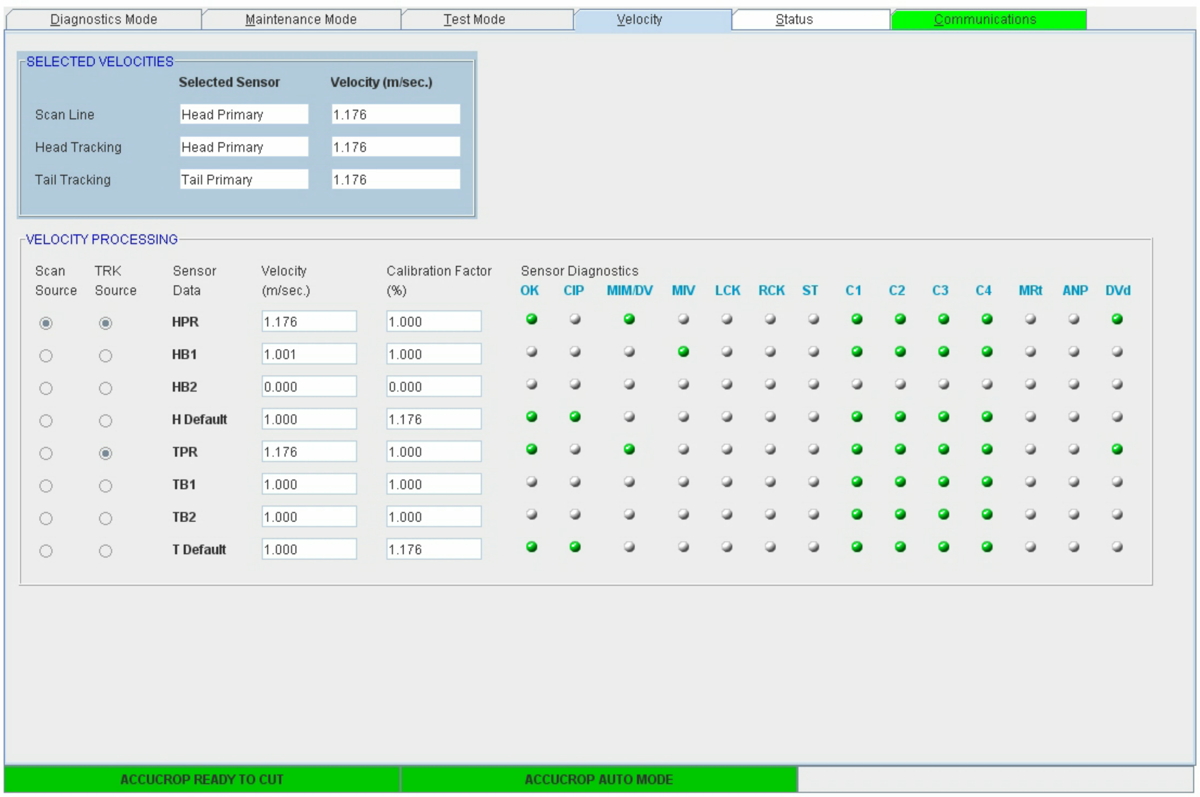


Figure 3.2 Accucrop Velocity Processor Interface

The Velocity processor window is composed of two smaller windows: Selected velocities and Velocity processing. The importance of each window is described below.

3.9.1 Selected Velocities Window

This window displays the System speed at the scan line (HMD 2048 location), Head tracking speed and Tail tracking speed. The selected sensor and the speed in m/sec will be displayed in real time depending on the bar position and the speed sources available.

3.9.2 Velocity Processing Window

This window contains important information on what velocity sources are available, their value and calibration factors. It displays the selected speed sources at the scan line (HMD 2048 location) and the one used for Head and Tail tracking. A sensor diagnostic table composed of green lit radio buttons is available as well.

Scan source and Tracking (TRK) source columns will indicate using radio buttons what speed source is selected at the Scan line (HMD 2048 location) and which one is selected for tracking the Head and Tail.

Sensor data columns contains all the velocity sources available as follows:

- HPR = Head primary speed
- HB1 = Head backup 1 speed
- HB2 = Head backup 2 speed
- H default = Head default speed
- TPR = Tail primary speed
- TB1 = Tail backup 1 speed
- TB2 = Tail backup 2 speed
- T default = Tail default speed

Velocity and Calibration factor columns will display the Sensors velocity (m/sec) and the calibration factor (%) real time when a calibration is successful.

Sensor diagnostics is a table of status buttons for all velocity sources available, which will lit green when active and grey when inactive. By positioning the mouse on top of the first line, you can get the full description of the status bits as follows:

- OK = Last calibration OK
- CIP = Calibration in progress
- MIM/DV = Metal in mill or Data valid
- MIV = Material in view
- LCK = Calibration locked
- RCK = Bar rocking (cut inhibit)
- ST = Start calibration OK
- C1 = Acceleration OK
- C2 = Calibration change within limits
- C3 = Velocity above zero

- C4 = Ratio within range
- MRt = MR time on
- ANP = Abort no path
- DVd = Debounce data valid

Depending on bar position and speed sources availability, the operation of the velocity processor can be observed by following the status green lit radio buttons. Maintenance personnel can use this screen to troubleshoot any problems related with the speed sources and observe if the calibration is completed successfully.

PART 4 ACCUCROP SYSTEM OPERATION

4.1 Introduction

This chapter describes the operation of the Accuband Closed Loop Crop Optimization System, C965C-CBE-CL. This system is comprised of:

- Accuband Crop Imaging System (Coilbox entry location)
- Accuspeed Laser Velocimeter (Crop shear entry location)
- Accuspeed Laser Velocimeter (Crop shear exit location) - optional depending on the mill layout
- Accuscan HMD 2048 (Crop shear entry location)
- Accucrop Closed Loop Controller System

This system is referred to as the Coilbox Entry model (CBE), because the Crop Imaging is performed at the entry of the coilbox.

4.2 Scope

This chapter focuses on the Accucrop Closed Loop Crop Shear Controller, Model ACP 1X1 - CBE, Version 3.0 for a Coilbox entry configuration. It details how the Accucrop ACP 1X1 interacts with the other components of the system. This chapter treats the Accuband Crop Imaging System, Accuspeed Laser Velocimeter and Accuscan HMD 2048 as functional blocks.

The Accuband Crop Imaging System determines the amount that has to be cut from the bar ends. The Accuspeed Laser Velocimeter (Crop shear entry location) provides the primary Head bar speed. The optional Accuspeed Laser Velocimeter (Crop shear exit location) provides the primary Tail bar speed. The Accuscan HMD 2048 provides the MIV signal for the cut line tracking. Accucrop controller tracks the cut line and controls the shear dynamically in order to perform a very accurate cut.

For additional information, the reader should refer to the following User’s manuals: Accuband Width Gage, Accuband Crop Imaging, Accuspeed Laser Velocimeter and Accuscan HMD 2048.

4.3 System Overview

The Accuband Coilbox Entry Closed Loop Crop Optimization System model C965C-CBE-CL is made up of the following main components:

- Accuband Crop Imaging system located at the coilbox entry, model C965C, version V6.0.
- Accucrop Crop Shear Controller system Model ACP 1X1 - CBE, Version 3.0, which is a closed loop controller.
- Accuspeed Laser velocimeters placed at CBE(Coilbox entry), CSE(Crop shear entry) and optional CSX (Crop shear exit) locations which supply very accurate bar speeds.
- Accuscan HMD2048 at CSE location which is a linescan HMD.

Detailed wiring and interconnection diagrams can be found in the drawing package supplied with the equipment.

The following fundamental points should be noted:

- The Accuscan HMD2048 supplies the cut initiate signal to Accucrop.
- Crop shear entry Accuspeed is the primary velocity source for bar head speed.
- The calibrated F1 or F2 speed is the backup velocity source for bar tail speed.
- Crop shear exit Accuspeed (optional) is the primary velocity source for bar tail speed.
- Accucrop controller uses an incremental encoder to measure the speed of the crop shear motor and an absolute encoder to measure the position of the crop shear blades.
- The analog output of the Accucrop is the current reference to crop shear drive.

The above items make it possible for Accucrop to keep track of the four critical parameters:

- crop shear speed
- crop shear position
- transfer bar speed
- transfer bar position

4.4 System Block Diagram

Figure 4.1 is the system level block diagram of the Accuband Crop Optimization System, Coilbox Entry model C965C-CBE-CL. It has been drawn with emphasis on the Accucrop Controller, system Model ACP 1X1. For this reason the Accuband Crop Imaging System (C965C) at CBE location, the Accuscan HMD2048 and the Accuspeed Laser Velocimeter have been shown as single blocks.

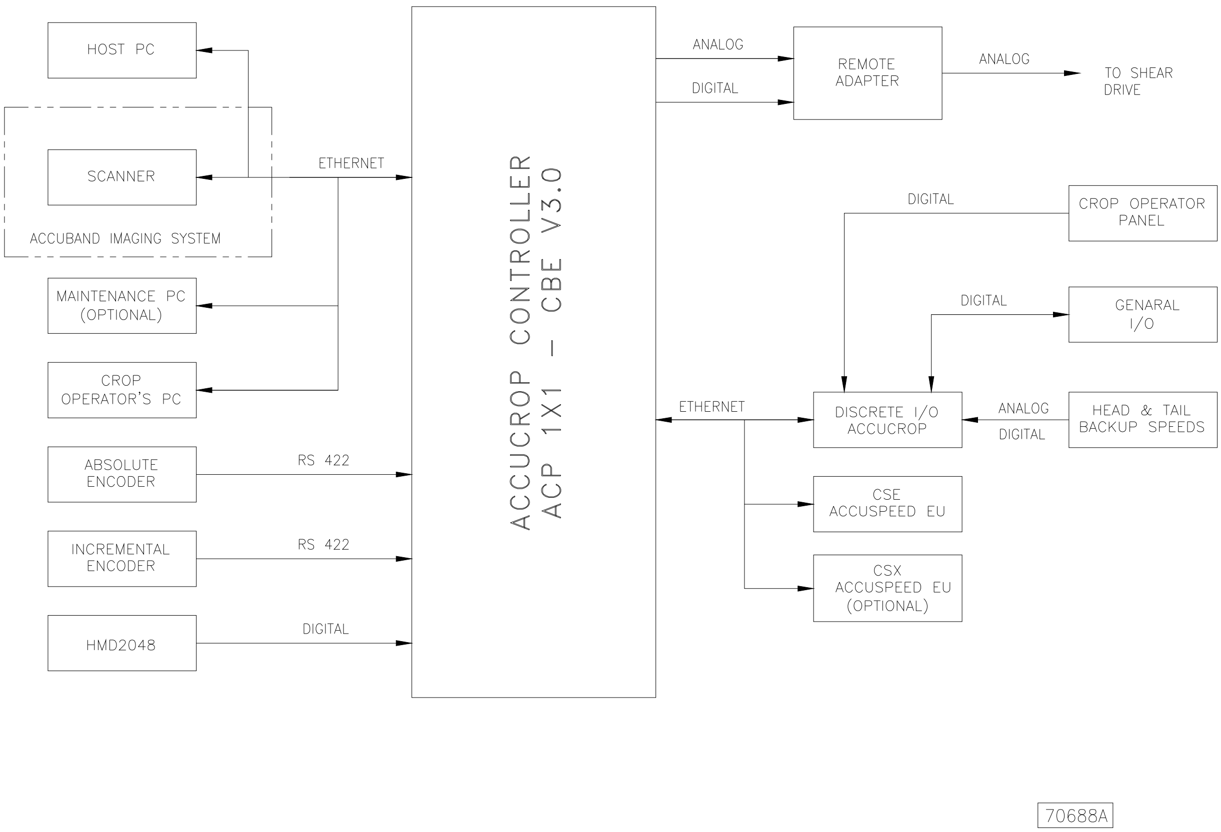


Figure 4.1 Accucrop Controller System Block Diagram

4.5 System Components

This section will provide a brief description of the main parts of the Accucrop Closed Loop Crop Shear Controller, Model ACP1X1, Version V3. The majority of these parts interface directly to the Accucrop controller.

4.5.1 Incremental Encoder

The incremental encoder produces 6000 pulses per revolution. It is installed on the shear motor shaft and has a robust design with a stainless steel housing. The output driver is an RS422 line driver with a quadrature type signal. The encoder interface board 63400 processes these signals and produces a resolution of 12,000 pulse per revolution.

4.5.2 Absolute Encoder

The absolute encoder is a 13 bit serial device with an RS422 line driver output. One revolution of the shaft covers a count range of 0 to 8191. It is installed on the shear drum shaft and has a robust design with a stainless steel housing. The encoder interface board 63400 processes this serial data being able to handle binary or gray code type encoders.

4.5.3 Remote Crop Shear Adapter

The remote cropshear adapter provides the interface between the analog output of the Accucrop controller and the customer's shear drive. This device provides the following functions:

- Differential to single ended conversion
- Rate of change limiter
- Galvanic isolation
- System selector support

The analog output from the Accucrop is a differential signal. The remote adapter converts this signal from a differential signal to a single ended signal. This single ended signal is then applied to a rate of change limiter. It also provides the galvanic isolation between the KELK system and the customer’s shear drive. Lastly, a relay on the output allows either the Accucrop output or the customer’s existing control system to be applied to the shear drive.

4.5.4 Analog Output

The analog output is a 12 bit differential signal. The maximum voltage between the two outputs is ±20 volts. The voltage from either output to ground is ±10 volts.

4.5.5 Loop Time

The controller has a loop time of 4 milliseconds. All controller data is updated every 4 milliseconds. The fundamental data are:

- predicted shear trajectory
- bar position
- bar velocity
- shear position
- shear velocity

4.5.6 Bar Velocity

The Velocity Processor on the Accucrop controller system dynamically selects the best and most accurate bar speed source. CSE Accuspeed Laser Velocimeter is the Head primary speed and the CSX Accuspeed (optional) is the tail primary speed. All other roll backup speed sources require calibration in order to be used. Velocity processor has three outputs: Bar speed , Head speed and Tail speed to be used by the Accucrop controller.

4.5.7 Accucrop Discrete I/O Kit

The Discrete I/O kit provides communication with the Accucrop controller through analog and logic I/Os. It is connected via an Ethernet Modbus interface with the Accucrop controller. Here is the Discrete I/O kit default configuration:

- Digital inputs - 4 modules of 4 inputs each, typical connections are to the Crop Operator’s control panel and customer control inputs
- Relay outputs - 1 module with 8 digital outputs, provide Accucrop system status and process state to customer’s equipment
- Analog inputs - 2 modules of 2 inputs each, usually connected to the Head and Tail roll speed sources.
- Tachometer inputs (optional) - 3 modules of 1 input each, usually connected to the Head and Tail speed sources (when analog signal is not available)

4.5.8 Crop Operator’s Panel

The Crop Operator’s Panel provides physical switches and push buttons to the mill operators. It provides digital inputs to the Accucrop controller via the Accucrop Discrete I/O kit. The following are provided:

- System Selector Switch: Customer / KELK
- Mode Selector Switch: Auto / Manual
- Immediate Cut Push Button
- Continuous Cut Push Button

4.5.9 Ethernet Ports

Accucrop has 2 Ethernet ports: Host and I/O. The Host Ethernet port performs communication with the Host network: Accuband Crop Imaging system, Crop Operator's PC and any Maintenance PC connected. The I/O Ethernet port performs communication with any I/O device like: Accucrop Discrete I/O kit, CSE Accuspeed Laser Velocimeter, and CSX Accuspeed (optional).

4.6 Automatic Head Cut Sequence

This section describes the cutting sequence in the automatic mode. Some of the items in this sequence are displayed on the Crop Operator PC - KIP, KELK Instrumentation Panel. Others are displayed in the Maintenance interface.

4.6.1 Sensor Location

Figure 4.2 shows the position of the sensors that are referred to in the following sequence description. We assume that the bar moves from left to right.

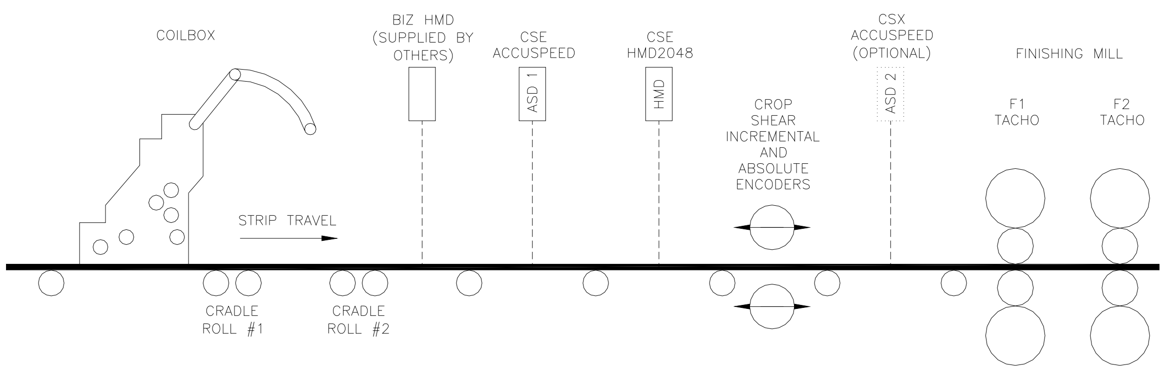


Figure 4.2 Accucrop Sensors Location

4.6.2 Bar in Zone (BIZ) HMD

This event is generated by the Bar In Zone HMD (BIZ HMD). When BIZ HMD is asserted it signals the Accucrop controller that the bar head end is in the Crop shear zone (approaching the shear). The signal is used by the Queue manager to synchronize the bars between the coilbox entry and the Crop shear.

4.6.3 CS Entry LV Data Valid

This event occurs when the bar head end enters the field of view of the CSE Accuspeed. The LV data valid bit informs Accucrop velocity processor that Accuspeed is reliably measuring the velocity of the bar. The data valid bit will trigger the start of the calibration for the Head backup speeds (Measuring/cradle roll and/or default speed). If the data valid bit is low then the velocity processor will select the calibrated Head backup speed. See the velocity processor part in this manual for a detailed explanation of velocity source selection and set up.

4.6.4 Hot Metal Detector - Accuscan HMD 2048

This event is generated when the tip of the bar is detected by the Crop Shear Entry Accuscan HMD 2048. This marks the beginning of the Head cut line tracking process. This event defines a reference distance, HMD to Shear distance. At this instant, the distance from the Head tip of the bar to the crop shear is known. The controller adds the Head cut length to this distance and begins tracking the head cut line. This point is sometimes referred to as the Head cut mark position.

The reference distance is measured from HMD 2048 scan line to the crop shear centreline, (zero blade position). The reference distance must be greater than twice the shear knives travel distance (from park to zero blades position). The shear travel distance is calculated from the largest park angle that may be used.

HMD 2048 signals the Accucrop controller to request the cut length parameters from the Queue manager. When the signal is asserted the head and divide cut parameters are requested.

4.6.5 Cut Parameters Received

This event is an indication that Accucrop has received the requested parameters from the Queue Manager. The information sent is the cut length, bar thickness, bar width, type of cut, head or tail and the divide cut length if applicable. Divide cut is an optional feature.

4.6.6 Cut Initiated

This signal is an indication that the Accucrop has started the Head cut cycle and that the shear has begun to move. The Head cut marker position is based on the largest park angle. After receiving the cut marker the Accucrop calculates the actual shear travel distance from the real park position to the shear zero position. When the Head crop line is twice this distance from the shear, the shear starts to move.

4.6.7 Cut Complete

The cut complete signal indicates that the blades have reached the zero position and that Accucrop has entered the delay and shear parking cycle.

4.6.8 Cut Inhibit (Bar Rocking)

The Accucrop system is designed to accommodate the cut inhibit (bar rocking) condition. This feature is intended to prevent a cut from being started while the bar is rocking. The input to the Accucrop system for the bar rocking condition comes from the customer's equipment. Two possible bar rocking cases are covered**:**

- **Case 1, Rock Before Cutting**. The cut inhibit (bar rocking) input is asserted before the bar reaches the KELK sensors, then the bar is rocked. The cut inhibit (bar rocking) input is deasserted only when the bar is NOT under the KELK system. The bar then proceeds into the KELK sensor zone and the cut is made. When the bar reaches the KELK sensors, the bar is expected to be within the speed limits specified by the user.
- **Case 2, Cut Before Rocking**. First the cut is made, then the cut inhibit (bar rocking) input is asserted and the bar is rocked. The cut inhibit (bar rocking) input must be deasserted when the bar is under the KELK sensors.

In either case, the system does not start a cut when the bar rocking input is asserted.

4.7 Automatic Tail Cut Sequence

The sequencing for tail cuts is similar to that of the head cuts. The only notable differences are:

- the signals in the sequence now de-assert, go low, false, as opposed to asserting, picking up, going high, true.
- the tails speed must come from the crop shear exit Accuspeed (optional) or a secondary speed source (F1, pinch roll or F2) which has been calibrated by the Velocity processor.

4.7.1 CS Exit LV Data Valid (optional)

This event occurs when the bar head end enters the field of view of the crop shear exit (CSX) Accuspeed. The CSX LV data valid bit informs Accucrop velocity processor that CSX Accuspeed is reliably measuring the velocity of the bar. The velocity processor will use CSX Accuspeed as a Tail primary speed. If the data valid bit is false then the velocity processor will select the calibrated Tail backup speed instead. See the Velocity Processor part in this manual for a detailed explanation of velocity source selection and set up.

4.7.2 Metal In Mill F1

When the bar head end enters the F1 stand, the MIM F1 signal is asserted. This will trigger the Tail backup speeds (F1, pinch roll or default speeds) calibration process. The Tail backup speeds are calibrated against the crop shear entry(CSE) Accuspeed or CSX Accuspeed depending on the Data valid status priority (CSE first and then CSX). Refer to the Velocity Processor part for more details.

4.7.3 Metal In Mill F2 (optional)

When the bar head end enters the F2 stand, the MIM F2 signal is asserted. This input is optional and is used only if F1 stand is run in "Dummy" mode (no reduction applied). In this case the F2 stand speed is used as a Tail backup speed, and will be calibrated against the CSE or CSX Accuspeed depending on the Data valid status priority (CSE first and then CSX). See the Velocity Processor part in this manual for more details.

4.7.4 Bar In Zone (BIZ) HMD

This event is generated by the Bar In Zone HMD (BIZ HMD). When BIZ HMD is de-asserted it signals the Accucrop controller that the bar tail end is in the Crop shear zone (approaching the shear). The digital input is used by the Queue manager to synchronize the bars between the coilbox entry and the crop shear.

4.7.5 CS Entry LV Data Valid

For a tail cut, this event is signalled when the bar tail end leaves the field of view of the CSE Accuspeed. The Accuspeed data valid bit is used to signal this condition. This event terminates the calibration process for the F1 roll speed (Tail backup speed if CSX Accuspeed is not used). These details can be found in the Velocity Processor part of this manual.

4.7.6 Hot Metal Detected - Accuscan HMD 2048

This event is generated when the tail end of the bar is detected by the Crop Shear Entry Accuscan HMD 2048. This marks the beginning of the tail cut line tracking process. At this instant, the distance from the tail tip of the bar to the crop shear is known. The controller subtracts the tail cut length from this distance and begins tracking the tail cut line. This point is referred to as the Tail cut mark position. This event also forces Accucrop to use the optional CSX(Crop shear exit) Accuspeed (Tail primary speed) or the calibrated tail speed signal as the velocity source.

The reference distance is measured from HMD 2048 to the Crop shear centreline, (zero blade position). The reference distance must be greater than twice the shear knives travel distance (from park to zero blades position). The shear travel distance is calculated from the largest park angle that may be used.

Once the tail leaves the field of view of the KELK HMD, the drop in signal instructs the Accucrop controller to request the cut length parameters from the Queue manager. This event marks the end of the time period the Crop operators can manually adjust the Tail Cut length.

4.7.7 Cut Parameters Received

This event is an indication that Accucrop has received the requested parameters from the Queue manager. The information sent is the cut length, bar thickness, bar width, type of cut, head or tail and the divide cut length if applicable. Divide cut is an optional feature.

4.7.8 Cut Initiated

This signal is an indication that the Accucrop has started the Tail cut cycle and that the shear has begun to move. The Tail cut marker position is based on the largest park angle. After receiving the Tail cut marker the Accucrop calculates the actual shear travel distance from the real park position to the shear zero position. When the tail crop line is twice this distance from the shear, the shear starts to move.

4.7.9 Cut Complete

The cut complete signal indicates that the blades have reached the zero position and that Accucrop has entered the delay and shear parking cycle.

4.8 Blade Tracking

Since the Accucrop system provides default speeds for head and tail cuts, some method must be employed to track the head and tail blade positions for the purpos of synchronizing these parameters.

4.8.1 Double Bladed Shear

With a shear that has two sets of blades, one set for the head cut and one set for the tail cut, Accucrop is able to keep track of the crop shear blades because each set of blades has a unique zero position.

4.8.2 Single Bladed Shear

With a shear that has only one set of blades the zero position is the same for head and tail, so a somewhat more arbitrary method of tracking blades must be used. In this case, when the controller is switched into KELK mode, Accucrop moves the blades to the head park position based on the head park angle. The Shear Parked indicator will illuminate when the shear is parked in either the head or the tail park position. The head or tail cut indicator illuminates while the shear is parking or is parked in that position (depending on the head or tail park angle).

4.9 Crop Operator's Panel

Crop Operator's panel provides manual controls of the Accucrop system to the mill operators. It is a simple metal panel with a number of switches and pushbuttons.

4.9.1 System Selector Switch

This switch has two positions: KELK position and Customer position. The system selector switch is used to select which control system is used to control the crop shear. When the switch is in the customer's position the remote adapter allows the control signal from the customer's equipment to reach the current regulator. If the switch is in the KELK position, the output from the remote adapter is the Accucrop current reference.

Note: When the switch is moved to the KELK position Accucrop will move the shear to the closest park position. Do NOT change the selector switch during a cut!

4.9.2 Mode Selector Switch

The switch has two positions: Auto and Manual. If the switch is in Manual mode, then the only way that the cut can be started from the KELK system is to push the Manual Cut button. When the system is in Auto mode, the cut starts automatically by Accucrop. Switching from Auto mode to Manual mode before a cut is started (before the bar passes under the CSE HMD 2048) aborts the cut. Switching back to Auto mode before the tail end passes under CSE HMD 2048 results in a normal automatic tail cut.

4.9.3 Manual (Immediate) Cut

Pressing the Manual Cut button starts a cut cycle. The position of the Mode Selector switch has no effect on a Manual cut. The manual cut button can also be thought of as the Emergency Cut. The velocity source used for the cut is defined by the Configuration Manager. See the Configuration Manager part for details.

4.9.4 Continuous Cut

This feature applies for the Head end of the bar. Main purpose would be to chop a desired portion of the bar Head end without pressing the Manual cut button repeatedly. The Mode Selector switch must be in the Manual position. Head end of the bar must be positioned between the shear drums. Pressing this button causes the shear to rotate until the button is released. The bar will advance by itself due to the shearing action. The shear velocity is set in the Configuration Manager and is called Sickle Cut Velocity. The shear comes to rest in the tail park position after the button is released.

4.10 Divide Cut

The purpose of a divide cut is to cut the bar into two pieces. The length of the first piece is entered into the KELK system through the host computer or manually by the user via the Accucrop User's interfaces. The length of the first piece is measured from the head cut line.

The head cut must be completed in Auto mode. Switching to Manual mode after the head cut is completed cancels the divide cut for this bar. Switching back to auto mode allows the tail to be cut automatically.

The divide cut starts with a normal automatic head cut. The divide cut is initiated by Accucrop. Accuband Crop image system transfers the divide cut bit and divide cut length to the Queue Manager. When requested to perform a divide cut, Accucrop continues tracking the bar after the auto head cut is made and until the divide cut is made. Any Cut inhibit (Bar rocking) transition will cancel the divide cut for the bar.

When a divide cut is complete, divide cut parking is started. The purpose of this is to cycle the crop shear back to the tail park position so that the pending tail cut is made from the tail park position. To accomplish this it is necessary that the trailing portion of the bar be reversed out from under the crop shear to allow for the shear to automatically rotate to the tail park position.

4.10.1 Divide Cut Parking Sequence

Accucrop informs the mill control system that the divide cut has been made and that the second half of the bar should be reversed. This is done by means of the "Divide cut parking in progress" digital output.

The Accucrop system monitors the position of the bar and waits until the HMD 2048 drops MIV and the CSE Accuspeed drops Data valid signals. Once these conditions have been detected, Accucrop cycles the shear to the tail park position if the Divide cut Head length is 0 and resets the "Divide cut parking in progress" output. If a Head cut is requested for the divide cut, then the shear will not move since it is parked already for a Head cut. This terminates the divide cut sequence and the tail cut is performed as an automatic cut.

There is a timer associated with this sequence which aborts the divide cut parking sequence if the reversing of the bar is not completed in the specified time. This parameter is accessed through the Configuration manager and is called "Divide park time".

4.11 Standalone Mode

The standalone mode allows Accucrop to perform automatic fixed length cuts. This feature is intended as a backup mode of operation if the Accuband Crop Imaging system is not operational, although it can be put into this mode regardless of the status of Accuband.

The following conditions must be met before Accucrop enters standalone mode.

- Shear must be in the park position
- Hot Metal Detected must NOT have been received from the CSE HMD 2048
- Bar tracking for a divide cut must NOT be pending
- Divide cut parking must NOT be in progress

The following conditions must be met before Accucrop exits standalone mode.

- Shear must be in the park position
- Hot Metal Detected must NOT have been received from the CSE HMD 2048
- Bar tracking must NOT be in progress

4.12 Velocity Sources and Calibration

The velocity sources that Accucrop can use are configurable via the Configuration Manager. These sources are seperately configurable for head, tail, manual and automatic cuts.

Velocity sources include:

- CSE Accuspeed Laser Velocimeter and CSX Accuspeed Laser Velocimeter (optional)
- Analog input(s): Typically, an analog input would be a voltage generated by a tachometer from a finishing mill stand, a pinch roll, measure roll, cradle roll, or table roll. The analog inputs can be scaled through the Maintenance Interface.
- Digital tachometer inputs (optional): provisions for 3 digital tachometers are available through the Discrete I/O - Frequency counter modules. They can be finishing mill stand, a pinch roll, measure roll, cradle roll, or table roll. Scaling of these inputs is available through the Maintenance Interface.
- Default velocity: A fixed value which would typically be used as a backup when no other velocity source is available.

The scaling and the default velocity are accessed through the Configuration Manager, Maintenance Utility or Accucrop Graphical User Interface (GUI).

Parameters are provided to configure the following velocity masks:

- velocity sources for automatic head cuts.
- velocity sources for automatic tail cuts.

- velocity sources for manual head cuts
- velocity sources for manual tail cuts

The description, selection, configuration and set up of these parameters are described in the Configuration Manager Utility and Set Up part of this manual.

PART 5 CONTROLLER THEORY

5.1 Introduction

The Accucrop controller is unique in its control strategy. It has been designed to perform accurately and consistently under hot rolling mill operating conditions. Maintaining accuracy and reliable operation during times of high production pace requires that the controller be able to perform equally well in the presence of large amounts of bar acceleration, deceleration and to be able to handle the case when the period between bars is small.

This section is intended to provide information for those interested in understanding the difference between the old control systems (Traditional Acceleration Techniques) and the KELK system. It can be useful in helping the operators understand the observable differences in the way the shear moves during a cut cycle.

5.2 Scope

This chapter explains the traditional control strategies and those employed by the Accucrop controller. It details the major features of the controller and the principles employed. It emphasizes the theory behind the Accucrop controller. The details of the Accucrop controller that deal with the calculation of acceleration are proprietary and are not disclosed, although a general description is provide.

5.3 Controller Overview

The Accucrop controller is a component in the Accuband Closed Loop Crop Optimization system. It provides accurate closed loop control of cropshear position and velocity while maintaining positive torque to the crop shear motor. The Accucrop has a loop time of 4 milliseconds. All control parameters are updated every 4 milliseconds.

The predictor defines the path that crop shear must follow. The cut regulator uses the predictor as the reference and adjusts the speed of the shear to force the shear to follow the predictor.

The Accucrop is capable of providing control for both single-bladed and double-bladed crop shears. The concept of shear control is essentially the same in both cases. This chapter provides descriptions and illustrations using only the concept of single-bladed cropshear systems.

5.3.1 Cut Line Tracking

Accucrop controller receives the Cut mark signal from the Accuscan HMD2048. Accucrop immediately starts a timer through an interrupt service routine. Then, when the controller detects the next 4 millisecond system interrupt, it stops this timer and uses the result to find the exact position of the Cut mark signal relative to this 4 millisecond system interrupt.

The Cut line position is tracked and updated by the controller using the best velocity source provided by the Velocity processor. During the system interrupt the Accucrop controller also calculates the shear blades travel distance from the current park position to the point where they make contact with the bar. When the cut line to shear distance reaches twice the blades travel distance, the Cut initiate is issued, the Acceleration cycle starts, and the controller starts to move the shear.

5.3.2 Predictor

The Accucrop controller uses a proprietary variable acceleration algorithm to control the shear speed and position. The predictor produces the trajectory that the shear must follow to perform an accurate cut at the correct speed. The trajectory produced by the predictor is recursive because the trajectory is updated (recalculated) every 4 milliseconds. The predictor has been designed to vary the acceleration as required in order to make the shear accelerate from the park position right up to the moment of cut.

5.3.3 Cut Regulator

Once the Cut initiate is issued, the Cut regulator will ensure that the shear follows the trajectory defined by the predictor. The trajectory produced by the predictor is updated every 4 ms. The acceleration is calculated and can change every 4 ms as well. The Cut regulator will make the shear accelerate from the park position right up to the moment of cut.

When the shear blades have made contact with the transfer bar, Accucrop speed regulates the shear to the bar velocity. This continues for a period of time defined by a delay timer. Once this timer expires the shear starts the park regulation cycle.

5.3.4 Position Regulator

Accucrop controller uses the Position regulator during the Parking cycle to bring the shear to rest to the park position. The first phase of the parking cycle is to slow the shear down by outputting a constant negative voltage. This continues until the angle between the park position and the current position is less than 1 radian (approximately 58 degrees), or the velocity of the shear is in the range of the controller. At this time, the position regulator uses a position control algorithm to bring the shear to the park position. To ensure stability at the park position the controller uses and defines a dead band around the park position. If shear position is within the defined dead band then the Position regulator output to the shear drive is zero.

5.3.5 Park Position Regulation

The angular position of the shear motor shaft is read by the Accucrop with a resolution of 8192 counts per revolution. The Accucrop checks to see if the current shear position is within 8 counts (0.00097 radians) of the desired park position. If the current shear position is within this limit, Accucrop considers that the shear is in park position and uses the position regulator to maintain this position.

To ensure stability at the park position the controller uses and defines a configurable dead band around the park position. If the shear position is outside the dead band then the park control is activated to bring the shear back to its park position. This is achieved by the position control algorithm which implements a “reset integrator”. The shear park position is controlled dynamically so there is no need for mechanical brakes on the shear motor.

5.4 Shear Control Stages

The shear control stages are graphicaly shown in Figure 5.1. To simplify the figure, just the Top drum is represented. During a cut the shear goes through the following cut cycles:

- Stage A: Acceleration cycle
- Stage B: Cut Cycle
- Stage C: Delay Cycle
- Stage D: Parking Cycle

5.4.1 Stage A: Acceleration Cycle

During the Acceleration Cycle the cut regulator forces the shear to follow the trajectory defined by the predictor. The trajectory produced by the predictor is updated every 4 milliseconds. The predictor has been designed to vary the acceleration as required in order to make the shear accelerate from the park position right up to the moment of cut. The acceleration cycle ends when the blades have made contact with the bar.

5.4.2 Stage B: Cut Cycle

In this stage, the blades have already made contact with the bar and are now imbedded in it. During this stage the controller speed regulates the shear to maintain shear velocity equal to the bar velocity with the over / under speed factored in. The Cut Cycle is complete when the shear blades reach bottom dead zero.

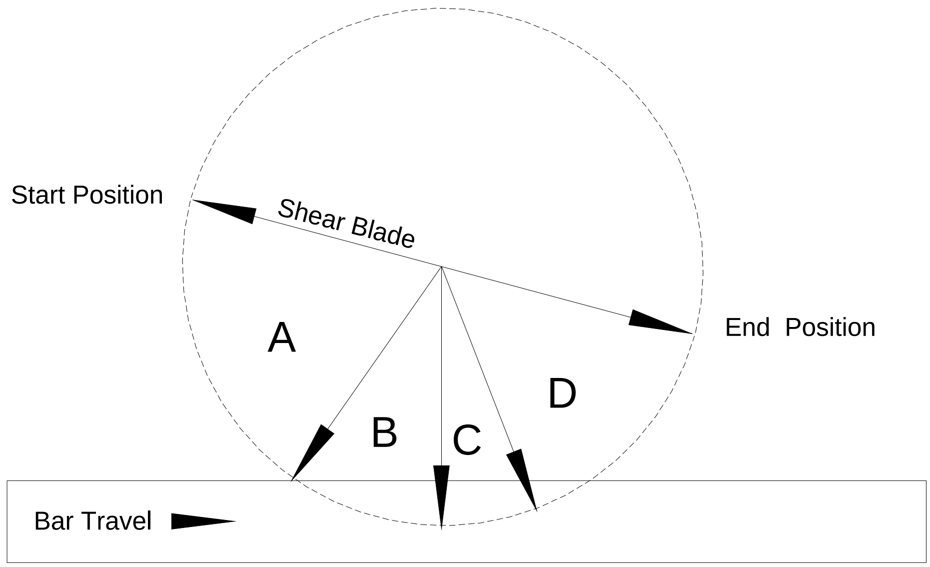


Figure 5.1 Shear Control Stages (Top drum)

5.4.3 Stage C: Delay Cycle

The Delay Cycle starts when the shear blades reach bottom dead zero. A Head and Tail delay timer (configurable) are defined in the Accucrop configuration parameters. The Parking Cycle is delayed according to these parameters. During this delay the Accucrop controller regulates the shear to the cut speed until the delay time elapses. Typical values are 10 to 40 ms.

5.4.4 Stage D: Parking Cycle

The Parking cycle starts when the delay time elapses. The first phase of the parking cycle is to slow the shear down by outputting a constant negative voltage. When the angular distance to the park position is less than 1 radian (approximately 58 degrees), or the velocity of the shear is in the range of the controller, the park control is activated to bring the shear back to its park position. This is achieved by the position control algorithm which implements a "reset integrator". To ensure stability at the park position the controller uses and defines a dead band (adjustable) around the park position.

5.5 Shear Control Strategies

The main design objective of the Accucrop controller is to ensure high accuracy in the cropping of the transfer bar while maintaining a positive torque throughout the cut cycle. In order to meet the above requirement, the following constraints must be satisfied:

- Position Constraint: the shear blades must contact the bar at the crop line
- Velocity Constraint: the shear velocity must match the bar velocity at contact point
- Positive Torque Constraint: positive torque must be maintained throughout this stage

Traditionally, either constant acceleration or maximum acceleration is used when cropping the transfer bar. From a control point of view both methods are the same. The only difference between the two is that the maximum acceleration method uses a shorter time to cut. This means that the tracking distance is shorter by approximately 15% or about 600 mm for a typical case.

When a laser velocimeter is used as the speed source this fact does not provide any advantages since tracking errors over a 600 mm distance are less than 1 mm.

Due to the nature of these strategies, all the control constraints described above cannot be met by using either of these strategies. These methods accelerate the shear to the target velocity then speed regulate the shear until the blades contact the bar. No attempt is made to match both speed and position. A significant point to note is that there is no torque applied to the motor at the moment of cut.

In the Accucrop, a proprietary Non-linear Recursive Prediction Algorithm is used in order to meet all the control constraints. The following briefly describes the traditional tracking strategies and explains the need for the Non-linear Recursive Prediction Algorithm for meeting all the control constraints.

5.5.1 Traditional Acceleration Techniques

In the case of constant acceleration, a fixed torque is applied to the shear. This means that the shear gains its speed with a constant acceleration. The target velocity is that of the bar. When the shear velocity reaches the bar velocity the controller then regulates the shear velocity to match the bar velocity.

The term constant acceleration refers to the fact that when a cut is started the shear moves with constant acceleration until it reaches the bar velocity. Furthermore, most of these controllers have only one acceleration profile, the acceleration cannot be changed from one cut to another.

When the bar end is detected this informs the control system that the bar is at a known distance from the cropshear. The controller also has access to the velocity of the bar at this time. Before the cut can be started a calculation is performed to calculate the time to cut.

$$Time\_to\_Cut = \frac{Distance\_to\_Cut}{Vbar}$$

Figure 5.2 ilustrates the Traditional Acceleration Techniques: Constant acceleration and Maximum acceleration. In Graph (a) you can see that the bar is moving with a constant velocity. The shear accelerates to the bar velocity with constant acceleration; this is referred to as the acceleration stage. Since the bar is moving with constant velocity and the shear is moving with constant acceleration, the bar travels twice the distance that the shear travels during the acceleration stage. The area under the graph is the distance travelled. At the end of the acceleration cycle the shear is moving at the velocity of the bar.

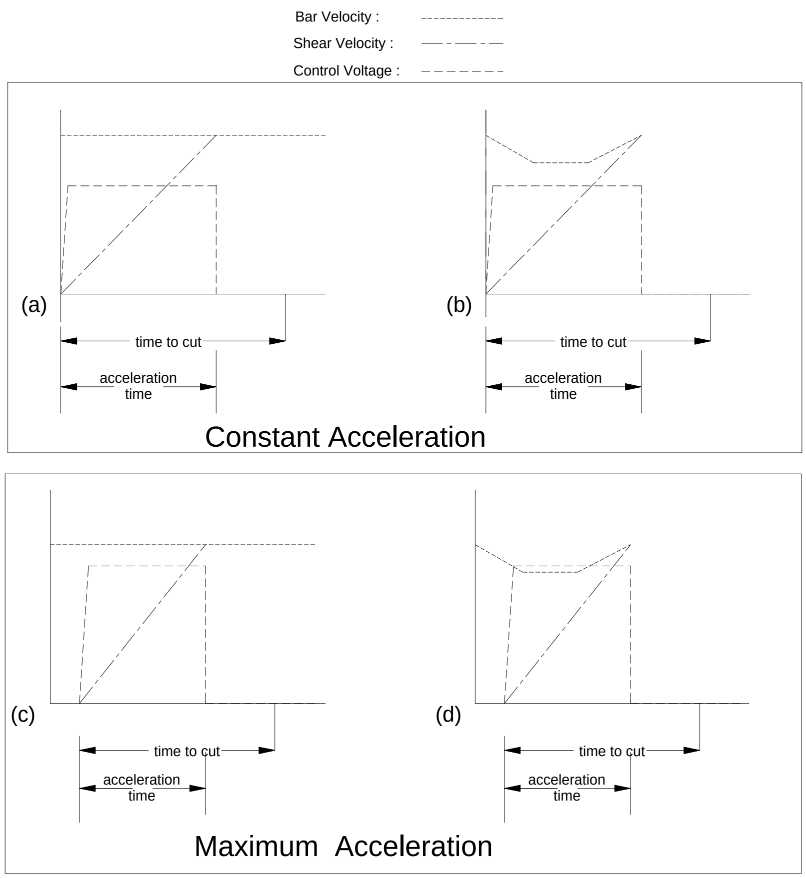


Figure 5.2 Traditional Acceleration Techniques

If you now refer to Graph (b) where the bar speed is not constant, you can see that at the end of the acceleration cycle the shear is moving at the bar speed. The distance travelled by the shear is the same as in (a), but notice that the distance travelled by the bar is much less. This is due to the change in bar velocity during the acceleration stage. During the remainder of the cut cycle the controller speed regulates the shear to match the bar speed. Clearly, the error that occurred during the acceleration stage cannot be corrected for. The result is a cut that is made at the correct velocity but length of the cut is incorrect.

The maximum acceleration method tries to minimize errors by reducing the time to cut. As you can see in Graphs (c) and (d) the start time for this method is later than for the constant acceleration method. As a result, some of the errors that were introduced by the change in bar velocity in the previous example are eliminated because they occurred before the cut was started.

In both methods, instability during the time between the end of the acceleration stage and the cut moment occurs due to backlash. This has a negative impact on cropping accuracy. In a practical sense, there is no significant difference between these two methods. Neither method is capable of making accurate cuts during normal hot mill rolling conditions.

The drawback of the constant acceleration strategy is very obvious in that it cannot compensate for changes in strip acceleration once the shear is set in motion. Any changes in strip acceleration introduce errors in the cut line accuracy and the cut point velocity.

The problem with the above two strategies is that the motion equations of the shear are assumed to be of the following forms.

velocity: $v(t) = v_0 + at$
distance: $s(t) = v_0 t + \frac{1}{2}at^2$

During the tracking stage, the transfer bar's velocity and its expected position, are constantly changing. It is impossible to satisfy both the velocity and position constraints by controlling only one parameter - the shear acceleration.

To solve the problem, the Accucrop uses a proprietary variable acceleration algorithm that satisfies both the velocity and position constraints. In this variable acceleration algorithm, its parameters are adjusted at intervals of 4 ms to meet the two constraints. This tracking algorithm is referred to as the Non-linear Recursive Prediction Algorithm and is explained in the following section.

5.5.2 Non-linear Recursive Prediction Algorithm

The predictor produces the trajectory that the shear must follow in order for the cut to be made with the correct length and at the correct velocity. It is recursive because the trajectory is updated, recalculated, every 4 milliseconds based on new data. The non-linear aspect comes about in the calculation of the shear acceleration. The acceleration can be changed every 4 milliseconds, if required.

The exact details of how the acceleration is calculated is proprietary and is not disclosed. Instead you can find here a description that outlines the principle that is used. When reviewing the graphs you should consider these facts:

- The time to cut varies inversely with bar velocity.
- The area under the velocity graphs is equal to distance

- The time scales are not all equal

The algorithm is recursively executed every 4 ms and in each cycle it performs the following tasks.

- Reads the velocity of the transfer bar
- Calculates the acceleration of the transfer bar
- Predicts the bar velocity at the cut point
- Calculates the time required for the blades to reach the cut point
- Calculates current shear position
- Calculates the current shear velocity
- Recalculates trajectory
- Calculates a new reference for the cut regulator

The Recursive Prediction Algorithm meets all control constraints (i.e., position, velocity, and positive torque constraints). The position and velocity constraints are met automatically by the use of the recursive algorithm. The positive torque constraint is met as long as the shear velocity lags the bar velocity.

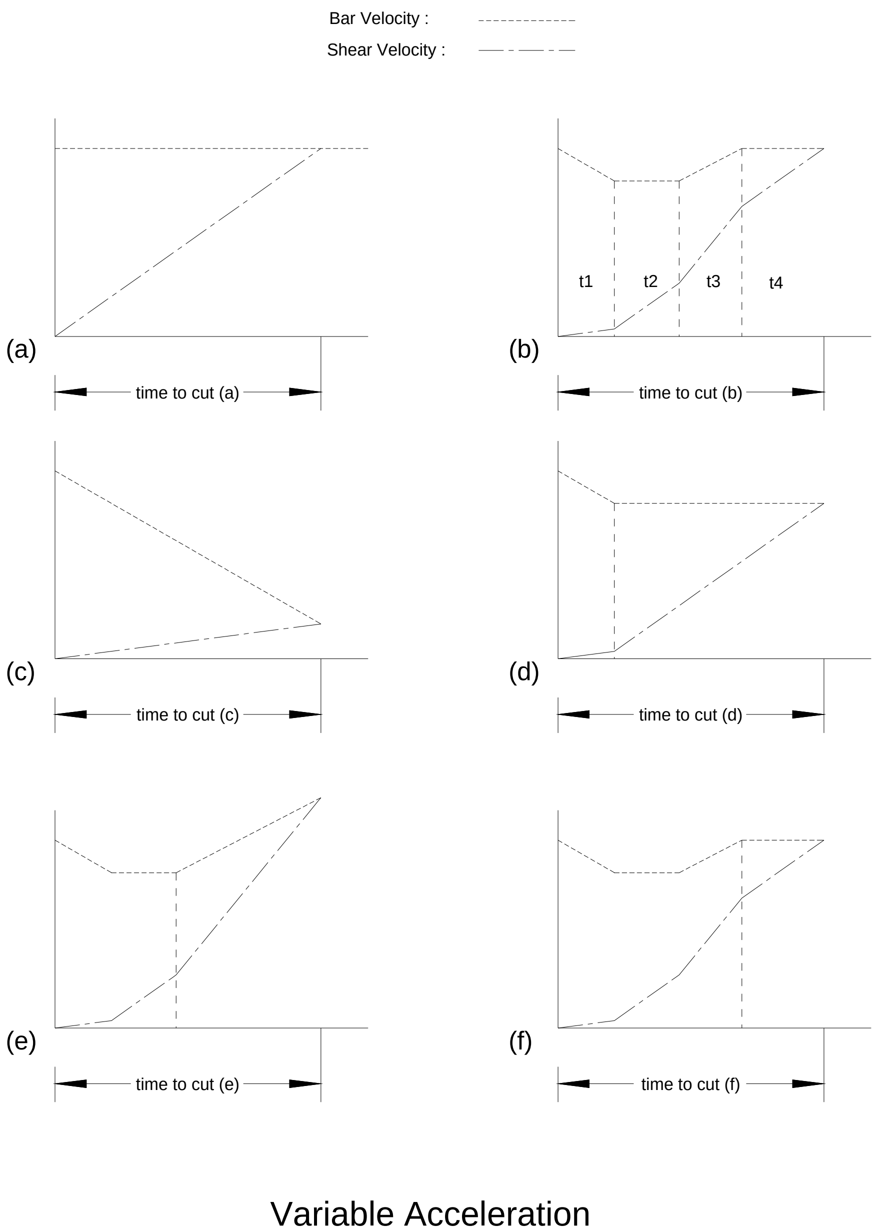


Figure 5.3 Variable Acceleration

5.6 Variable Acceleration

In Figure 5.3 Graph (a) the bar velocity is constant. The predictor calculates the acceleration that is required to allow the shear to reach the cut point at the correct time, with the correct velocity. The initial distance is equal to the distance between the bar detection point and the cropshear zero position.

$$Time\_to\_cut = \frac{Distance}{Velocity}$$

$$Acceleration = \frac{Vbar}{Time\_to\_cut}$$

The first obvious difference, compared to the constant acceleration method, is that the shear accelerates from start to finish. In this example, the acceleration is constant only because the bar velocity is constant. The remaining graphs demonstrate what happens when the bar velocity changes.

In Graph (b) we have the same bar velocity profile that was used to describe the shortcomings of the constant acceleration method. In this case the response of the Accucrop is shown. Graphs (c) to (e) show recursive action that leads to the final Graph (f). Note that the time scales are not the same for all graphs. The time to cut varies with bar velocity. What is being emphasized here is the principle of the recursive predictor.

In Graph (c), during the t1 period the velocity of the bar is decreasing with a constant deceleration. During this time period the predictor calculates the trajectory that the shear should travel based on the assumption that the bar continues to travel with this amount of deceleration. A new time to cut is calculated based on this velocity and the distance already travelled . This data is then used to calculate the required shear acceleration to make the shear reach the cut point at this new time. The time to cut increases since the bar speed is decreasing.

In Graph (d), at the beginning of t2 the bar velocity becomes constant. Based on this new bar velocity and the distance already travelled, the predictor calculates the new trajectory. Again, the trajectory is based on the assumption that the bar continues moving with this velocity.

In Graph (e), at the beginning of t3 the bar velocity begins to increase with a constant acceleration. Again the predictor recalculates the time to cut and adjusts the trajectory of the shear so that it reaches the cut point with the required velocity. The same is true in Graph (f) for t4.

In practice, the trajectory is recalculated every 4 milliseconds and the coarseness shown here is not present. You should also observe that the velocity of the shear always has a positive slope which implies that the shear is always accelerating.

5.7 Compensation for the Bar Thickness - The K Factor

In the discussion of the Recursive Prediction Algorithm, the thickness of the bar and the overlap of shear blades were assumed to be zero. However, in reality, since these two parameters are non zeros, they reduce both the shear travel distance and the bar travel distance. Figure 5.4 illustrates the situation.

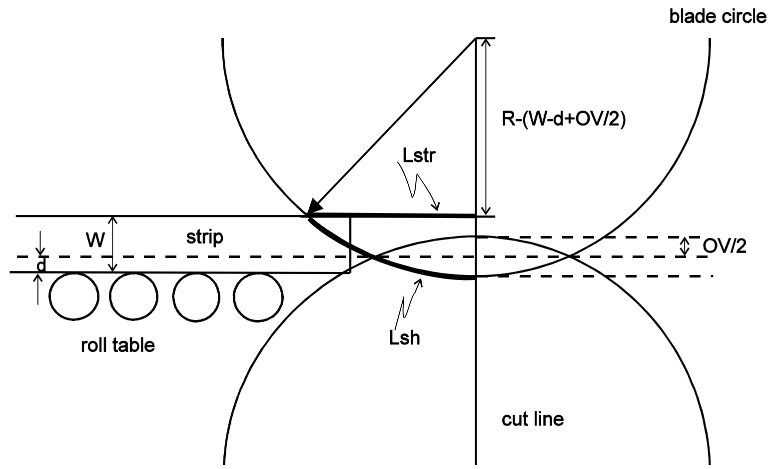


Figure 5.4 Compensation for the Bar Thickness - The K Factor

Variables in the Figure 5.4 are defined as:

- W = the bar thickness
- OV = the shear blade overlap
- R = the blade circle radius
- D = the distance from centre line to rolling table surface
- Lsh = shear travel distance reduction
- Lstr = bar travel distance reduction

The bar travel distance reduction is:

$$L_{str} = \sqrt{R^2 - \left[R - \left(W - d + \frac{OV}{2}\right)\right]^2}$$

The shear travel distance reduction is:

$$L_{sh} = R \text{ acos}\left\{\frac{R - \left(W - d + \frac{OV}{2}\right)}{R}\right\}$$

These distance reductions are taken into account in the Recursive Prediction Algorithm.

As the bar thickness and overlap of shear blades are non-zero, the shear blades do not impact the bar at the vertical position. In order for the shear to match the bar velocity, the horizontal velocity of the shear should equal the bar velocity as shown in the Figure 5.5.

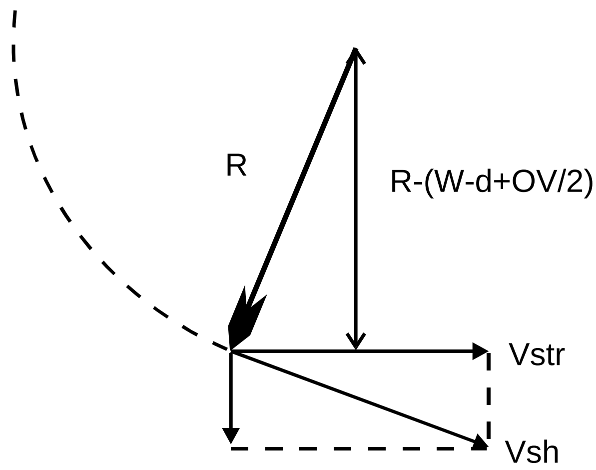


Figure 5.5 Shear Velocity

In mathematical terms,

$$v_{sh} = v_{str} \frac{R}{R - \left(W - d + \frac{OV}{2} \right)}$$

In the actual implementation, the above multiplication of bar velocity and a correction factor is treated as the effective velocity of the bar.

$$v_{str\_effective} = v_{str} \cdot f_c$$

where f_c is the Shear Velocity correction factor. The prediction algorithm which computes the desired shear velocity is used without any modification as long as the effective bar velocity is used instead of the true bar velocity.

The percentage of shear speed correction as a function of bar thickness W is referred to as K-factor.

$$K(W) = \left[\frac{R}{R - \left(W - d + \frac{OV}{2} \right)} - 1 \right] \times 100$$

Since the bar velocity and its acceleration are changing all the time due to hopping, slipping, friction, and so on, the bar velocity at the cut point is continuously updated. In this situation, the correction factor f_c is calculated once the bar thickness W is known.

5.8 Overspeed / Underspeed

It is common practice in mill operation to Overspeed or Underspeed the shear once the blades impact the bar. The Accucrop provides this Overspeed / Underspeed option. For Head cuts and Tail cuts the user can specify the amount of Overspeed and Underspeed. These parameters are configurable through the Accucrop configuration manager.

Suppose that the specified Overspeed / Underspeed percentage is ξ, then the effective bar velocity, considering also the shear velocity correction due to the strip thickness, is:

$$v_{str\_effective} = (1 \pm \xi) \cdot v_{str} \cdot f_c$$

For Overspeed the plus sign is used and for Underspeed the minus sign is used.

PART 6 ACCUCROP KIP INTERFACE

6.1 Introduction

The graphical user interface KELK provides to monitor the performance of the Accucrop system is an invaluable key tool for any mill operator. Although Accucrop is a fully self-automated system, users have the ability to modify its performance through an easy to use graphical user interface.

This chapter will discuss the layout of the Accucrop interface. It is assumed that the user has already installed the KELK Instrumentation Panel and has applied the Accucrop configuration. The user should also be somewhat familiar with the operation of the KIP (KELK Instrumentation Panel) and how to make simple modifications and changes to data.

The goal of this chapter is to familiarize the user with the layout of the Accucrop KIP and how to generally use it in making adjustments during mill production. Although much detail will not be discussed as to the function of the commonly used parameters, a brief description of them will be made.

Figure 1 displays the generic layout that is provided for the mill operator. The user may make any changes he/she feels fit with regards to window sizing, font size and selection, and even what data is presented or not. Regardless of what data is removed from the screen or added, it will not affect any operation of the closed loop system.

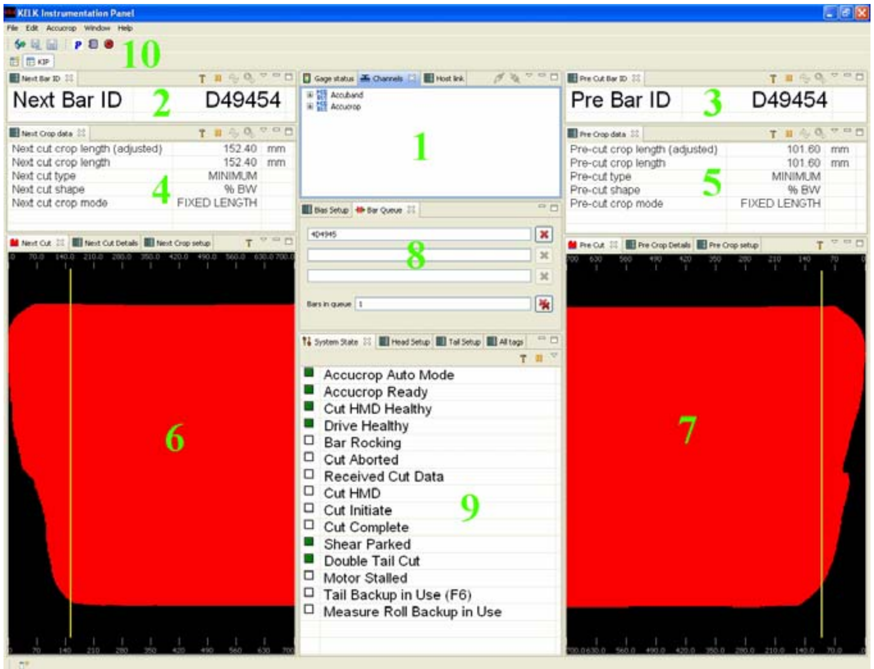


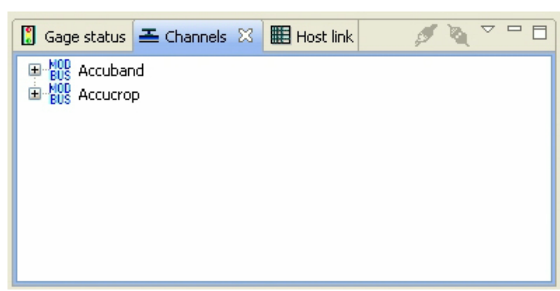
Figure 1 Accucrop KIP User Interface

The following chapter will discuss each window/section, from 1-10 in brief detail.

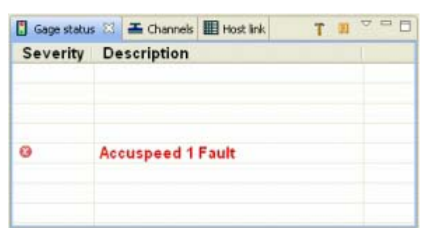
6.2 Section #1 - Channels

The **Channels** tab can be considered as an index for the KIP layout. It contains a list of all the parameters that the user can display on the screen. Users are not only restricted to displaying Accucrop statistics and/or data. Accuband data/graphs may also be displayed if desired.

The image on the right indicates that the KIP is currently connected to two devices: Accuband and Accucrop. By clicking on the "+" indicator just left of each device, the user can scroll through all the tags/data that can be displayed for viewing or monitoring.



The gage status tab provides the operator quick access to troubleshooting any Accucrop problems that may arise. During normal operation, this window will be blank. When a problem arises, a description of the cause of fault will appear as can be seen in this screen shot.



Faults that will be shown for gage status include:
Imaging Healthy, Accuband Communications Healthy, Accucrop Healthy, Accuspeed 0 healthy, Accuspeed 1 healthy.

The Host Link tab is used primarily for testing host communications between Accucrop and Level 2. It is not necessary for users/operators to access this tab.

6.3 Section #2 - Next Bar ID

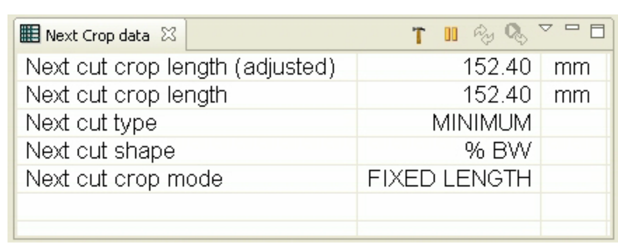
Displays the ID of the bar that is to be cut. The ID either be the head or the tail, depending on whether or not there are any bars in the queue. If production is slow and there is no queue, this window will display the bar ID of the head cut and window #3 will display the bar ID of the tail cut, which of course will be the same.

In case of a queue, if a new head image has been imaged, then this window will display the ID of the tail of the previous bar (assuming the head has already been cut) and window #3 will display the head end of the new head ID approaching the crop shear.

6.4 Section #3 - Pre Cut Bar ID

Displays the ID of the bar that is next to be cut. The ID can belong to either the head or the tail, depending on what has already been cut at the shear. If a head end has just been cut, this window will display the ID of the tail which will be the same. In case another image has been imaged and is in the queue, then once tracking of the tail piece begins, this window will display the bar ID of the approaching head of the next new bar.

6.5 Section #4 - Next Crop Data



The Next Crop Data window provides the user with crop statistics of the upcoming crop. Accucrop reports the length of the cut to the user in the parameter **Next cut crop length.** If the user adjusts the crop length, the adjusted amount will be displayed in the parameter **Next cut crop length (adjusted)**. The **Next cut type** parameter informs the user on the type of cut that will be performed. The values that will appear are:

MANUAL - This type means that no cut will be performed. The system allows the user to manually make the cut.

% BW - The system will be performing the cut based on percent body width algorithm.

FIXED - The system will be performing a fixed length cut. No optimization is performed. The amount of fixed length is an operator specified value.

FISH TAIL - The system will be performing the cut based on fish tail algorithm.

MAXIMUM - The system will perform a maximum cut length. When in optimized mode and depending on the shape of the imperfection, the system may desire to make a large cut. Since large cuts could cause major problems for mill operators, a maximum allowable cut length can be specified. If the cut value Accucrop calculates is larger than the maximum specified value, the system will clamp to the maximum and not make a larger cut.

MINIMUM - The system will perform a minimum cut length. When in optimized mode and depending on the shape of the imperfection, the system may desire to make a very small cut. Since too small cuts could cause major problems for mill operators, a minimum allowable cut length can be specified. If the cut value Accucrop calculates is smaller than the minimum specified value, the system will clamp to the minimum and not make a smaller cut.

***DOG BONE* -** The system will be performing the cut based on the dog bone algorithm.

***SYM* -** The system will be performing the cut based on the symmetry algorithm.

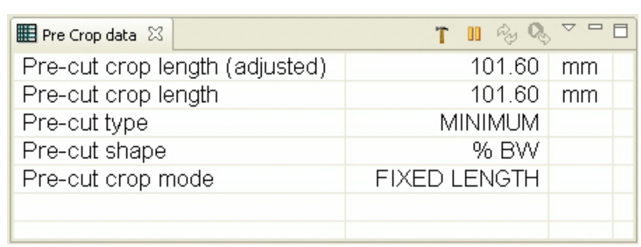
***SKIP* -** The system will abort the cut. The effect is the same as for *MANUAL*.

If the Accucrop system is set to function in optimized mode, depending on the shape of the imperfection, the system will select 1 of 5 algorithms in which to calculate the best cut length. The algorithm that the system assigns to the cut about to be performed is displayed in the **Next Cut Shape** field.

Next Cut Crop Mode informs the user what mode Accucrop is currently set to. Available modes include: *Optimized, Fixed Length, Manual, and Skip*. Please note that *Manual* and *Skip* mode are essentially the same.

6.6 Section #5 - Pre Crop Data

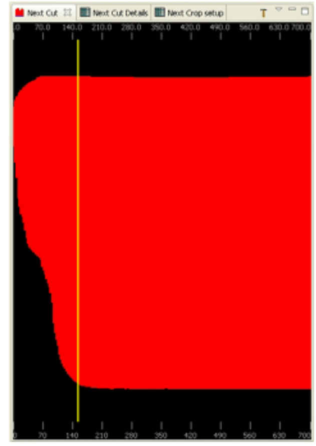
The **Pre Crop Data** window provides the user with crop statistics of the cut that will occur after the one currently in progress.
See window #4 for description of parameters.



Pre Crop data

Pre-cut crop length (adjusted)	101.60	mm
Pre-cut crop length	101.60	mm
Pre-cut type	MINIMUM	
Pre-cut shape	% BW	
Pre-cut crop mode	FIXED LENGTH	

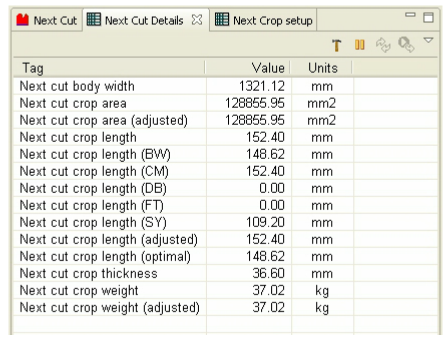
6.7 Section #6 & #7- Next Cut & Pre Cut



These two windows display to the user an image of the imperfection to be cut off for the current and next cut. In both images the user may adjust the horizontal scaling so as to improve resolution of the image. Vertical scaling may also be added if desired.

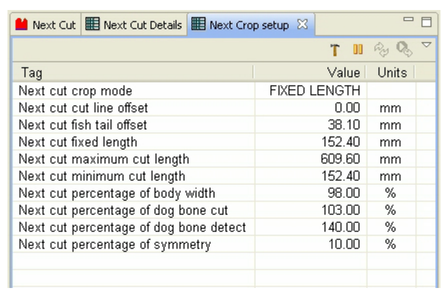
If the user adjusts the cut length, another line in addition to the one currently displayed will move to the user desired position. This is done to show the user the before and after cut positions.

Two additional tabs are available for the user to select from on this window. These are **Next Cut Details** and **Next Crop Setup**. These two tabs contain a wealth of information that will be discussed later on in this chapter.



Tag	Value	Units
Next cut body width	1321.12	mm
Next cut crop area	128855.95	mm2
Next cut crop area (adjusted)	128855.95	mm2
Next cut crop length	152.40	mm
Next cut crop length (BW)	148.62	mm
Next cut crop length (CM)	152.40	mm
Next cut crop length (DB)	0.00	mm
Next cut crop length (FT)	0.00	mm
Next cut crop length (SY)	109.20	mm
Next cut crop length (adjusted)	152.40	mm
Next cut crop length (optimal)	148.62	mm
Next cut crop thickness	36.60	mm
Next cut crop weight	37.02	kg
Next cut crop weight (adjusted)	37.02	kg

Next Crop Details tab provides numerous details about the upcoming cut. Although this tab does not provide the operator with much importance, its information can be quite useful for statistical analysis. Data such as the cut crop area and weight can be invaluable to improving crop yield. Accucrop uses 5 various algorithms to calculate the cut length. For every cut, each algorithm is applied and the one with the largest cut is the one that will be used. In this *details* tab, each algorithm's calculated cut length is shown.

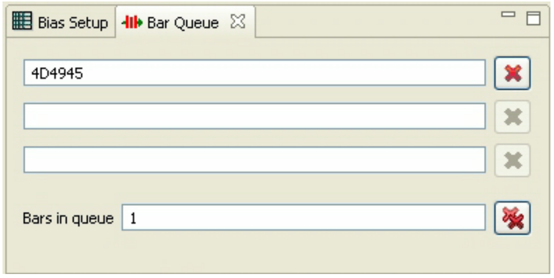


Tag	Value	Units
Next cut crop mode	FIXED LENGTH	
Next cut cut line offset	0.00	mm
Next cut fish tail offset	38.10	mm
Next cut fixed length	152.40	mm
Next cut maximum cut length	609.60	mm
Next cut minimum cut length	152.40	mm
Next cut percentage of body width	98.00	%
Next cut percentage of dog bone cut	103.00	%
Next cut percentage of dog bone detect	140.00	%
Next cut percentage of symmetry	10.00	%

Next Crop Setup tab displays the settings that will be used for the next crop cut. This setup data can be a head or a tail setup depending on how many bars are in the queue and if the next cut is going to be a head or tail end of the bar.

Note: The **Pre Cut Details** & **Pre Crop Setup** tabs are essentially the same except that they pertain specifically to the cut after the one currently in progress or being made.

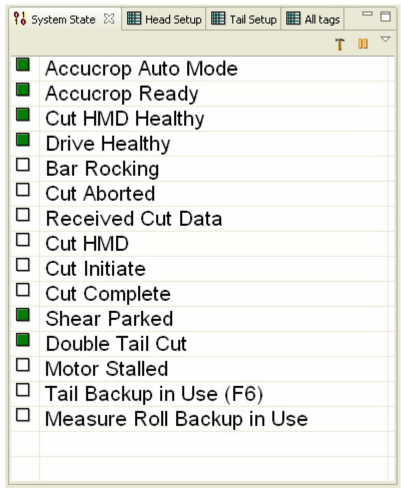
6.8 Section #8 - Bar Queue



The **Bar Queue** window is the Accucrop managed queue manager that handles head and tail cuts for up to three bars. If additional bars are imaged faster than they are being cut and passed through the mill, they will appended through the queue manager. Once a bar head and tail is cut, the queue moves up, first in, first out. The last field specifies the number of bars in the queue. If a problem occurs in the mill and a bar is removed before the final tail cut is made, it can be removed from the queue by clicking on the red "**X**" button located just right of the image. This will ensure that the next bar cut does not receive the removed bar's cut statistics. To remove all the bars from the queue, click on the button containing the double **"X"**s. Please see the end of this chapter for more information on how the bar queue works.

The **Bias Setup** tab allows the operator to specify how much overspeed and underspeed to assign to a head & tail cut respectively. The value entered is a percentage increase or decrease of the actual bar speed during the cut.

6.9 Section #9 - System State



The **System State** window provides the user with real time status on the processes and conditions of the Accucrop system. As an even occurs or a device is healthy, it will be lit as a green square as seen in the image on the right. If a devices goes unhealthy, the green box will turn red. A yellow box indicates a warning status and must be addressed. Below is a brief description of the system state signals:

Accucrop Auto Mode: Indicates that Accucrop is in automatic mode and all cuts will be performed by the system. If Accucrop is not in Auto mode, all cuts must be made manually; no shear control or tracking will occur.

Accucrop Ready: Indicates that the Accucrop system is ready to perform cuts. This status also indicates that all sensors are working and communicating with Accucrop properly.

Cut HMD Healthy: Indicates that the Hot Metal Detector is online and working properly.

Drive Healthy: Indicates that the crop shear drive is online and ready to cut. This is an external signal to Accucrop from the drive controller or PLC.

Bar Rocking/Cut Inhibit: Indicates that bar rocking/cut inhibit is enabled. This mode disables any transitions from the HMD. Once the user cuts the head, he/she may enable bar rocking to rock the bar on the rolls before entering the mill. When in this mode, the Accucrop system enters a “sleep” state where any changes to sensor condition will not trigger a response.

Cut Aborted: Indicates that the current cut will be aborted. Various conditions can cause the system to abort the cut such as when the bar travels at too high of a velocity towards the shear. For more conditions as to when a cut is aborted, please consult KELK.

Received Cut Data: Indicates that cut data has been transferred from Accuband to Accucrop.

Cut HMD: Indicates that the Hot Metal Detector (HMD) has triggered on material. For rougher exit applications, this is when tracking of the cut line begins.

Cut Initiate: Indicates that the cut sequence has begun. At this time, the shear will begin to rotate.

Cut Complete: Indicates that the shear has reached zero position and the cut is complete.

Shear Parked: Indicates that the shear is not parked. During a cut, this indicator will turn yellow. Do not be alarmed by this. After the completion of the cut, Accucrop will automatically park the shear at which time the indicator will turn green. If it does not, the shear will stall and a full system fault will occur.

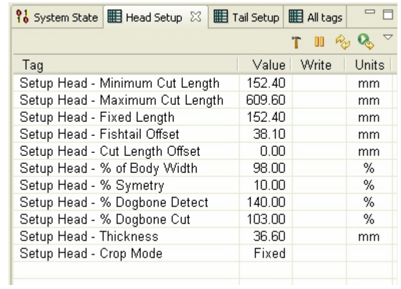
Double Tail Cut / Extra Revolution: Indicates that the double tail cut is enabled. Double tail cut is a condition strictly reserved for tail cuts in which the shear will make an extra revolution just to ensure that no piece is stuck to the blade.

Motor Stalled: Indicates that the shear has stalled. This condition occurs if the shear does not return to its parked position within a reasonable time from when it was issued to move. Conditions that can cause a motor to stall include a fuse blow in the drive or jammed shear blades.

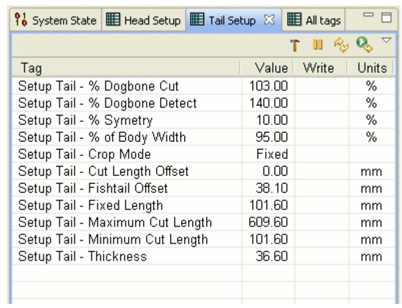
Tail Backup in Use (F6): Indicates that the velocity currently being used for tracking of the tail is being accomplished through the speed source found on the F6 finishing stand.

Measure Roll Backup in Use: Indicates that the velocity currently being used for head tracking is being accomplished through a measuring roll. This measuring roll is usually always located before the Hot Metal Detector.

The **head** & **tail setup** tab will display the settings for the head and tail of the bar. These parameters can be adjusted by the operator. All crop shapes/cut lengths are listed as follows: (*Dogbone cut and detect, Symmetry, Body width, Fixed length*). The crop mode (*Manual, Fixed, Optimized, skip, N/A*) can be selected with the mouse from the *Write* column. Above the units column, the green button must be pressed which sends the desired value to Accucrop. Cut length offset and fish tail offset can be adjusted as well. The maximum and minimum cut length can be set, and also the Bar thickness. The procedure to update any value is the same as mentioned above; Enter value, press enter, press green "Send" icon.



Tag	Value	Write	Units
Setup Head - Minimum Cut Length	152.40		mm
Setup Head - Maximum Cut Length	609.60		mm
Setup Head - Fixed Length	152.40		mm
Setup Head - Fishtail Offset	38.10		mm
Setup Head - Cut Length Offset	0.00		mm
Setup Head - % of Body Width	98.00		%
Setup Head - % Symetry	10.00		%
Setup Head - % Dogbone Detect	140.00		%
Setup Head - % Dogbone Cut	103.00		%
Setup Head - Thickness	36.60		mm
Setup Head - Crop Mode	Fixed		



Tag	Value	Write	Units
Setup Tail - % Dogbone Cut	103.00		%
Setup Tail - % Dogbone Detect	140.00		%
Setup Tail - % Symetry	10.00		%
Setup Tail - % of Body Width	95.00		%
Setup Tail - Crop Mode	Fixed		
Setup Tail - Cut Length Offset	0.00		mm
Setup Tail - Fishtail Offset	38.10		mm
Setup Tail - Fixed Length	101.60		mm
Setup Tail - Maximum Cut Length	609.60		mm
Setup Tail - Minimum Cut Length	101.60		mm
Setup Tail - Thickness	36.60		mm

Note: If the crop mode is selected as Optimized, the cut length will be optimized according to the crop shape. If the crop mode is selected in Fixed cut, then Accuband (imaging scanner) will draw the cut line at the specified fixed length set in this window. If the crop mode is in manual mode, then the cut length sent by Accuband will be zero and Accucrop will skip the cut.

6.10 Section #10 - Additiona KIP Controls

The following will overview the function of the three icons found in section 10 of Figure 1.

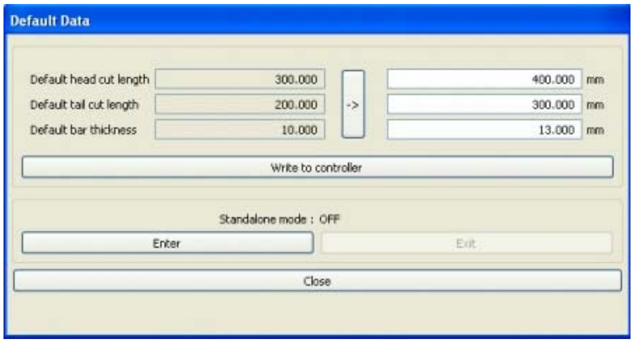
From left to right, the description of each icon are: **Parking Options**, **Default Data/Standalone Mode, Motor Status.**

Parking Options

Allows the user to enter a *Wiggle angle*. This angle (in Degrees) instructs the shear to swing the extra angle of revolution past the parking position after the tail is cut.

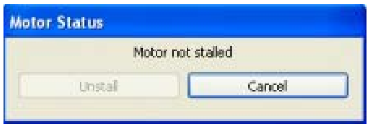
In situations where the user wishes to perform an extra revolution after the tail cut is made so as to ensure that no piece is stuck to the blades, enable the checkbox in this window.

Default Data/Standalone Mode



The upper part of the figure on the left allows the user to make modifications to the default data Accucrop uses. Values for default head, tail, and bar thickness can be entered in the three fields on the top right and written to the controller. These values will not be used unless the operator enters Standalone Mode. This mode allows Accucrop to function without the use of the imaging scanner. In this mode, the system will make cuts based on a user specified fixed length for both head and tail.

Motor Status



When a motor stalled condition occurs, this window will appear automatically. Once it is determined why the stall occurred and the situation resolved, Accucrop must be instructed to unstall the motor before it can return to the home position.

6.11 Accucrop Bar Queue Operation

The Accucrop bar queue manager provides the operator with worry free tracking of all pieces entering the shear. The crop optimization system can track up to three (3) bars or six (6) cuts at a time. Below is the process of how the images are displayed on the screen and how the queue works. Two conditions will be displayed. The first condition will simulate a mill with slow production, ie. the second bar does not get imaged until the tail end of the first is cut. The second condition will simulate a second bar being imaged while the tail of the first has not yet been cut.

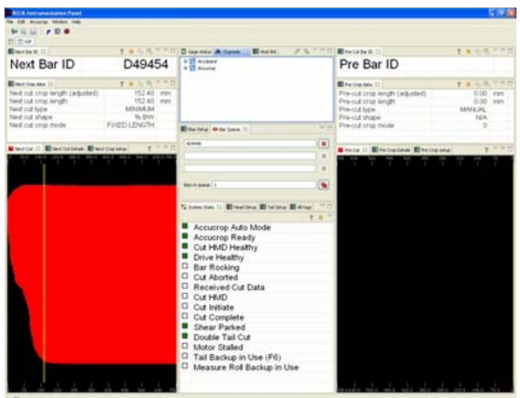
Installations that use a coilbox system will have the heads and tail automatically flipped to reflect the shape of the bar entering the crop shear. If the coilbox will not be used, the head and tail images will not be exchanged. The queue system will be most beneficial to coilbox mills that have more than one coilbox. While one bar is unrolling, another can be in the process of being imaged and coiled shortly after. In such cases, all head and tail images will be stored in the queue manager and processed sequentially.

Note #1: The images below contain colors that are important in the understanding of the queue sequence. If this document is printed in black & white, color detail will be lost and it may be difficult to understand the process. In such cases, KELK advises that you reference to the soft copy of this document.

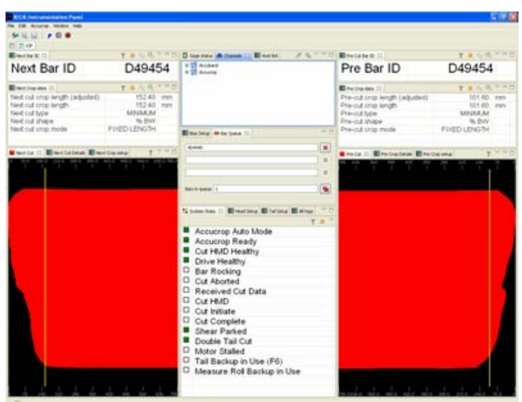
Note #2: Installations that use a coilbox will have have the head and tail images automatically exchanged to reflect the piece entering the scrop shear. For simplicity and ease of understanding, the two conditions below do not reflect this swap of images.

Condition #1.

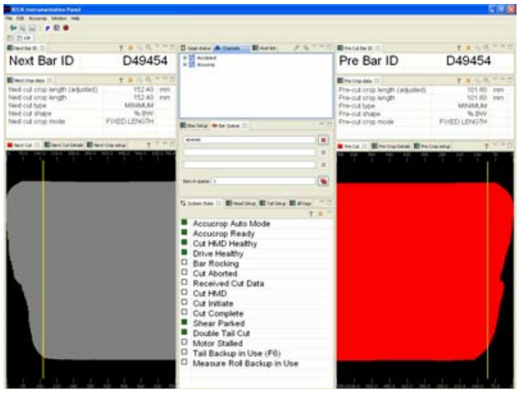
When the bar enters Accuband (imaging scanner) for the first time, a head profile is drawn and displayed on the screen. The bar ID is also updated. During this time the operator may make adjustments to the cut line. Once the tip of the head end reaches the KELK HMD, adjustment is locked out because tracking of the cut line has begun:



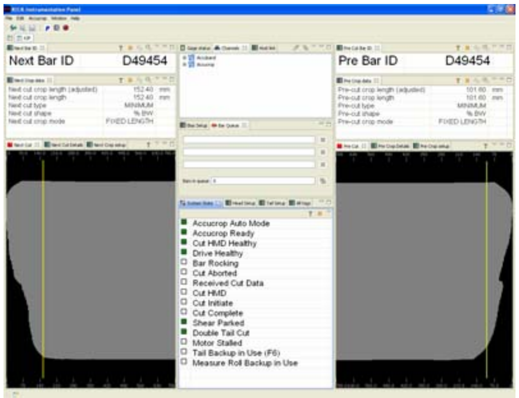
Once the tail end gets imaged, the tail image will appear on the screen. The bar ID is also updated. Cut line adjustment can be made for the tail until the KELK HMD drops out:



Once the head reaches the HMD, the head end color will turn gray to indicate that no more adjustments are allowed and that tracking is in progress. Even if the operator is skipping a head cut, this event will occur:



Finally, once the tip of the tail passes through the HMD and the sensor signal drops, the tail image is turned to gray just like the head. Tail cut line adjustments are locked out at this time:



Condition #2.

This condition will demonstrate how the queue handles multiple bars. The situation in this example will include a bar (ID #10) that has been imaged (both head and tail) and has just gotten the head end cut off. While the tail end approaches the KELK HMD, a new bar (ID #11) enters Accuband (imaging scanner) and proceeds towards the shear.

Once the head end of bar ID #10 gets imaged, it will display on the screen. The bar ID will also display above the left image and the bar queue will display ID #10.

Next Cut Image Pre Cut Image

Once the tail gets imaged it is then shown on the screen. The right window displays bar ID #10 as well since it is the same bar:

Next Cut Image Pre Cut Image

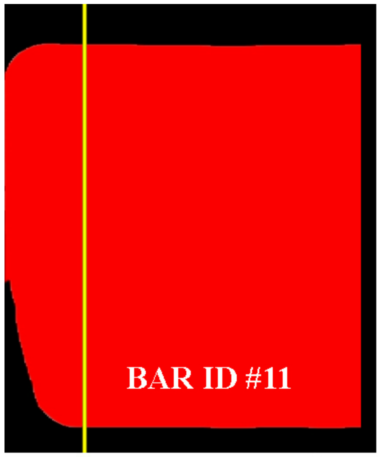
The head end of the bar (ID #10) enters the field of view of the KELK HMD and now tracking of the head begins. The operators is notified of this moment when the **Next Cut Image** window turns gray in color:

Next Cut Image Pre Cut Image

A new bar (ID #11) is now imaged at the imaging scanner. As soon as the new head image gets profiled, it is sent to the operator. At this time, the Pre Cut Image (tail of bar ID #10) displayed above will shift left into the Next Cut Image window and it's bar ID will remain as ID #10. The new head image will display in the Pre Cut Image window and its bar ID window will display ID #11. The queue will now show ID #10 in position #1 and ID #11 as in position #2.

Next Cut Image Pre Cut Image

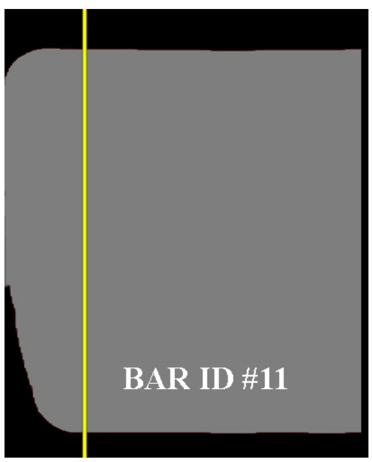
As soon as the tail end of bar #10 reaches the HMD, bar ID #10 will disappear from the queue (since both it's head and tail has been cut) and bar ID #11 will take place in position #1. The head end of bar #11 will shift left into **Next Cut Image** replacing bar #10 tail image since it is next in line for cutting. The bar ID will also update to #11. The tail image of bar #11 will display in the **Pre Cut Image** window as soon as it is available.



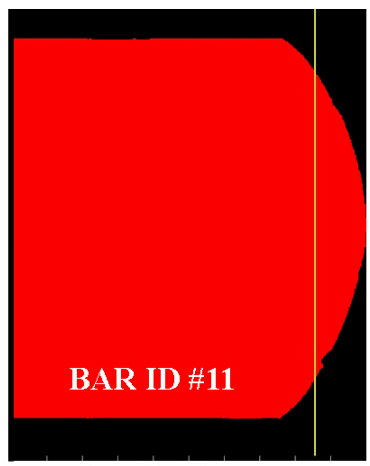
Next Cut Image

Pre Cut Image

Assuming that no new bars are imaged, once the Head end of bar #11 reaches the HMD it will gray out in color. As soon as the tail end reaches the same point it too will gray out in color. No shift will occur.

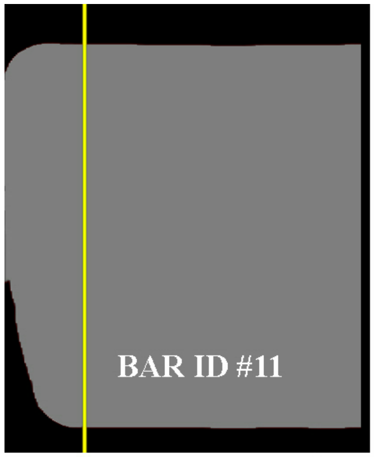


Next Cut Image



Pre Cut Image

The tail of bar ID #11 now causes the HMD signal to drop, thereby causing the tail image to gray out.



Next Cut Image

Pre Cut Image

Note that since the time bar #11 got imaged, there was no graying of the images. This effect only occurs if there is one bar in the queue at one time and no new bars are being imaged. As soon as more than one appears, the images shift from right to left as their corresponding ends approach the shear.

PART 7 ACCUCROP MAINTENANCE INTERFACE

7.1 Introduction

The Accucrop Closed Loop Crop Shear Controller system includes several user's interfaces designed to help with system operation, maintenance and troubleshooting. The intention of this section is to provide the customer with a reference document for the Accucrop Maintenance interface.

7.2 Scope

The Accucrop Maintenance interface provides the necessary tools to monitor the system performance, adjust and configure the system parameters and assist in performing regular maintenance. This section is intended for maintenance personnel and includes a description of:

- How the interface can be accessed
- What features are available
- The design behind these features
- A description of the parameters
- References to other sections where information already exist

7.3 General Overview

Accucrop controller includes a pre-installed user maintenance software incorporation several windows for use during setup, maintenance and troubleshooting. 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 Accucrop controller (recorded on a Compact Flash memory card) and can be executed on any Internet browser on the Accucrop network. This eliminates the need of installing any proprietary software on each computer.

7.4 Access

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

To start the Maintenance interface:

- Establish a network connection between a PC or laprop and the Accucrop controller primary Ethernet port
- Ensure that your PC's network card is properly configured to communicate with the Accucrop controller.
- Launch a Web browser and type in the address bar the IP address on the Accucrop controller primary port
- A KELK web screen will display a selection between the KELK Accucrop V3 Maintenance interface and KELK Configuration Manager utility
- Select with the mouse the Maintenance interface - Run Applet link and after a short delay, the Maintenance interface is automatically downloaded from the Accucrop.
- A Communication tab window will appear on the screen and the connection with the Accucrop controller is established.
- Note that Accucrop controller allows only one user at a time to connect and use the Maintenance interface.
- If another user is connected and using the Maintenance interface, then when you try to connect you will get a Warning pop up message with the IP address of the user connected and your connection will be refused.

7.5 Maintenance Interface Windows

The Maintenance Interface is arranged as a series of windows accessible via tabs across the main browser window. Some windows will display various status bits and read only values used for Accucrop monitoring. Other windows will have access to Accucrop parameters and controls. Care must be taken when entering different operation modes or adjusting different parameters.

The following paragraphs will provide all the necessary information to understand the usage and operation of the Maintenance Interface. Refer to "Accucrop system operation" and "Accucrop setup" chapters from this manual for a full description of Accucrop operation and parameters setup.

At the bottom of the Maintenance interface window are displayed 3 status bits. The description is as follow from left to right:

- **Accucrop ready to cut (green)** = Accucrop is ready to perform a cut; **Accucrop not ready to cut (red)** is the opposite state.
- **Accucrop auto mode (green)** = Kelk mode selector switch is in Auto mode; **Accucrop manual mode (yellow)** = Kelk mode selector switch is in Manual mode
- **Motor stalled (red)** = Motor stalled condition is enabled. If Motor stalled condition is disabled then this field is blank (white).

Note: When Motor stalled condition is enabled, a Motor condition window will pop up on the screen. See Figure 7.1.

Figure 7.1 Motor condition

The Motor stall feature was designed to force the controller into a “sleep state” upon the detection of a Motor stall condition. This means that the controller stops trying to control the motor and it sets its output control voltage to zero.

One common case when the Motor stalled condition may happen is when the cut cycle exceeds 12 seconds to complete. Complete means that the cut has been started (Cut ini) but after 12 seconds the cut was not completed (top drum bottom dead zero). This usually implies that the main breaker of the motor has tripped. When the main breaker trips and the controller is operating normally it can be expected that the controller output voltage will be near maximum since this condition represents a large control error. If the main breaker is rest under these conditions the drive will likely trip again due to a large output voltage. This feature was included to prevent this from happening.

The Motor stalled condition can be cleared (reset) by pressing the Clear Motor Stall button. However, if the internal status fault bit that generated the Motor stalled condition is still present, then the Motor stalled window will stay on the screen. Make sure the maintenance personnel investigates the status bit fault. Refer to Status tab window for more details.

7.6 Diagnostics Mode Window

The Diagnostics mode window was designed for commissioning and maintenance of the Accucrop system. This window displays the feedback from the ABS and INC encoders, current reference, Accucrop Analog and Digital I/O and Accuspeed from CSE(crop shear entry) and CSX(crop shear exit) locations. All this data and status bits can be monitored off-line without interfering with the system operation. These are some additional features (Analog input scaling, Current reference test and Step response test) that can be accessed while in Diagnostics mode. Only trained personnel who know the Accucrop system operation must use these features. To enter Diagnostics mode, first select the Diagnostics mode tab window and then inside the Accessing mode field press the Enter Diagnostics mode button. A warning message will pop up on the screen. Press Yes and the Diagnostics mode status will change to ON. See Figure 7.2.

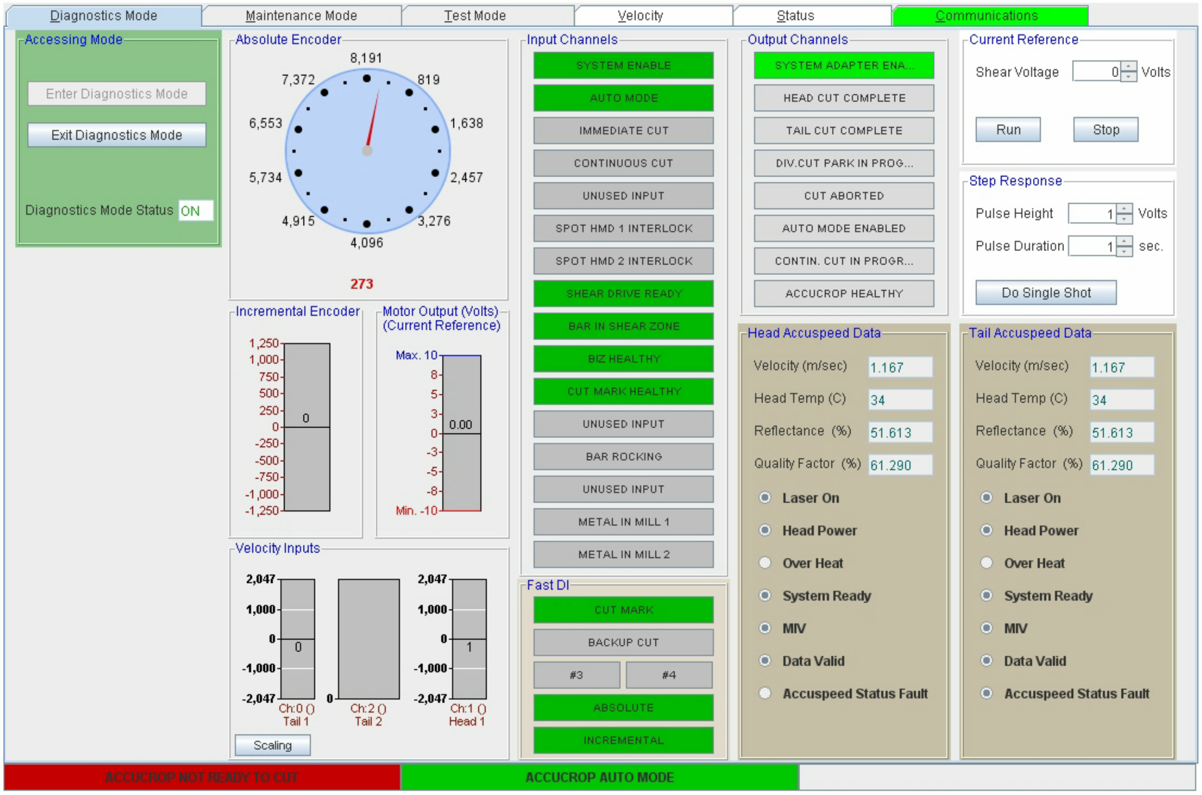


Figure 7.2 Diagnostics Mode Window

Caution! When you enter Diagnostics mode, Accucrop system does not perform automatic or manual cuts. When you exit the Diagnostics mode, the shear moves to the Head park position.

- **Absolute encoder field:** This is a graphical representation of the ABS encoder. The dial hand indicates the position values reported by the encoder. The dial hand must turn clock wise when the shear is moving in the cut direction. The absolute position values are displayed at the bottom, and the values are between 0 and 8192. This encoder is used to measure the position of the crop shear blades
- **Incremental encoder field:** The Incremental encoder feedback can be monitored here. It is displayed like a bar graph with values between - 1250 and + 1250. The scaling is counts per 4 milliseconds. When shear moves in the cut direction the Incremental encoder values must be positive.
- **Current reference field:** This field displays the Cropshear Remote adapter Analog output. This is the reference signal which is sent to the Shear drive current regulator. It is displayed like a bar graph with values between - 10V and + 10 V.
- **Velocity inputs field:** In this field you can monitor the Accucrop controller Analog input signals (Head and Tail backup speeds). They are displayed like bar graphs with values between -2047 and + 2047. The Analog inputs default assignment is: Tail speed 1 (F1 speed), Head backup (measure roll) and Tail speed 2 (F2 speed). The

analog inputs can be scaled by pressing the Scaling button. A new window will pop up and here you can scale each Analog input.

- **Input channel field:** This field displays the status of the Accucrop controller digital inputs from the Discrete I/O. There are 16 digital inputs available and the status is indicated with colors: green = high (enable) and grey = low (disable). The Digital inputs channels assignment can be set via Configuration manager utility and the channels description will be automatically updated in this field once the Maintenance interface is reloaded.
- **Fast digital inputs field:** In this field you can monitor the Accucrop controller fast digital inputs status. There are 6 fast digital inputs available and the status is indicated with colors: green = high (enable) and grey = low (disable). Three channels are pre-assigned to the following signals: Cut mark HMD 2048, Absolute encoder power OK, Incremental encoder power OK.
- **Output channels field:** This field displays the status of the Accucrop controller digital outputs from the Discrete I/O. There are 8 digital outputs available and the status is indicated with colors: green = high (enable) and grey = low (disable). The Digital outputs channels assignment can be set via Configuration manager utility and the channels description will be automatically updated in this field once the Maintenance interface is reloaded. When Diagnostics mode is on, you can enable/disable the digital outputs by pressing with the mouse on these buttons. It is a useful tool during commissioning when the interconnection cables must be checked.
- **Current reference field:** This field is active only when the Diagnostics mode is ON. Here you can force the Cropshear Remote adapter analog output to a certain value between -10 V and + 10 V. The volts numerical field allows the user to set the reference voltage value and the Run / Stop control buttons begin or terminate the process.
- **Step response field:** This field is active only when the Diagnostics mode is ON. Here you can force the Cropshear Remote adapter analog output to generate a pulse with a certain amplitude for a certain amount of time. The Pulse Height field represents the amplitude of the Analog output signal and can be set between -10 V and + 10 V. The Pulse Duration field represents for how long the Analog output will be energized. By pressing the Do single shot button the Cropshear Remote adapter will send a “Step response” to the Shear drive.
- **Head Accuspeed data field:** This field displays data and status from the CSE Accuspeed laser velocimeter (Head primary speed). The user can monitor the Bar velocity, Optics head temperature, reflectance and Quality factor. There are 7 status bits available via color indicators: Grey = high (enable) and White = low (disable).
- **Tail Accuspeed data field:** This field displays data and status from the CSX Accuspeed laser velocimeter (Tail primary speed). The user can monitor the Bar velocity, Optics head temperature, reflectance and Quality factor. There are 7 status bits available via color indicators: Grey = high (enable) and White = low (disable). If there is no Tail primary speed source available (CSX Accuspeed laser velocimeter is optional) then no data will be displayed in this field.

Refer to the Accucrop system operation and setup chapters for a detailed description of the features and parameters selection.

7.7 Maintenance Mode Window

The Maintenance mode window was designed to aid in commissioning and maintenance of the Accucrop system. When Maintenance mode is ON you can get access to “Zero blades” and “Jog Shear RPM” features. Only trained personnel who know the Accucrop system operation must use these features. To enter Maintenance mode, first select the Maintenance mode tab window and then inside the Accessing mode field press the Enter Maintenance mode button. A warning message will pop up on the screen. Press Yes and the Maintenance mode status will change to ON. See Figure 7.3.

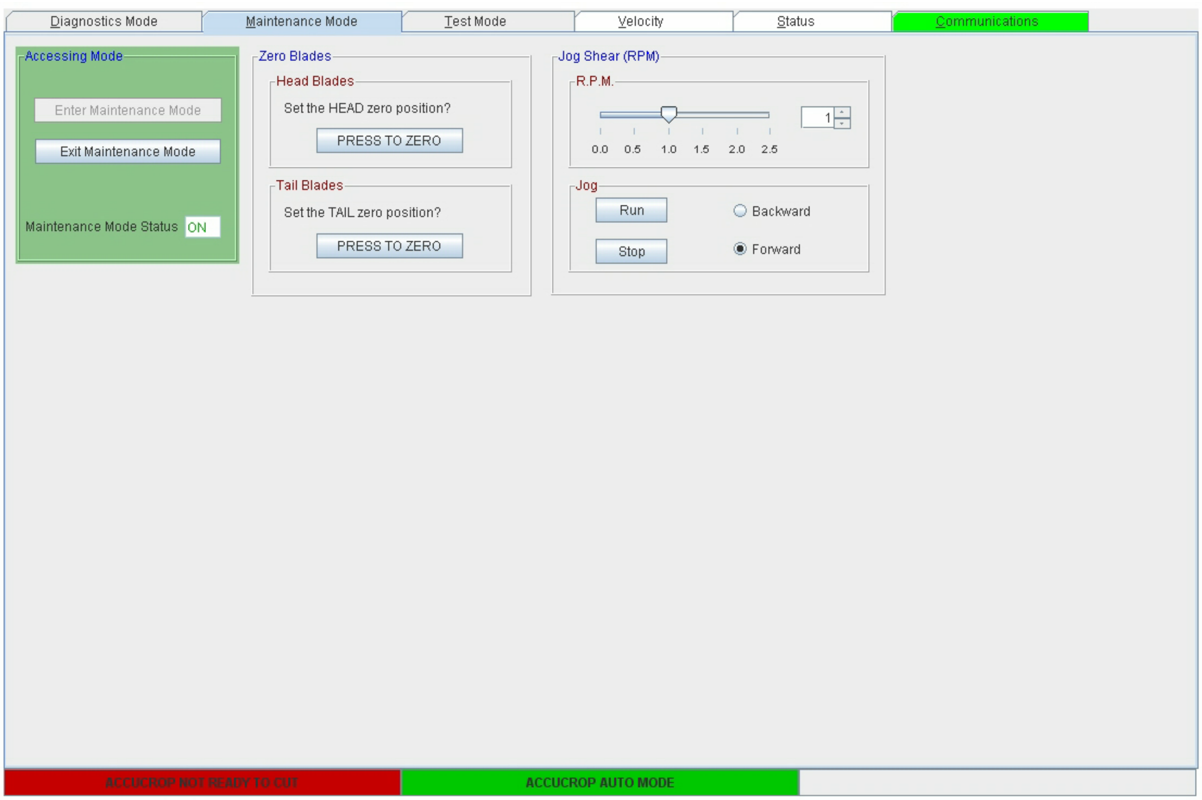


Figure 7.3 Maintenance Mode Window

Caution! When you enter Maintenance mode, Accucrop system does not perform automatic or manual cuts. When you exit the Maintenance mode, the shear moves to the Head park position.

- **Zero blades field**: it is used to zero the shear blades. This feature must be used only if the Shear drum/blades has been changed or the Absolute encoder/coupling has been changed or it was any change in the shear geometry between the shear drum and the Absolute encoder. If your crop shear has two sets of blades, one for head cuts and one for tail cuts, then first set the “Double blade shear” parameter to Yes in the Configuration Manager utility. Then two buttons - “Press to zero” will appear in the “Zero blades” field. One button is used to zero the Head blades and the other button is used to zero the Tail blades. If your shear has only one set of blades used for Head and Tail cuts as well, then the “Double blade shear” parameter must be set to No and only one “Press to zero” button will appear in the Zero blades field.
- **Jog Shear (RPM) field**: contains the Jog controls - Run, Stop, Forward and Backward and the RPM numeric field slider. The user can set the value of rotations per minute for the shear by either using the RPM numeric field or slider. The shear is put into motion by pressing the Run button. The direction can be changed at any time by pressing the Forward or Backward buttons. To stop the shear rotation press the Stop button.
- This feature was designed to assist in zeroing the crop shear blades. The idea is to use this field to position the shear blades in the zero position. With one person near the shear giving signals to the operator it is possible to accurately position the blades.

Refer to the Accucrop system operation and setup chapters from this manual for a detailed description of the features and parameters selection.

7.8 Test mode window

The Test mode window was designed as a commissioning tool to assist in tuning the park and cut regulators. Only trained personnel who know the Accucrop system operation must use these features. To enter Test mode, first select the Test mode tab window and then inside the Accessing mode field press the Enter Test mode button. A warning message will pop up on the screen. Press Yes and the Test mode status will change to ON. See Figure 7.4.

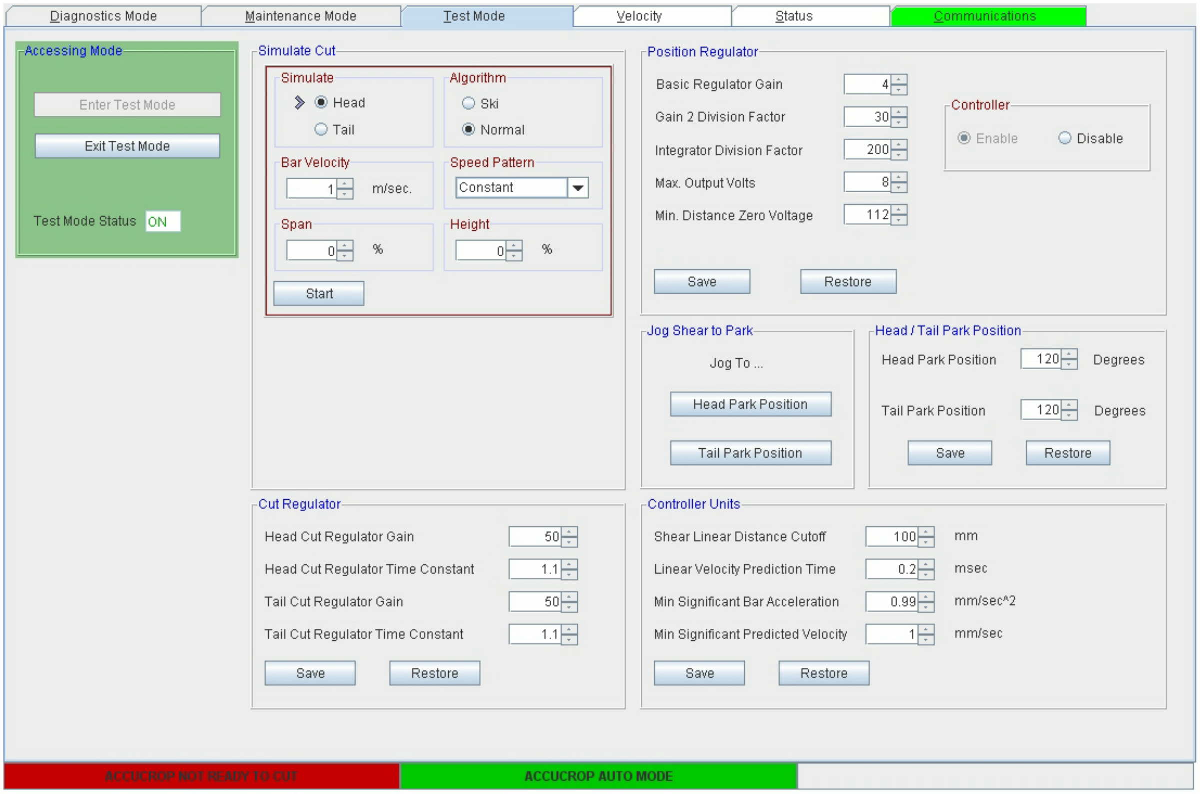


Figure 7.4 Test Mode Window

Caution! When you enter Test mode, Accucrop system does not perform automatic or manual cuts. When you exit the Test mode, the shear moves to the Head park position.

The Test mode window contains six fields which give you access to different parameters and features. Below is a description of them:

- **Simulate cut**: This window was design to assist in tuning of the Cut regulator. The type of simulate cut (Head or Tail) can be selected. When you simulate a head cut from the tail park position, the shear first moves to the head park position using the park regulator before starting the simulated cut. The cut velocity must be entered together with type of control algorithm (speed pattern, span and height). There are 5 speed patterns: Constant, Positive step, Negative step, positive ramp, Negative ramp. The Span and Height parameters determine the time and amplitude the simulated velocity deviates from set velocity. Once the Start button is pressed the shear will perform a cut according to the selected parameters.
- **Position regulator**: This window contains the Position regulator parameters and the maximum voltage output of the Accucrop controller. It also contains a selector which allows the user to enable or disable the operation of the Crop Shear Controller. This is very useful during the tuning of the position regulator. This provides a method to disable the controller should it become unstable. When the disable position is selected the controller is not regulating the shear position, the controller is in sleep

state. The Save and Restore buttons are used to save the parameters values on the CF card or read the saved values.

- **Jog shear to park**: This window was design to aid in commissioning the position regulator. It provides a method of moving the shear by using the park regulator. This allows the commissioning engineer to evaluate the operation of the position regulator without having to use the cut regulator. The important practical point to understand is that the cut regulator cannot be tuned without first tuning the position regulator. This window contains 2 buttons: Jog to ... Head park position and Tail park position. The position regulator will jog the shear to the indicated park position. If the shear is parked at the position selected , the shear moves 360 degrees in the cut direction to reach that position.
- **Head /Tail park position**: This window contains 2 numerical fields: Head Park position and Tail park position. Their corresponding values denote the angular distance (in degrees) from the park position to the shear blades bottom dead zero. This is measured in the direction of the cut. The Save and Restore buttons are used to save the parameters values on the CF card or read the saved values.
- **Cut regulator**: This window contains the Head and Tail Cut regulator parameters (Gain and Time constant). They can be adjusted using the numerical fields. The new values can be saved on the CF card by pressing the Save button. T hey can be checked with the Restore button. This window is used during the Cut regulator fine tuning.
- **Controller units**: This window contains the 4 parameters used for the Accucrop controller fine tuning. They impose some limits in regards with the speed and acceleration values received by the controller. Acting like filters, these parameters can determine de difference between real acceleration and noise. Acceleration is more important when the shear is further away from the cut point and is progressively less of a factor the closer the shear is to the cut ponit.

ibaPDA data logger must be running in the background. The real time display can be used for viewing the simulate cut results and tuning the position and cut regulators. Data can be stored for future reference.

Refer to the Accucrop system operation and setup chapters for a detailed description of the features, parameters selection and controllers tuning.

7.9 Velocity window

The Velocity window represents an interface for the Accucrop Velocity processor. This window provides valuable information about the velocity sources availability, selections and processing. It should be used by the maintenance personnel in monitoring and troubleshooting of different faults. See Figure 7.5.

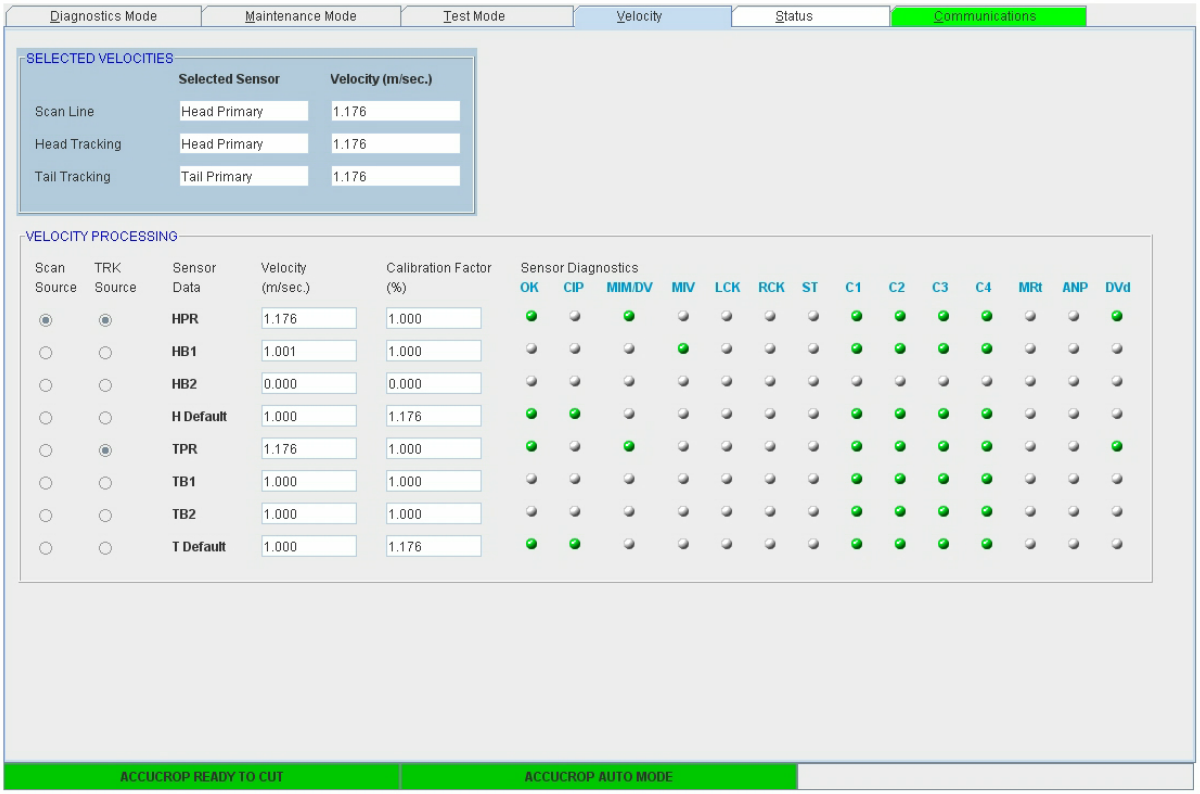


Figure 7.5 Velocity Window

The Velocity window contains two smaller fields: Selected velocities and Velocity processing. Below is a brief description of these windows :

- **Selected velocities field:** displays the System speed at the scan line (HMD 2048 location) and also the speed source selected for the Head tracking and Tail tracking. The data is displayed real time.
- **Velocity processing field:** displays what velocity sources are available, their value and calibration factors. A sensor diagnostic table composed of green/grey radio buttons is available as well.

Refer to Accucrop Velocity processor chapter for more information about all these parameters and how the velocity sources are selected.

7.10 Status window

The Status window will assist the maintenance personnel in troubleshooting different Accucrop faults. It contains a series of most common status bits representing digital inputs, operation modes, healthy mode, tracking state, parking state and some internal modules state. The current status is represented by different colors: grey, green, red and yellow. The meaning of the colors for each status bit may be different so refer to the description below. See Figure 7.6.

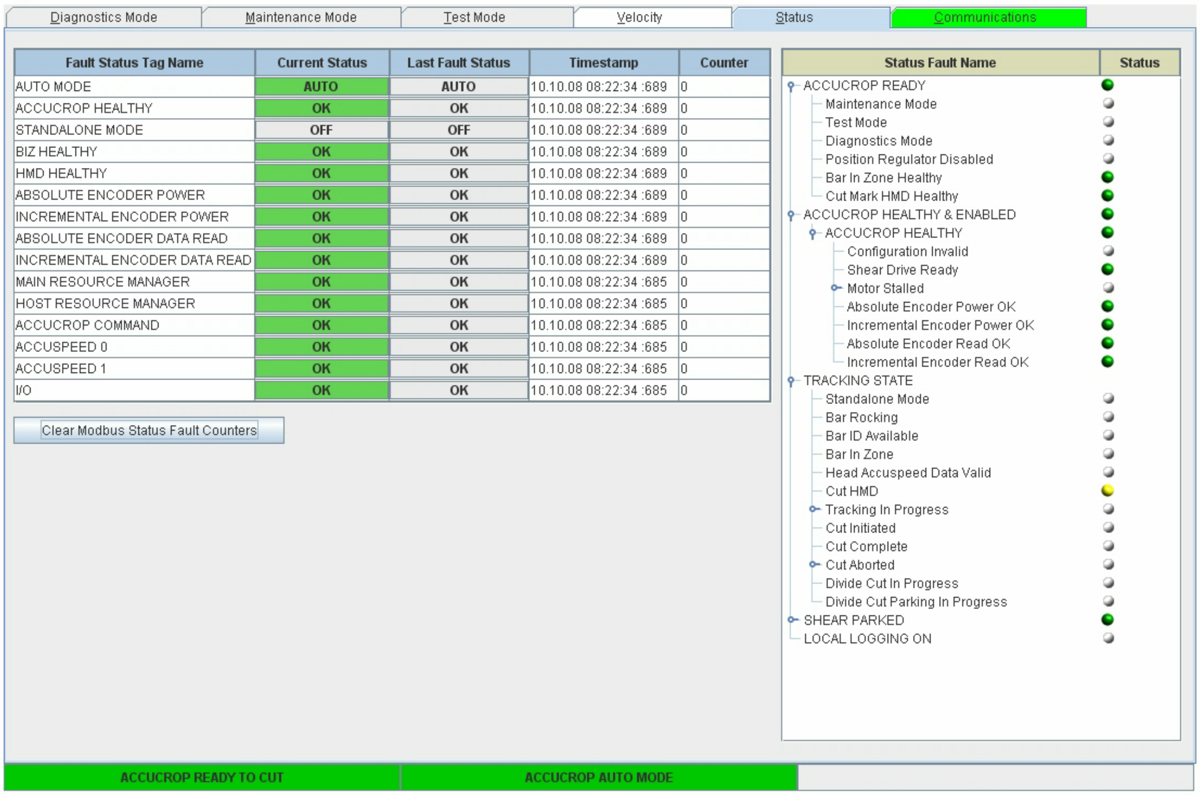


Figure 7.6 Status Window

The left table includes some of the most common status bits. It includes the Current status, Last fault status, a Timestamp when the last change in the status occurred, and a counter. The Timestamp and counter can help troubleshoot different faults that occurred in the past or they lasted just for an instant. To clear the counters just press the “Clear Modbus Status Faults Counter” button.

Here is the color meaning of the status bits:

- **Auto mode**: When Auto mode is selected the color is green. If Manual mode is selected then the color is yellow.
- **Accucrop Healthy**: When Accucrop is healthy the color is green. If Accucrop is unhealthy them the color is green.
- **Standalone mode**: When Standalone is selected the color is yellow. Otherwise the color is grey.
- **BIZ healthy**: When digital input is high, the color is green. Otherwise the color is red.

- **HMD Healthy**: When digital input is high, the color is green. Otherwise the color is red.
- **Absolute encoder power**: When fast digital input is high, the color is green. Otherwise the color is red.
- **Incremental encoder power**: When fast digital input is high, the color is green. Otherwise the color is red.
- **Absolute encoder data read**: When connection to Absolute encoder is OK the color is green. Otherwise the color is red.
- **Incremental encoder data read**: When connection to Incremental encoder is OK the color is green. Otherwise the color is red.
- **Main resource manager**: When Main resource manager module status is OK, the color is green. Otherwise the color is red.
- **Host resource manager**: When Host resource manager module status is OK, the color is green. Otherwise the color is red.
- **Accucrop command**: When Accucrop core can communicate with other modules the status is OK and color is green. Otherwise the color is red.
- **Accuspeed 0**: When the CSE ASD status and link is OK then the color is green. Otherwise the color is red and the fault is indicated.
- **Accuspeed 1**: When the CSX ASD status and link is OK then the color is green. Otherwise the color is red and the fault is indicated.
- **I/O**: When the Accucrop Discrete I/O status and link is OK then the color is green. Otherwise the color is red.

Some of the status fault bits (eg: Accucrop Ready to Cut, Accucrop Healthy, Motor stalled) are complex containing multiple internal bits. The right field of the Status window displays a tree with some of them. To view the description of these internal bits together with the status fault indicators just press with the mouse on the nodes. Here is the component bits for some of them:

Accucrop Ready to Cut (green) = Accucrop Ready <and> No Maintenance mode <and> No Test mode <and> Position regulator enable
Note: Diagnostics mode status bit will trigger Maintenance mode status bit.
Accucrop Ready (green) = Accucrop Healthy <and> Accucrop system Enable
Accucrop Healthy (green) = Configuration valid <and> Shear drive ready <and> Motor not stalled
Motor stalled (red) = INC encoder data error <or> INC encoder power off <or> ABS encoder data error <or> ABS encoder power off <or> Cut cycle too long (more than 12 sec. from Cut ini to Cut complete) <or> Encoder card error (encoders driver fault) <or> System not enable (System was deselected during a cut) <or> Comparison error (ABS vs INC encoder data error) <or> Shear drive not ready (not_parked_stall bit enabled) <or> Shear too late (shear didn't move from park when cut line is already in shear).

7.11 Communications Window

The Communication window is the first window that opens when the Maintenance Interface is launched and a connection is established with the Accucrop controller. This window contains information about the Accucrop controller software, ports functionality and communication status. It also contains the Motor stalled condition status bit, a Reboot Accucrop button and a link to the Default data window. See Figure 7.7.

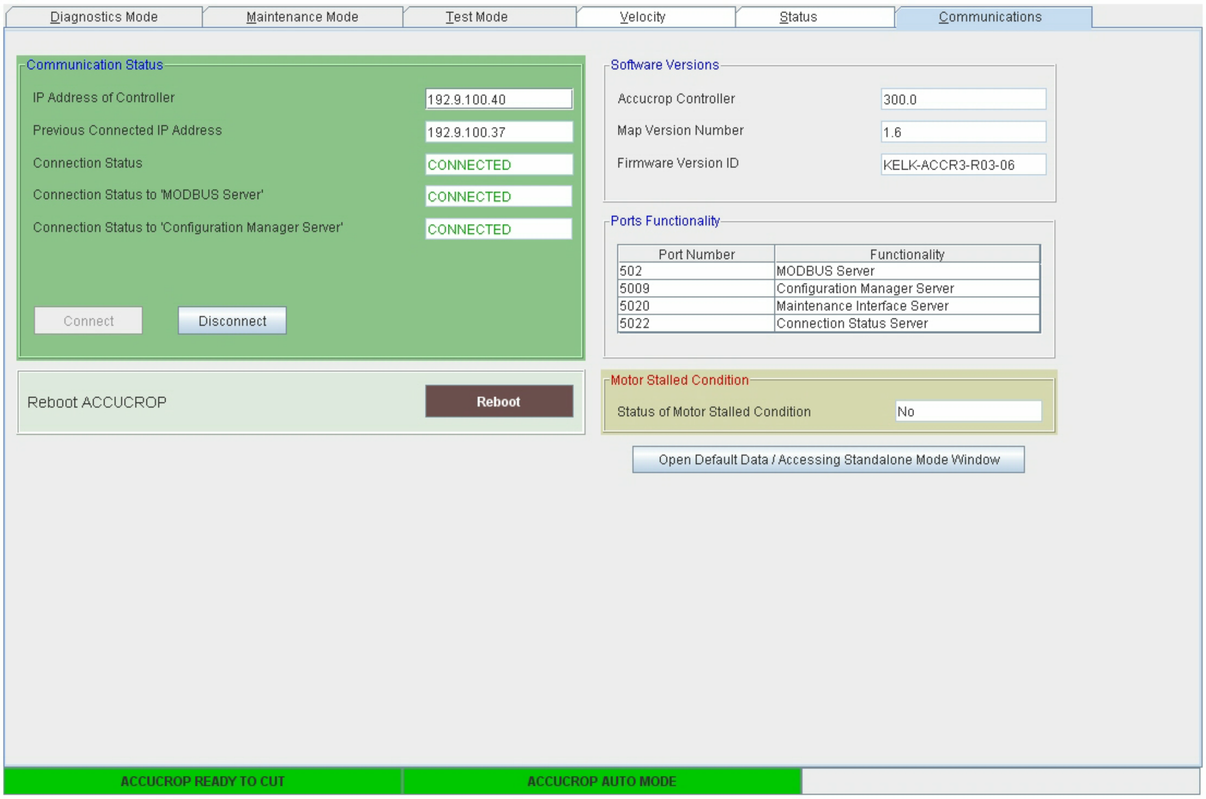


Figure 7.7 Communication Window

Communication window contains the following fields:

- **Communication status field:** contains the IP address for the Accucrop controller and the previous PC (running the Maintenance interface) connected to Accucrop. Also, it displays the connection status for the following devices: Maintenance interface, Modbus server and Configuration manager server. Contains 2 buttons: “Connect” and “Disconnect” to begin or terminate the communication.
- **Software version field:** contains the Accucrop controller version, Map version number and Firmware version ID.
- **Ports functionality field:** contains the port numbers used for communication the functionality for each of them.

- **Reboot Accucrop field:** contains a Reboot button. It allows the user to reboot the Accucrop system remotely. Certain parameters update require a software reboot in order to take effect. Make sure you know what you are doing!
- **Motor stalled condition field:** contains the Motor stalled status bit.
- **Default data /Standalone mode field:** by pressing this button the Default data window will pop up. See Figure 7.8.

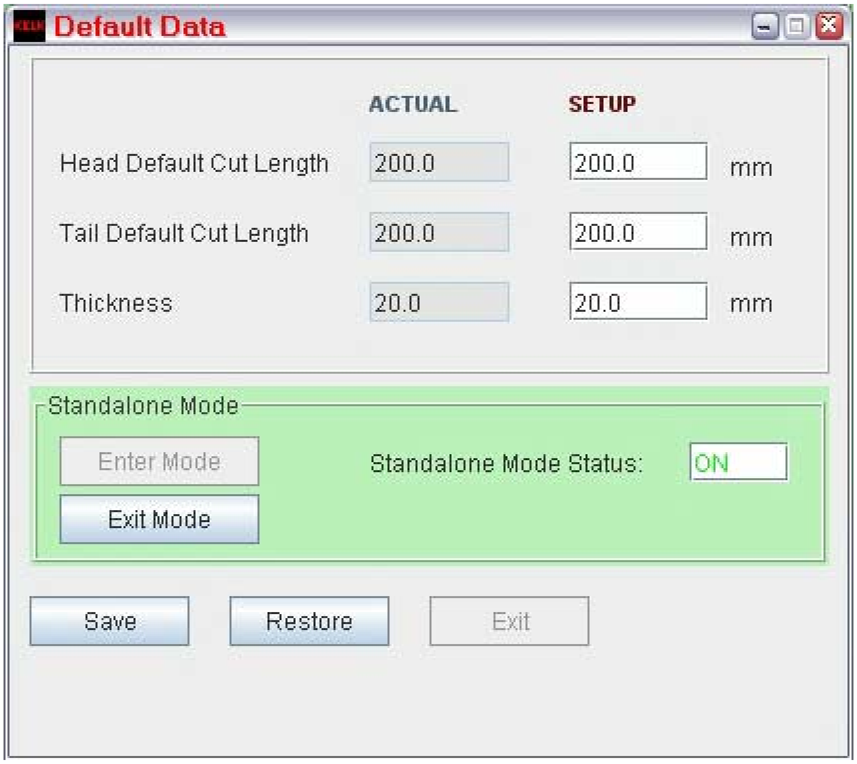


Figure 7.8 Default Data Window

There are three parameters that can be accessed by means of this window:

- Head Default Cut Length
- Tail Default Cut Length
- Bar Thickness

Operators can access the Default data window and these parameters via the Accucrop KIP interface as well.

The Head Default Cut Length, Tail Default Cut Length, and Bar Thickness parameters are used only when Accucrop system is in Standalone mode or the cut parameters have not been received by the Queue manager (connection to the Scanner/Host is lost).

Standalone mode operates without the Accuband Imaging system. In this case the cut length and thickness are specified here.

To enter Standalone Mode you have to press the “Enter mode” button in the Standalone Mode field. The Standalone mode status bit will change to ON. The Accucrop system will switch to Standalone mode only when certain conditions are met.

Refer to Accucrop system operation and Setup chapters for a detailed description of the feature and or parameter selection and tuning.

Part 8 CONFIGURATION MANAGER

8.1 Introduction

The Configuration Manager program provides the user with an easy interface to display, modify or update parameters in Accucrop. The Configuration Manager may be accessed through two methods, either through an applet or by a standalone application running on the local hard drive.

Using the standalone application provides the user with the added capability of being able to save or retrieve the parameters from the Configuration Manager to a file. The standalone application can only be used on the computer it is installed on. However the applet allows the user to access the Configuration Manager anywhere on the network.

When using the standalone application, all of the parameters or a list of selected parameters may be saved to a file in .KCM or .TXT format. Parameters saved in .KCM format may be reloaded in the Configuration Manager to restore Accucrop to some previous setting. Hence the .KCM format is useful for creating a backup of the Accucrop settings. Parameters saved to a file in the .TXT format are only usefull for viewing or printing the parameter settings, units, format and descriptions. This file format cannot be used as a backup, ie. It restrict the user from reloading the file back to the Configuration Manager. In such a case, the user would need to manually enter all the data.

The applet and the application both have the same user interface except in the application the user is able to save and retrieve the configuration from a file. Because of these similarities, the remaining discussion will focus mainly on the standalone application. The term “Utility” will be used collectively to refer to both the application and applet. Where differences between the applet and application user interfaces exist, the application or the applet will be referred to specifically and the differences will be highlighted as appropriate.

Either the application or the applet may be used with the Configuration Manager to update, display or modify parameters.

8.2 Running the Applet

To access the Configuration Manager through the applet, launch the default internet browser such as Internet Explorer, and type the Accucrop IP address in the address bar. If communication with Accucrop is successful, the user will be prompted to enter a KELK set password. If entered correctly, web-based Accucrop user interface is displayed (Figure 8.1).

Figure 8.1 Main window of Accucrop User Interface

To run the applet, click on the *Run Applet* button beside the Kelk Configuration Manager Utility box.

8.2.1 Installing and Starting the Stand-alone Application

Installation files can be accessed directly from the Accucrop controller. Using the procedure outlined in section 8.2, access the Accucrop menu (Figure 8.1) through the applet. When the menu appears, click on the text *Download Application.* Follow the prompt to install the application or save the installation file **CFG_Utility_Setup.exe** to the disk. If the latter is selected, make note where the file is being saved. Navigate to the noted directory and double click on the downloaded file to install the application. Follow the step by step instructions until complete. After installation, the icon labelled "Configuration Manager Utility" will be present on the desktop. Double-click on this icon to launch the application.

8.3 Description of the User Interface

Figure 8.2 displays the typical layout of the Utility's user interface main window. The main window can be broken down into eight separate section as listed below:

1. Menu
2. Toolbar
3. Communication Panel
4. Nodes Panel
5. View Panel
6. Status Panel
7. Updates/Errors Panel
8. Item Selection Panel

The following sections of this chapter will provide usage and detailed description of each of the above sections..

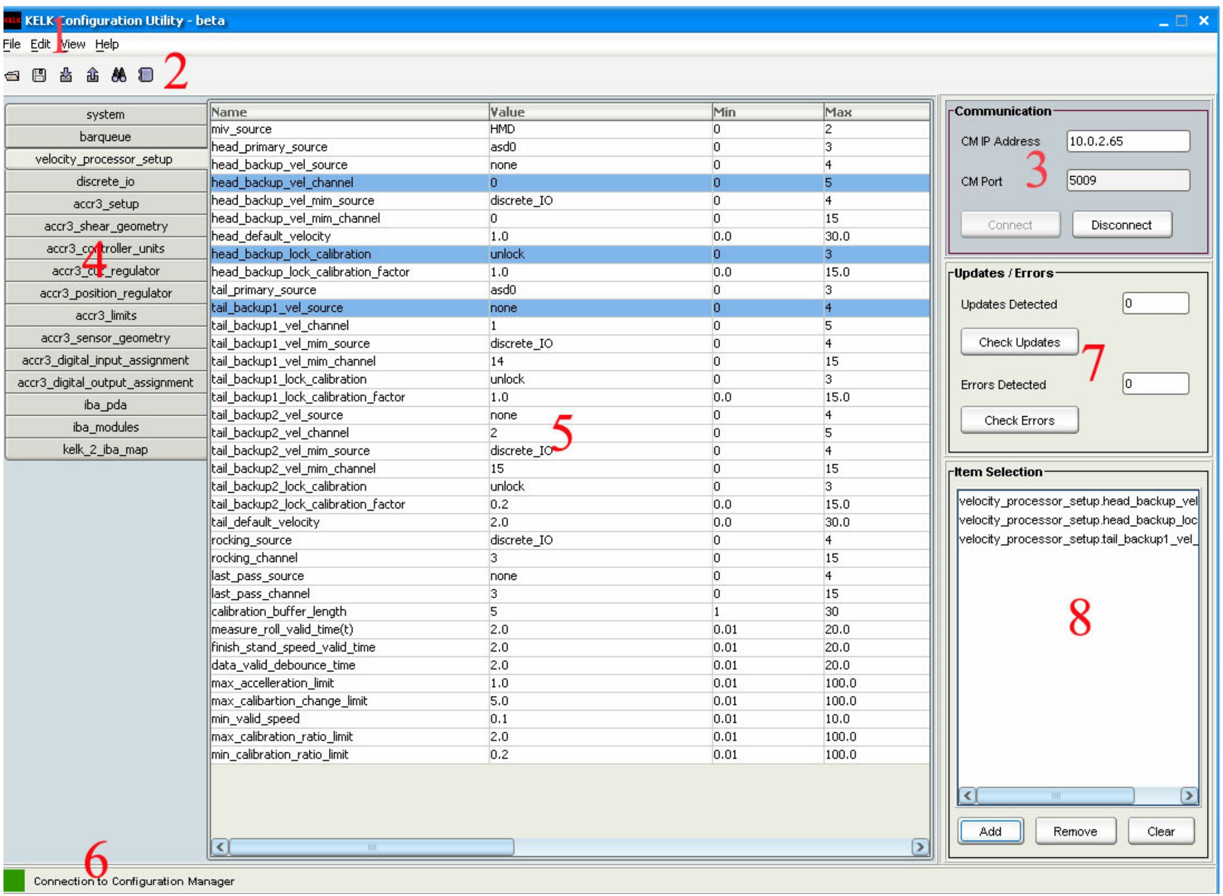


Figure 8.2 Utility's Main Window

8.3.1 Menu

The Menu **(available only in the application**) contains the following sub-menus:

8.3.1.1 File

- **Open**
  Allows the user to open a .KCM configuration file and load it to the Utility and display its data on the View Panel. An open file dialog will appear to allow the user to choose the file to load. After a file is selected, the "Items in File" dialog will appear, displaying all available data found in the file. The dialog box allows the user to select what items to load into the utility.

  Parameters saved in .KCM format may be reloaded in the Configuration Manager to restore Accucrop to some previous setting. Hence the .KCM format is useful for creating a backup of the Accucrop settings. Parameters saved to a file in the .TXT format are only usefull for viewing or printing the parameter settings, units, format and descriptions. This file format cannot be used a backup, ie. It restrict the user from reloading the file back to the Configuration Manager. In such a case, the user would need to manually enter all the data.

- **Save**
  Saves data to a configuration .KCM or to a text .TXT file. The user has the choice to save the data in either file format as well as the choice to save all data currently displayed on the View Panel or only the items added to the "Item Selection" list (See section 8.3.6 for more detail on the "Item Selection" list).

- **Set Data**
  Sends the values of the parameters in the "Item Selection" list to the Configuration Manager. If the list is empty, then all of the selected items in the currently displayed node will be sent to the Configuration Manager.

- **Get Data**

  Get Selected Item(s)
  Retrieves the previous settings of the parameters in the "Item Selection" list (See section 8.3.6 for more detail) from the Configuration Manager. If the list is empty, then all of the items currently visible on the screen will be retrieved. This option

will overwrite any new changes that have been made but not yet saved to the Accucrop controller.

Get All Items
Retrieves settings for all parameters from the Accucrop controller. A progress bar indicating percentage of data transfer can be found on the bottom left hand corner when this option is selected.

- **Close Loaded File**
  If a saved file is loaded to the Utility, this option clears all imported data.

- **Exit**
  Closes the Configuration Manager.

8.3.1.2 Edit

- **Find**
  Allows the user to search the currently displayed data for a specified string.

8.3.1.3 View

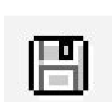
- **Configuration Manager Utility Console**
  The console contains a table that displays all commands that are sent to or received from the Configuration Manager. The text area in the Console displays extra information such as number of items received by Accucrop, connection status, etc. This acts as a useful tool for troubleshooting connection problems with the Configuration Manager.

- **About**
  This dialog displays the Configuration Manager's version number.

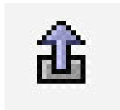
8.3.2 Tool bar

The toolbar provides quick access to various functions available from the Menu options. For detailed functional explanation, see section 8.3.1.

Open: Allows the user to open a .KCM configuration file and load it to the Utility (**Available only in the application**)



Save: Saves data to a .KCM file. (**Available only in the application**)



Get Data: Retrieves values selected in the "Selected Items" list from the Accucrop controller.

Set Data: Writes all items in the "Selected Items" list to the Accucrop controller.

Find: Displays Find dialog.

Figure 8.3 Communication Panel

This panel is used to enter the IP address of the Configuration Manager that the user would like to connect to. The **Disconnec**t button closes the connection to the Configuration Manager.

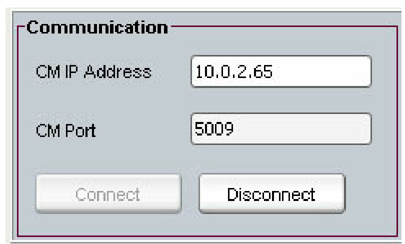


Figure 8.4 Communication Panel

8.3.3 Nodes Panel

Nodes are logical grouping of parameters. These nodes are listed in the nodes panel as outlined in figure 8.5.

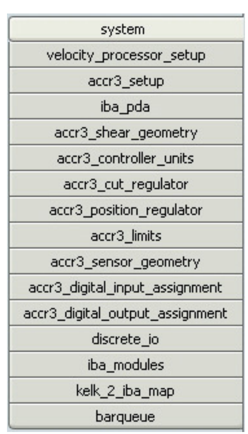


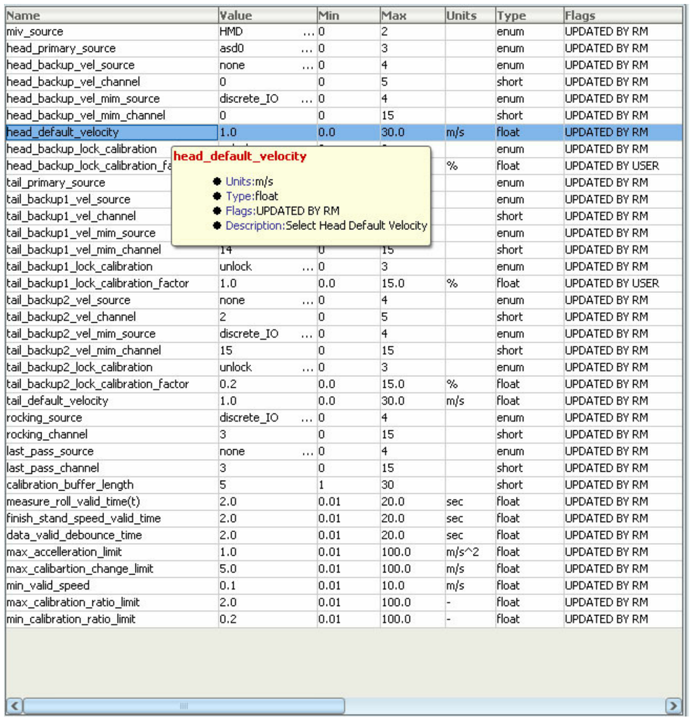
Figure 8.5 Nodes Panel

The following parameters are defined under the nodes

System	Contains the name, IP addresses, netmasks, timezoneand type of application.
Velocity processor Setup	Defines the head and tail velocity sources, primary, backup and default velocities, calibration factors, velocity channels, and other parameters required for proper system operation.
Accr3 Setup	Contains various setup parameters such as default bar thickness, fixed velocites, encoder thresholds, etc.
IBA PDA	Define the settings, module definitions and mappings of Accucrop parameters to ibaPDA. The user is advised not to change these parameters without consulting Kelk.
Accr3 Setup Geometry	Defines shear geometry such as blade overlap, shear gear ratio, head/tail parking positions, etc.
Accr3 Controller Units	Defines shear velocity & acceleration.
Accr3 Cut Regulator	Cut regulator parameters.
Accr3 Position Regulator	Position regulator parameters.
Accr3 Limits	Limits for head/tail bar velocities. Specifies the maximum accepted cut length the system is allowed to make.
Accr3 Sensor Geometry	Define distances from scanner to shear zero position for both head/tail, and backup HMD to tail/head cut positions.
Accr3 Digital Input Assignment	Define the input assignment for the Accucrop digital input channels.
Accr3 Digital Output Assignment	Define the output assignment for the Accucrop digital output channels.
Discrete I/O	Analog input gain and offset values for channel 0-3.
IBA Modules	Define the settings, module definitions and mappings of Accucrop parameters to ibaPDA. The user is advised not to change these parameters without consulting Kelk.
Kelk 2 IBA MAP	Define the settings, module definitions and mappings of Accucrop parameters to ibaPDA. The user is advised not to change these parameters without consulting Kelk.
Barqueue	Allows for the disable/enable of queueing and for the max allowable queue.

8.3.4 View Panel

The View Panel displays all the data associated to the highlighted node (see section 8.3.3). Any data loaded from a previously saved configuration file (.KCM) will also be displayed here. Figure 8.6 displays the View panel when the node **velocity processor setup** is highlighted.



Name	Value	Min	Max	Units	Type	Flags
miv_source	HMD ...	0	2		enum	UPDATED BY RM
head_primary_source	asd0 ...	0	3		enum	UPDATED BY RM
head_backup_vel_source	none ...	0	4		enum	UPDATED BY RM
head_backup_vel_channel	0	0	5		short	UPDATED BY RM
head_backup_vel_mim_source	discrete_IO ...	0	4		enum	UPDATED BY RM
head_backup_vel_mim_channel	0	0	15		short	UPDATED BY RM
head_default_velocity	1.0	0.0	30.0	m/s	float	UPDATED BY RM
head_backup_lock_calibration					enum	UPDATED BY RM
head_backup_lock_calibration_fa				%	float	UPDATED BY USER
tail_primary_source					enum	UPDATED BY RM
tail_backup1_vel_source					enum	UPDATED BY RM
tail_backup1_vel_channel					short	UPDATED BY RM
tail_backup1_vel_mim_source					enum	UPDATED BY RM
tail_backup1_vel_mim_channel	14	0	15		short	UPDATED BY RM
tail_backup1_lock_calibration	unlock ...	0	3		enum	UPDATED BY RM
tail_backup1_lock_calibration_factor	1.0	0.0	15.0	%	float	UPDATED BY USER
tail_backup2_vel_source	none ...	0	4		enum	UPDATED BY RM
tail_backup2_vel_channel	2	0	5		short	UPDATED BY RM
tail_backup2_vel_mim_source	discrete_IO ...	0	4		enum	UPDATED BY RM
tail_backup2_vel_mim_channel	15	0	15		short	UPDATED BY RM
tail_backup2_lock_calibration	unlock ...	0	3		enum	UPDATED BY RM
tail_backup2_lock_calibration_factor	0.2	0.0	15.0	%	float	UPDATED BY RM
tail_default_velocity	1.0	0.0	30.0	m/s	float	UPDATED BY RM
rocking_source	discrete_IO ...	0	4		enum	UPDATED BY RM
rocking_channel	3	0	15		short	UPDATED BY RM
last_pass_source	none ...	0	4		enum	UPDATED BY RM
last_pass_channel	3	0	15		short	UPDATED BY RM
calibration_buffer_length	5	1	30		short	UPDATED BY RM
measure_roll_valid_time(t)	2.0	0.01	20.0	sec	float	UPDATED BY RM
finish_stand_speed_valid_time	2.0	0.01	20.0	sec	float	UPDATED BY RM
data_valid_debounce_time	2.0	0.01	20.0	sec	float	UPDATED BY RM
max_accelleration_limit	1.0	0.01	100.0	m/s^2	float	UPDATED BY RM
max_calibartion_change_limit	5.0	0.01	100.0	m/s	float	UPDATED BY RM
min_valid_speed	0.1	0.01	10.0	m/s	float	UPDATED BY RM
max_calibration_ratio_limit	2.0	0.01	100.0	-	float	UPDATED BY RM
min_calibration_ratio_limit	0.2	0.01	100.0	-	float	UPDATED BY RM

Figure 8.6 View Panel

Moving the cursor over any field of the parameter momentarily displays a pop-up window that displays the name, units, type, flags and a brief description of the parameter. Moving the scroll bar to the right displays the field **Description** which is also shown in the pop-up window.

Parameters are of the type numeric, enum and string. The **Flag** field contains any of the following strings or a logical AND of one or more of these strings:

- **UPDATED BY RM** (Resource Manager, ie. Accucrop) - The current value displayed is from Accucrop
- **UPDATED BY USER** - The current value is entered by the user and has not been sent to the Configuration Manager for updating. Once the value is sent to the Configuration Manager successfully, this will change to **UPDATED BY RM** (Resource Manager, ie. Accucrop).
- **NEEDS REBOOT** - The current value takes effect only after a reboot of Accucrop.

- **ALLOW ADD ITEM** - Only available for parameters in nodes *iba_pda, iba_modules and kelk_2_iba_map.* Parameters in these nodes are preconfigured at KELK and normally should not be changed.

> **Example:** The flag **UPDATED BY USER & NEEDS REBOOT** means that the parameter value was updated by the user and has not been sent to the Configuration Manager. After the parameter is sent to the Configuration Manager, the flag changes to **UPDATED BY RM & NEEDS REBOOT**. After a reboot, the flag changes to **UPDATED BY RM** (Resource Manager)**.**

For numeric parameters, the entered value is checked against the minimum and maximum values for data validation. The user may also choose to change the minimum and maximum values as appropriate.

A parameter is selected by clicking on any of its field and results in the corresponding row becoming highlighted in blue. When a parameter of type ***enum*** is selected, a list of allowable values in the **Value** field is shown in a drop-down menu whenever the **Value** field is double clicked. Figure 8.7 shows the list of allowable values or inputs that the user may wish to assign to digital input channel 3.

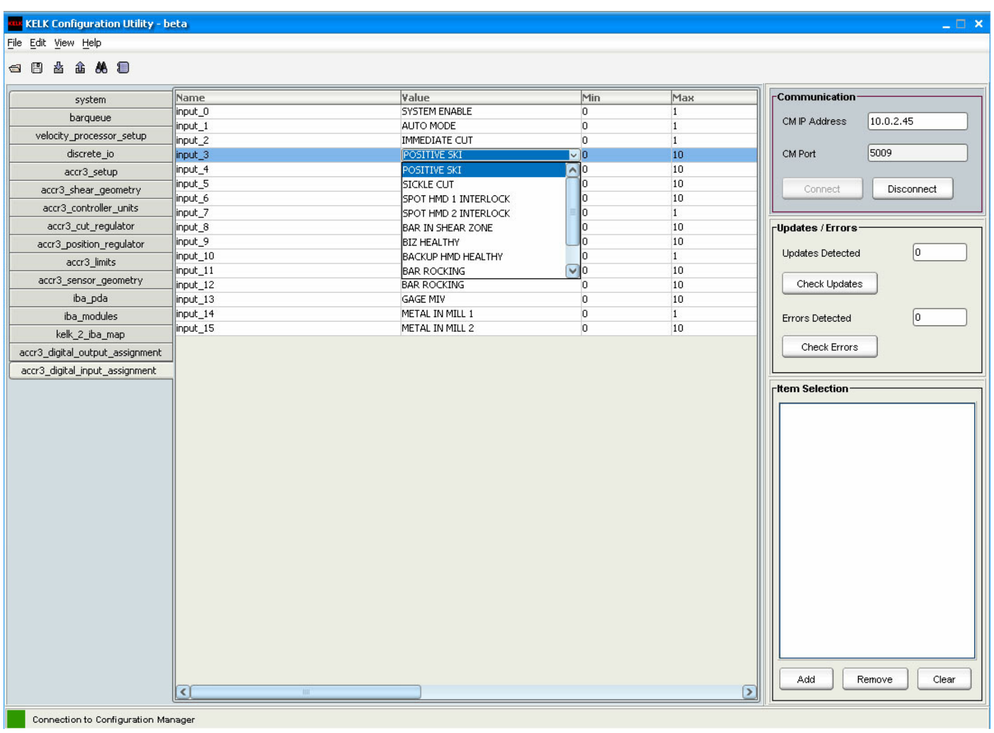


Figure 8.7 Drop down list in Value Field

8.3.5 Updates/Errors Panel

This panel displays number of updates and error messages received by the application/ applet from the Configuration Manager. It also gives the user the ability to check the details of the messages received.

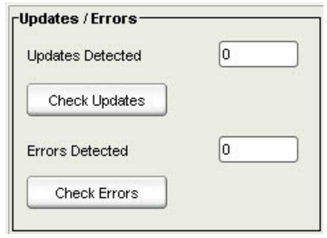


Figure 8.8 Updates / Errors Panel

The **Updates** window is displayed when the user clicks on the **Check Updates** button. The **Errors** table is displayed when the user clicks on **Check Errors**.

When the user double clicks on the parameter name in the **Updates** or **Errors** table, the Utility will jump to the table of the item's node and highlight the selected item's parameter.

The **Updates** table displays the parameter’s name, time that the message was received from the Configuration Manager, and whether the item was added or deleted. The **Errors** table displays the time stamp and parameter that was not received correctly by the Configuration Manager

8.3.6 Item Selection Panel

The **Item Selection** panel contains all items the user added before issuing a **Get Data** or **Set Data** command to the Configuration Manager. If the user makes a mistake in the initial selection, the **Remove** button may be used to delete the parameter from the list. Figure 8.9 shows the **Item Selection** panel containing three modified parameters in the **velocity_processor** node.

Figure 8.9 Item Selection Panel

8.3.7 Status Panel

This panel indicated whether or not a connection has been established to Accucrop (**Green** = **Connected**, **Red** = **Disconnected**). The Status Panel will also display a progress bar on the right side of the screen whenever data is being sent or received from the Configuration Manager. Figure 8.10 shows the Status Panel showing the progress bar.

Figure 8.10 Status Panel

8.4 Using the Configuration Manager

When the Utility is first started or when connection to Accucrop is reestablished after a disconnect, the current settings of the parameters from Accucrop are loaded and displayed in the View Panel. The user navigates through the parameters using the Nodes Panel or by using the **Find** button in the toolbar to search for the parameter name.

8.4.1 Loading and Saving to a file

These features are only available using the application.

The Configuration Manager allows the user to back up Accucrop settings to a configuration file to restore the system to a known good state in cases where the system settings become corrupted. This is easily done by selecting the toolbar icon using the application. Figure 8.11 shows the pop up window that comes up when the icon is selected.

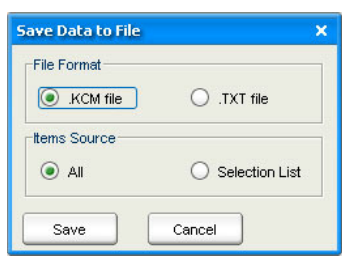


Figure 8.11 Pop up window when saving data to a file

Selecting the **All** button saves all the parameters to a file. Once the **Save** button is selected, the user is prompted for the folder where to save the configuration file.

> **The user is strongly advised to keep a copy of the configuration file in a safe place for error recovery.**

The application also gives the user the option to save all or a subset of the parameters to a file in the .TXT format for documentation purposes. Only, files saved in the .KCM format may be opened by the application to load back into the Configuration Manager.

8.4.2 Saving Selected Items to a File

To save a list of parameters from Accucrop to a file, the desired parameters in the display must first be selected and added to the **Item Selection** panel. This is done by holding the **Shift Key** down while the left mouse button is pressed and then dragging the mouse to highlight the group of parameters that the user wishes to select. Then the **Add** button in the **Item Selection** panel is selected to add the list to the **Selection list**. A list of parameters that are not on adjacent rows can be selected by holding down the **Ctrl** key and left mouse clicking the desired parameters.

When the desired parameters to be included in the list are in different nodes, the user must select the parameters in one node and send them to the **Item Selection** panel before selecting another node.

If the user made a mistake in selecting parameters, a parameter can be deleted from the **Item Selection** list by using the **Remove** button. Pressing the **Clear** button empties the entire list and the user must begin again.

To save the selected parameter settings to a file, the user must now click on the icon .

A dialog similar to the one in Figure 8.11 will appear requesting input from the user as to what type of file the data should be saved to and from where the data should be aquired from. After selecting the type of file desired, the radio button labelled **Selection List** is selected and when **SAVE** is pressed, the File Dialog opens to prompt the user for the folder location of the file.

8.4.3 Loading from a File

The current settings of the parameters from Accucrop are automatically retrieved and displayed by the Utility at startup.

To load a configuration file (.KCM) to the Configuration Manager, the user selects the icon in the toolbar. After the user is warned that a ne w file will be loaded, a File dialog appears to allow the user to select the configuration file to load. Once a file is selected, a window similar to Figure 8.12 appears.

Note: Clicking on the ***system*** node selects all the parameters for loading.

To select individual nodes and parameters for loading, depresses the **Ctrl** key during the selection process. Parameters in any node may be selecting by clicking on the **+** sign box beside the node name which will display the list of parameters under the node. While still holding the **Ctrl** key depressed, parameter(s) may be picked individually from the list. When all the parameters have been selected, the user clicks on the ***Load Selected Item(s)*** button to load the parameters to the application.

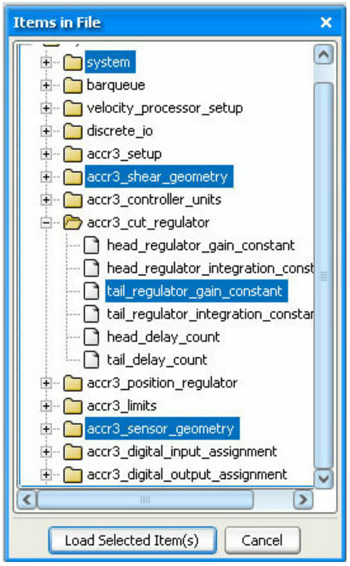


Figure 8.12 Items in File

While the parameter(s) are being loaded to the Configuration Manager, the **Updates Detected** and **Errors Detected** fields will display the running count of the number of parameters that have been updated and the number of errors, if applicable. The Status Panel displays the current progress of the loading process. Figure 8.13 shows a window when the update process is ongoing. When finished, the user may check the updated parameters or errors encountered using the **Check Updates** or **Check Errors** buttons.

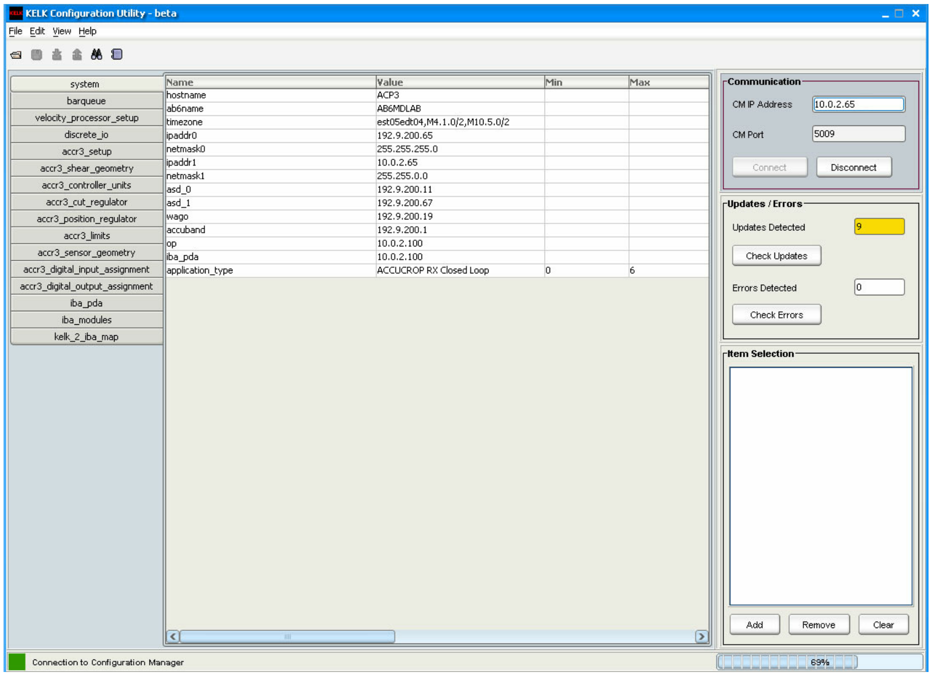


Figure 8.13 Updates/Errors panel during update

The KELK Configuration Utility allows the user to open and view the configuration file (.KCM) without connection to Accucrop. This is particularly useful when the user wants to look at the parameter settings without the availability of a .TXT version. The parameters may also be updated and saved to a file and downloaded to the Configuration Manager at a later time.

The list of nodes and parameters are displayed in the **Nodes** and **View** panels, respectively. Because there is no connection to Accucrop, the menu/toolbar items **Get Data, Set Data** and **View** in the menu are greyed out. The Status Panel remains **Red** to indicate that there is no connection to Accucrop.

8.4.4 Updating Parameters

To change parameter settings, click on the **Value** column of the parameter of interest. For numeric values, the entered value should be within the minimum and maximum values of the corresponding parameter otherwise the error message in Figure 8.14 will appear.

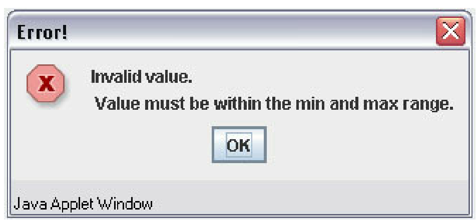
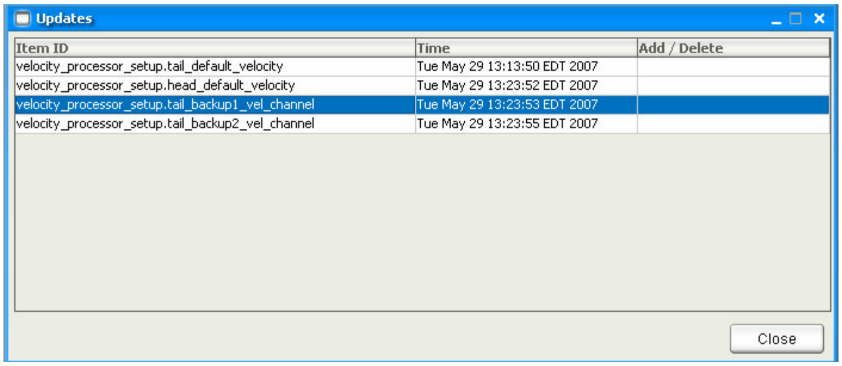


Figure 8.14 Error Message when data is out of range

The minimum and maximum values of numeric parameters (unsigned short, float, etc.) may also be changed using the Utility.

For parameters that are of type ***enum*,** the user may select a value from a list of allowable values in the drop down menu that appears.

When a value is successfully entered in the **Value** field and is different from the current setting in the Configuration Manager, the parameter name with the node name prefixed to it is added to the Item Selection panel. After the values of the desired parameters are entered, click on the toolbar icon  or select ***File-Set Data*** in the Menu to send the data to the Configuration Manager (ie. Accucrop). Afterwards, the Updates/Errors Panel will show the number of parameters updated highlighted in the **Updates Detected** box and the number of errors detected in the **Errors Detected** box. Clicking on the **Check Updates** box displays a table showing the list of parameters and the time stamp of when the update occurred. Clicking on the **Check Errors** box displays a table of parameters that were not successfully updated. Figure 8.15 shows a typical Updates table after the updating process.



Updates

Item ID	Time	Add / Delete
velocity_processor_setup.tail_default_velocity	Tue May 29 13:13:50 EDT 2007	
velocity_processor_setup.head_default_velocity	Tue May 29 13:23:52 EDT 2007	
velocity_processor_setup.tail_backup1_vel_channel	Tue May 29 13:23:53 EDT 2007	
velocity_processor_setup.tail_backup2_vel_channel	Tue May 29 13:23:55 EDT 2007	

Close

Figure 8.15 Updates Table

Double-clicking on the parameter name highlights the same parameter in the View panel. A similar effect happens if a parameter in the Error Table is double clicked.

8.4.5 Retrieving Parameters from the Configuration Manager

The user has the option to retrieve all or a subset of all the parameters from the Configuration Manager.

8.4.5.1 Get All Items

To retrieve all parameters from the Configuration Manager, left click with the mouse on the toolbar icon  and select ***Get All Items*** from the drop-down list. Alternatively, the user may select ***Get Data*** from the ***File*** pull down menu and then select ***Get All Items*.**

8.4.5.2 Get Selected Items

To retrieve a list of parameters from the Configuration Manager, the desired parameters in the View Panel are first selected and added to the Item Selection panel.

The user may hold down the **Shift Key** down while the left mouse button is pressed and then dragging the mouse to highlight the group of parameters that the user wishes to select. Then the **Add** button in the **Item Selection** panel is pressed to add the list of parameters to the selection list. To select individual nodes and parameters for loading, depresses the **Ctrl** key during the selection process. Parameters in any node may be selecting by clicking on the **+** sign box beside the node name which will display the list of parameters under the node. While still holding the **Ctrl** key depressed, parameter(s) may be picked individually from the list. When all the parameters have been selected, click on the **Add** button in the **Item Selection** panel to add the list of parameters to the selection list.

When the desired parameters are in different nodes, the user selects the parameters in a node and add them to the **Item Selection** panel. Another node is chosen and the same procedure applies in selecting the parameters until all the desired parameters are included in the **Item Selection** list.

If the user made a mistake in selecting parameters, a parameter can be deleted from the Item Selection list by using the **Remove** button in the **Item Selection** panel. Pressing the **Clear** button empties the **Selection List**.

To retrieve the parameters from the Configuration Manager, the user clicks on the toolbar icon I and selects ***Get Selected Item(s)*** in the drop-down list. Alternatively, the user may select ***File-Get Data*** in the menu. and select ***Get Selected Item(s).***

After the retrieve operation is finished, the Item Selection Panel is cleared and the current values of the selected parameters from Accucrop are displayed in the View Panel.

PART 9 ACCUCROP SETUP

9.1 Introduction

This part provides useful information for Accucrop system commissioning and maintenance. Care must be exercised when setting up and adjusting different Accucrop parameters since sudden move of the shear may occur. The local safety procedures must be followed and the maintenance personnel must be informed.

9.2 Scope

The information provided here allows the maintenance personnel to set up all the configurable parameters and fine-tune the Accucrop Closed loop system. After commissionig and any subsequent changes these parameters can be saved to a file for future reference.

Before using any of the Accucrop Interfaces and controls, the user should read the Accucrop theory described in this manual and get familiar with Accucrop controls and operation. Only qualified and trained personnel familiar with the KIP Graphical User Interface (GUI), Maintenance utility and Configuration manager should attempt these changes.

In addition, the reader should refer to the following User's manuals: Accuband Width Gage, Accuband Crop Imaging, Accuspeed Laser Velocimeter and Accuscan HMD 2048.

9.3 Parameters Setup

The Configuration Manager utility is the main tool used for setting and configuring the Accucrop parameters. Some of the parameters are also accessible via the Maintenance interface or KIP interface. Reference will be made to these interfaces and the windows used to access these parameters. Included are the tools, features and procedures used for Controller setup and fine tuning.

Before starting the parameters setup process, refer to the Interconnection diagram and ensure that all cables are accordingly connected and properly grounded. Never power up the equipment before the commissioning engineer arrives on site or without KELK permission. Refer to the Accuband Width gage manual and Accuspeed User's manual for details about interconnection and sensors installation.

Start the Configuration Manager utility (applet) from the Crop operator PC or any other PC connected to the Accucrop Host network. Once connected a list of nodes containing various setup parameters will be displayed on the screen. See Figure 9.1.

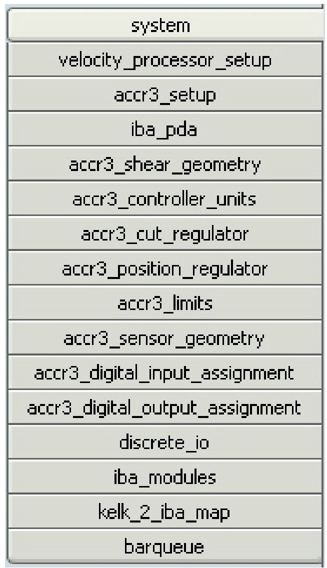


Figure 9.1   Nodes Panel

9.4 System Node

The System node contains the Scanner/Accucrop controller names, IP addresses, netmasks, time zone and the type of application. The Accuspeed and Discrete I/O IP addresses are included too.

- **Hostname**: Customer and location of the KELK sensors. This name is only used for identification purposes only.
- **Ab6name**: Installation job number. KELK internal use only.
- **Timezone**: Specifies the time zone the equipment is installed in.
- **Ipaddr0**: The IP address of ethernet port 0 of the Accucrop EU.
- **Netmask0**: The netmask of ethernet port 0
- **Ipaddr1**: The IP address of ethernet port 1 of the Accucrop EU.
- **Netmask1**: The IP address of eithernet port 0 of the Accucrop EU.
- **Asd_0**: The IP address of the first Accuspeed Velocimeter in the system. This laser will primarily be used for tracking of the head end of the bar.
- **Asd_1**: The IP address of hte second Accuspeed Velocimeter in the system. This laser will be primarily used for the tracking of the tail end of the bar. This sensor is optional and can be used for improved tail tracking performance.
- **Wago**: The IP address of the WAGO digital I/O module.
- **Accuband**: The IP address of the Accuband imaging scanner.

- **Op:** The IP address of the operator's PC. The user will use this PC to view the head and tail images and their optimized cut lengths. The operators PC also provides the user with valuable troubleshooting indicators and many bar and crop stastics.
- **Iba_pda**: The IP address of the IBA logger. This logger is used for logging all sensor activity graphically. It is extremely useful in troubleshooting and problem solving.
- **Application_type**: The location of the installation within the mill and the type, either open loop or closed loop.

9.5 Bar Queue Setup

The Queue manager in Accucrop handles the tracking of up to 3 bars (head and tail crops). The Barqueue node provides the parameters that define the Queue's operation.

- **Queue size**: Specifiy the queue size for Accucrop to maintain. Accucrop can only handle up to a maximum of three bars in the queue at this time.
- **Enable_queueing**: Enables or disables bar data to be stored within the queue manager.

9.6 Velocity Processor Setup

The velocity processor setup node contains setup for both head and tail velocity sources. Listed below is a brief description of the parameters that must be set for head end speed sources. Due to the similarity in description of the tail parameters, these have been omitted from this section.

- **Miv_source**: Allows the user to select what sensor to use for MIV (Material In View). Select AB6 for Accuband and HMD for Accucrop with cut HMD.
- **Head_primary_source**: Allows the user what sensor will be used for the primary head speed source. Options available are: none, Accuspeed 0, Accuspeed 1.
- **Head_backup_vel_source**: Select the backup speed source to use for tracking of the head. When the primary speed source is not available or data is not valid, this speed source will take its place. Options available to the user include: Discrete I/O, pulse tachometer, host set register.
- **Head_backup_vel_channel**: Select the backup speed source channel number. If discrete I/O or pulse tachometer is used, refer to the interconnect diagram to determine what channel this signal is assigned to.
- **Head_backup_vel_mim_source**: Allows the user to select what input source Accucrop should monitor to use as a validation signal for the head backup speed.
- **Head_backup_vel_mim_channel**: What channel, either through discrete I/O or through a specified host register bit the backup velocity speed will be read from.
- **Head_default_velocity**: The default velocity to use in case the primary and backup speed sources are not available.
- **Head_backup_lock_calibration**: Allows the user to lock and unlock the calibration factor.
- **Head_backup_lock_calibration_factor**: Allows the user to specify the calibration factor.

9.7 Discrete I/O Setup

This node contains two parameters that repeat for four analog input channels found on the discrete I/O, ie. WAGO. These include:

- **Analog_input_gain_0**: Allows the user to specify the input gain used on channel 0 of the discrete I/O.
- **Analog_input_offset_0**: Allows the user to specify the input gain offset on channel 0 of the discrete I/O.

The Maintenance interface - Diagnostics mode tab - Velocity inputs field can be used to configure the Accurop analog inputs parameters. See Figure 9.2.

The Velocity analog inputs default assignment is: Tail speed 1 (F1 speed), Head backup (measure roll) and Tail speed 2 (F2 speed). The analog inputs can be scaled by pressing the Scaling button. A new window “Velocity Source Scaling” will pop up and here you can scale each Analog input.

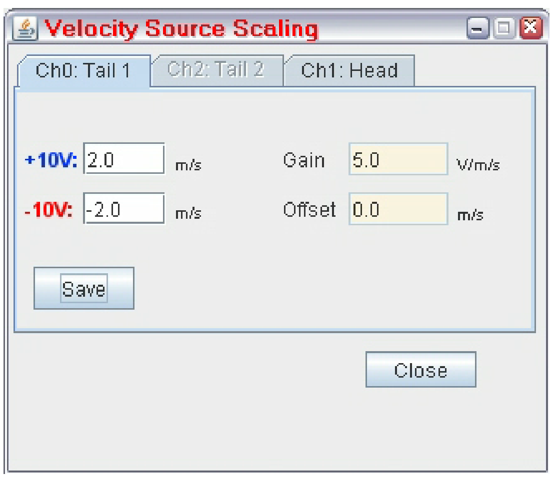


Figure 9.2 Velocity source scaling

9.8 Accucrop Setup

The Accr3 setup node contains a list of parameters that are being setup during commissioning by the KELK engineer. Some of the default data parameters can be accessed via the Accucrop KIP interface. Below is a brief description of the most significant ones.

- **Version:** Specifies the firmware version.
- **Sickle_cut_velocity**: Allows the user to speficy the speed the shear should turn at when performing continuous cuts.

- **Default_bar_thickness**: Allows the user to specify the default bar thickness. This parameter may also be modified through the KIP user interface.
- **Use_fixed_head_velocity_manual_cut**: The user must specify here whether or not to use the manual velocity when a manual head cut is being made.
- **Fixed_head_cut_velocity**: This velocity is used for manual head cuts if enabled.
- **Use_fixed_tail_velocity_manual_cut**: The user must specify here whether or not to use the manual velocity when a manual tail cut is being made.
- **Fixed_tail_cut_velocity**: This velocity is used for manual tail cuts if enabled.
- **Default_head_cut_length**: Specifies the default length of head to crop. The length specified here also applies to imaged cut lengths.
- **Default_tail_cut_length**: Specifies the default length of tail to crop. The length specified here also applies to imaged cut lengths.

9.9 Shear Geometry Setup

The shear geometry defines a set of parameters required by the Accucrop controller in order to calculate the shear blades position and speed using the feedback from the Absolute and Incremental encoders.

Some of these parameters can be configured from the Maintenance interface - Test mode tab, or from the Accucrop KIP interface. All of them can be adjusted using the Configuration Manager utility - “accr3_shear_geometry” node. Here is a description of them:

- **Blade radius**: Represents the top drum blade radius measured from center of the drum to the blade tip.
- **Blade overlap:** The blade overlap is measured at the bottom dead zero position. It is the distance between the tip of the top blade and the tip of the bottom blade. See Figure 9.3.
- **Shear gear ratio:** It is defined as the number of turns the Incremental encoder (motor shaft) does for one complete turn (360 deg.) of the shear drum.
- **Head park position:** Defines the Head blade park angle and for shear top drum the angle is measured in the normal cut direction from the Head blade park position to the drum bottom dead zero.
- **Tail park position:** Defines the Tail blade park angle and for the shear top drum the angle is measured in the normal cut direction from the Tail blade park position to the drum bottom dead zero.
- **Tail park method:** This parameter selects the shear park method after a Tail cut executed in Auto mode. When it it set to “Yes”, after the Tail cut is completed, the shear drum will do an extra revolution and then go to Head park postion. This feature is used for certain materials rolled to clear the tail crop from the shear knives.
- **Tail wiggle angle:** This parameter defines the shear drum wiggle angle (overshoot the park position) after a Tail cut executed in Auto mode. When it is set different then zero (max. 60 deg), after the Tail cut is completed the shear drum will wiggle (overshoot) the park position by this angle and then go to the Head park position.

- **Double blade shear:** Defines the number of blades per drum. When set to “Yes” means the top drum has two blades, one for Head and one for Tail cut.
- **Maximum length for tail park method:** Defines the maximum Tail cut length for which the Tail extra revolution is accepted. This parameter protects the system of doing a double tail cut when the shear extra revolution feature is selected. It must be calculated according to the shear drum geometry.
- **Extra revolution cut speed percent:** This parameter defines the speed used for the shear extra revolution after a Tail cut executed in Auto mode. It is defined as a percentage of the Tail cut speed.

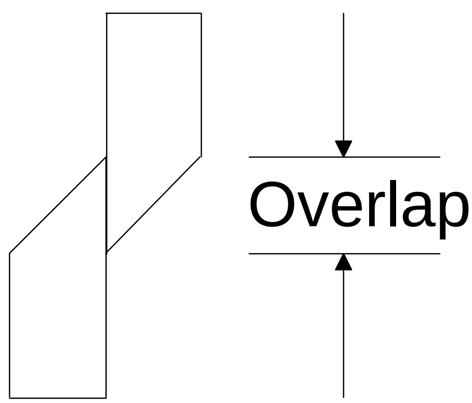


Figure 9.3 Shear blades overlap

9.10 Controller units setup

The controller monitors the acceleration of the bar, therefore, some limits must be imposed on how the controller sees this acceleration. Acceleration is calculated from the difference between successive velocity readings. This calculation results in small values of acceleration which are attributed to noise and/or mechanical vibration. These values must somehow be filtered but if the bar actually does speed up or slow down then those variations must be recognized. Acceleration is progressively less of a factor the closer the shear is to the cut point, and more important when the shear is further away from the cut point.

The Maintenance interface - Test mode tab - Controller units field can be used to configure the Controller units parameters. After entering a new parameter value, the Save button must be pressed to accept the change. By pressing the Restore button, the new value can be confirmed.

The Controller units parameters can also be accessed via the Configuration manager - accr3_controller_units node.

- **Shear Linear Distance Cut-off:** When the distance remaining to the cut point reaches this value the controller no longer uses bar acceleration in calculating the remaining time to the cut point.
- **Linear Velocity Prediction Time:** When the remaining time to the cut point is less than or equal to this value, the controller no longer uses acceleration in the calculation for the remainder of the cut cycle.
- **Min. Significant Bar Acceleration:** Values of acceleration that are below this value are ignored and the velocity is assumed to the constant.
- **Min. Significant Predicted Velocity:** Values of velocity below this value are considered to be zero.

Refer to the “Controller units adjustments” paragraph regarding the fine tuning of these parameters.

9.11 Cut regulator setup

The cut regulator moves the shear from the park position to the cut position (Shear acceleration cycle). There are two parameters that have a direct effect on the performance of this regulator: Gain and Time constant (integration).

The Maintenance interface - Test mode tab - Cut regulator field can be used to configure the Cut regulator parameters. After entering a new parameter value, the Save button must be pressed to accept the change. By pressing the Restore button, the new value can be confirmed.

Two sets of parameters are defined: one set for head cut and one set for tail cut. This allows flexibilty if the Head and Tail park position is different. Here is a description of them:

- **Head Cut Regulator Gain:** This parameter sets the amplification of the error signal and is directly proportional to the head regulator gain.
- **Head Cut Regulator Time Constant:** This parameter sets the time delay applied to the error signal. This parameter represents the head regulator integration constant.
- **Tail Cut Regulator Gain:** This parameter sets the amplification of the error signal and is directly proportional to the tail regulator gain.
- **Tail Cut Regulator Time Constant:** This parameter sets the time delay applied to the error signal. This parameter represents the tail regulator integration constant.

The Cut regulator parameters can be accessed via the Configuration manager - accr3_cut_regulator node. In this node, two more parameters that define the shear delay cycle can be found. Here is a description of them:

- **Head delay count:** this parameters defines the delay time after the Head cut complete until the parking cycle starts. Multiply the counts by 4ms to determine the delay time.
- **Tail delay count:** this parameters defines the delay time after the Tail cut complete until the parking cycle starts. Multiply the counts by 4ms to determine the delay time

When the shear blades reach bottom dead zero the cut is complete and the controller starts the parking cycle. These parameters delay the start of the parking control cycle. During this delay the controller regulates the shear to cut speed until the delay time elapses. Values up to 10 decimals (40 ms) are typical.

As these values are made larger the shear begins to overshoot the park position. After it overshoots the park position it reverses its direction of travel and moves to the park position. This overshoot can be useful in the case where the crop piece lay on the shear drum after a cut. The overshoot allows the crop piece to slide off the shear drum.

Caution: The shear rotates at cut speed until these parameter expires. If you make this number large, the shear goes around and around until this value expires, only then does it park.

Refer to the “Controllers tuning” paragraph where the Current regulator fine-tuning is described.

9.12 Position Regulator

The position regulator provides the necessary control to bring the shear to the park position after the cut is made. The park position is maintained by closed loop control.

The Maintenance interface - Test mode tab window - Position regulator field can be used to configure the Position regulator parameter. After entering a new parameter value, the Save button must be pressed to accept the change. By pressing the Restore button, the new value can be confirmed.

The same parameters can be accessed via the Configuration manager - accr3_position_regulator node panel. Here is a description of them:

- **Basic Regulator Gain:** This parameter is directly proportional to the gain of the position regulator. If this parameter is too large the controller becomes unstable and oscillates around the park position.
- **Gain 2 Division Factor:** This parameter is inversely proportional to the second gain element of the position regulator.
- **Integration Division Factor:** This parameter is inversely proportional to the integration factor of the position regulator.
- **Maximum Output Voltage:** During the first stage of parking the controller outputs a negative voltage to slow the shear down before it starts the closed loop regulation. This parameter sets this value. It also sets the limit of the voltage that can be used during the cut cycle.

- **Minimum Distance Zero Voltage:** It is also called the Park regulator dead band and represents the dead band around the park position where the Position regulator will output 0 volts. It is measured in Absolute encoder units.

Refer to the "Controllers tuning" paragraph where the Position regulator fine-tuning is described.

9.13 Accucrop limits setup

To get access to these parameters use the Configuration manager utility and select the accr3_limits node. Use the shear mechanical specification to determine the minimum and maximum allowable shear speed and the maximum crop length the shear and crop bin can handle. Set these limits within the admissible range.

9.13.1 Velocity limits

The following limits should be considered from both a practical and a safety point of view. The minimum values are there to prevent a motor stall condition. If the bar is travelling too slow it is possible that the blades will get stuck in the bar resulting in an over current condition. The maximum values are there to prevent an overspeed condition in the crop shear motor. The units are mm/sec.

- **Minimum head bar velocity:** this value represents the minimum shear speed for a Head cut. If the actual bar speed is lower than this speed limit when the Cut ini pulse has to be issued, then the Head cut is aborted. If the bar speed goes under this value during the shear acceleration cycle (Head cut in progress), then the shear speed will clamp to this speed limit.
- **Maximum head bar velocity:** this value represents the maximum shear speed for a Head cut. If the actual bar speed is above this speed limit when the Cut ini pulse has to be issued, then the Head cut is aborted. If the bar speed goes above this value during the shear acceleration cycle (Head cut in progress), then the shear speed will clamp to this speed limit.
- **Minumum Tail bar velocity:** this value represents the minimum shear speed for a Tail cut. If the actual bar speed is lower than this speed limit when the Cut ini pulse has to be issued, then the Tail cut is aborted. If the bar speed goes under this value during the shear acceleration cycle (Tail cut in progress), then the shear speed will clamp to this speed limit.
- **Maximum Tail bar velocity:** this value represents the maximum shear speed for a Tail cut. If the actual bar speed is above this speed limit when the Cut ini pulse has to be issued, then the Tail cut is aborted. If the bar speed goes above this value during the shear acceleration cycle (Tail cut in progress), then the shear speed will clamp to this speed limit.

9.13.2 Cut Length Limits

- **Maximum accepted cut length:** this parameter defines the maximum cut length for a Head or Tail cut. The main purpose is to ensure that the crop will fall into the bin and not get stuck in the shute.

9.14 Sensor Geometry

To get access to these parameters use the Configuration manager utility and select the accr3_sensor_geometry node.

- **Head mark to cut distance:** This represents the HMD 2048 to Shear (Head cut complete) distance for Head cut and it is used by Accucrop controller to track the Head cut line.
- **Tail mark to cut distance :** This represents the HMD 2048 to Shear (Tail cut complete) distance for Tail cut and it is used by Accucrop controller to track the Tail cut line.

When Accucrop receives the MIV signal from CSE HMD 2048 it begins the cut tracking process. The nominal values for these parameters are the same since the HMD 2048 filed of view is very narrow. This distance is referred to as Cut Marker position and represents the diatance between the HMD 2048 field of view and the Shear bottom zero (cut complete).

The minimum value is calculated using the largest park angle possible for your installation. From this worst case park position the distance to the zero position is calculated and twice this distance is used. This defines the minimum value for these parameters.

$$d = 2 \times 2\pi Blade\_radius \times \frac{Park\_position}{360}$$

During the design phase of the project, the distance from HMD 2048 to Shear centerline is calculated more precisely including the maximum bar speed, body width length, processing time delay and maximum tail cut length. The nominal HMD to shear distance is indicated in the Installation drawing and must be confirmed in the field during commissioning.

These nominal values are adjusted based on empirical data. During commissioning Accucrop is set into Fix lengh cut mode and the crop cut length pieces are measured and compared to the requested fixed length cut.

There is a one to one relationship between these parameters and the error in the cut length. A minimum of 10 samples should be cut in fixed length mode. The average of the measured pieces should be used to fine tune these parameters as follow:

For Head cuts: If the cut length is greater than the requested value then this parameter should be reduced   If the cut length is smaller than the requested amount this parameter should be increased.

For Tail cuts: If the measured cut length is greater than the requested value then this parameter should be increased. If the measured cut length is smaller than the requested amount then this parameter should be reduced.

9.15 Digital inputs assignment setup

To get access to these parameters use the Configuration manager utility and select the accr3_digital_input_assignment node. There are 16 digital inputs available via the Discrete I/O kit and the assignment can be done here. Refer to the Interconnection diagram for a list of the Digital inputs available for your installation.

Please note that some of the Digital inputs are pre-assigned so the Channel assignment cannot be changed. Here is a list of them:

- CH 0 - System enable: KELK Accucrop system is selected - KELK system controls the shear
- CH 1 - Auto mode: Accucrop system is in Auto mode. KELK system tracks the cut line and performs auto cuts
- CH 2 - Manual (immediate) cut: Manual cut button is pressed to perform an immediate cut.
- CH 7 - Shear drive ready: Shear drive is ready to turn the shear motor
- CH10 - Cut mark (HMD 2048) healthy: HMD 2048 is healthy (temperature inside is below 55 deg. C
- Ch14 - Metal In Mill (MIM) 1: Bar is in Finisher entry stand (F1).

After the Digital input channel assignment is complete, user can verify the change by loading the Maintenance interface - Diagnostics mode tab - Inputs channels field. The description indicators of the Digital inputs should correspond to your adjustmets. The status is displayed in colors: green (enabled) and gray (disabled).

9.16 Digital outputs assignment setup

To get access to these parameters use the Configuration manager utility and select the accr3_digital_output_assignment node. There are eight digital outputs available via the Discrete I/O kit and the assignment can be done here. Refer to the Interconnection diagram for a list of the Digital outputs selected for your installation.

Please note that Digital output “System adapter enabled” (KELK system selected) is pre-assigned so the assignment cannot be changed.

After the Digital outputs channel assignment is complete, user can verify the change by loading the Maintenance interface - Diagnostics mode tab - Outputs channels field. The description of the Digital outputs should correspond to your adjustmets. Relay output operation can be tested by clicking with the mouse on the corresponding indicator. A green color will indicate an energized relay output.

9.17 ibaPDA setup

The ibaPDA setup is done during the Accucrop system factory setup and test and it is loaded in the Accucrop Compact Flash card. All parameters are preconfigured and no further modifications are required. It contains KELK proprietary module assignment and mapping. Any alteration of these parameters may result in malfuntion of the ibaPDA logger. Before making any changes to the iba modules or mappings, please consult with KELK.

9.18 Sensor Setup

In order for the Accucrop to function properly the wiring of the incremental encoder, the absolute encoder and the remote adapter have to be electrically configured to provide the correct signal orientation. The Maintenance Interface - Diagnostics mode tab is a very helpful tool for this purpose.

While all of the following items have been set up during commissioning it is important to provide these details for future reference.

9.18.1 Remote Adapter

The Accucrop controller must be configured so that a positive output voltage moves the shear in the cut direction. To confirm this wiring setup the Accucrop must be forced to output a positive voltage and the direction of shear rotation must be confirmed.

The Maintenance Interface - Diagnostics mode tab - Step response field can be used to force the Accucrop to output a positive voltage. Start the test by placing the System Selector switch in the customer position, not the KELK position.

- Open the Maintenance Interface and select the Diagnostics Mode tab

- Enter Diagnostics mode by pressing the button in the “Accessing Mode” window
- In the Step Response window set the Pulse Height voltage to 1 volt and the Pulse Duration to 1 second.
- Enable the Output Channel labelled “System Adapter Enable”
- Press the “Do Single Shot” button to perform the Step response test.

This results in a 1 volt pulse of 1 second in duration to appear on the output of the Remote Adapter. Check if the shear moves in the cut dirrection. If the shear moves in the wrong direction then the differential inputs to the Remote Adapter have to be reversed. The inputs to the Remote adapter are on TB1 pins 3 and 4.

During this test, observe the response of the incremental and absolute encoder. The incremental encoder signal is displayed by the bar graph labeled “Incremental Encoder”. The absolute encoder signal is displayed by the dial labelled “Absolute encoder”, and the dial hand must turn in a clock wise direction.

9.18.2 Incremental Encoder

The Incremental encoder must produce a positive velocity when the shear is moving in the cut direction. This polarity is altered by reversing the connection to either of the encoder signal pairs. Exchange the connections of A and A! or B and B!, but NOT both.

9.18.3 Absolute Encoder

The absolute encoder must produce an “up count” for the above test condition. This can be controlled by the “Direction” bit on the encoder. This input is either connected to +24 volts or 0 volts. Changing the voltage that this line is connected to changes the direction that Absolute encoder counts.

9.19 Shear Zero Position

The shear zero position is defined as the position where the cut is complete (tip of the blades are perpendicular to the passline). Whether your system has one pair of blades or two pairs of blades the basic procedure for zeroing is the same.

First the correct number of blades per drum must be entered in the Accucrop system using the Configuration manager utility - accr3_shear_geometry node. The parameter is called “Double_blade_shear” and must be set to “No” for single blade per drum or “Yes” for double blade per drum.

The Maintenance interface - Maintenance mode tab window assists in zeroing the shear blades.

User must enter Maintenance mode by pressing the buton in the “Accessing mode” window.

Caution! When you enter Manitenance mode, Accucrop system does not perform automatic or manual cuts. When you exit the Maintenance mode, the shear moves to the Head park position.

Using the “Jog shear (RPM)” feature, you can rotate the shear slowly with the selected RPM in order to position the blades into the bottom dead zero position. By pressing the Start / Stop buttons and selecting the Forward or Reverse direction the shear blades can be positioned very accurately.

Once the mechanical alignment of the top and bottom drum blades is confirmed, the zero position can be recorded by using the “Zero blades” window and the “Press to zero” button. A warning window will pop up, then press “Yes” to proceed.

If the crop shear has two sets of blades, one for head cuts and one for tail cuts, each pair of blades must be zeroed separately. First select “Yes” for “Double blade shear” parameter in the Configuration manager - accr3_shear_geometry node. After restarting the Maintenance interface, 2 buttons will apear in the Maintenance mode tab - Zero blades window. One button is to zero the Head baldes and the other is to zero the Tail blades. After the Head blades are positioned and zeroed, the Tail blades can be moved in the dead bottom zero position and zeroed. It is important that you keep the orientation of the blades correct and use the the corect button for the corect blades.

9.20 Controller tuning

Since the Accucrop controller and the input sensors are digital, it is unlikely that any changes will be required over time. If there are changes to the shear gear box, if the physical shear is replaced with a new design, or if the shear drive is replaced, then some adjustment may be required in the controller parameters.

The Maintenance interface - Test mode tab window can be used to configure the regulators parameters and controller units.

The Position regulator parameters can befound in the “Position regulator” window. The Cut regulator parameters can be found in the “Cut Regulator” window. There are some additional parameters for the cut regulator which can be found in the “Controller Units” window. After entering a new parameter value, the Save button must be pressed to accept the change. By pressing the Restore button, the new value can be confirmed.

9.20.1 Position regulator tuning

Before carrying out this procedure, the shear head and tail blades must be zeroed and the Head and Tail park positions (parking angle) must be set. To set the Shear park position the Maintenance interface - Test mode tab - Head/Tail park position window can be used.

IbaPDA plays an important roll in tuning the controllers. It provides a real time display of the main shear parameters like current and speed. They can be compared with the controller predictor to see how the system responds. If the response is undesirable, further adjustments will be necessary.

Iba PDA must be running and logging in the background while the Maintenance utility - Test mode tab window is used to control the shear.

The procedure for tuning the position regulator starts with placing the System Selector switch in the customer position, not the KELK position.

- Enter Test mode and inside the Position Regulator window switch Controller to disable by selcting the “Disable” radio button.
- Move the System Selector switch to the KELK position.
- Enable the Position Regulator controller by selecting the “Enable” radio button. The shear should now go to the park position smoothly.
- If it oscillates around the park position without ever coming to a stop then the Basic Regulator Gain is too high.
- If the shear over shoots the park position but then returns to the park position the Basic Regulator Gain is too low.
- If it oscillates around the park position a number of times but comes to a stop then the Gain 2 Division Factor and/or the Integration Division Factor are too high.

If the shear becomes unstable during these tests, switch the Controller to the disable position and make the necessary changes to the parameters. Save the changes, enable the Controller and observe the results. To tune the “Parking regulator” parameters the “Jog Shear to park” feature must be used. The controller is forced to jog the shear either to the Head park position or to the Tail park positon. If the shear is parked at the position selected, the shear moves 360 degrees in the cut direction to reach that position.

The Position regulator dead band parameter can be adjusted as well to ensure that when shear is parked there is no current reference to the Shear drive.

If during the above test the shear becomes unstable then be prepared to disable the controller and make the necessary changes. Then enable the controller and resume the test. Observe the drive predictor and current together with the shear speed and current on the ibaPDA to ensure that Parking regulator is properly tuned.

9.20.2 Cut Regulator

The Maintenance mode - Test mode tab - Simulate Cut window is very helpful in tuning the Cut regulator controller. The “Simulate cut” feature allows the user to set the velocity of the cut, the type of cut (head or tail cut), and the type of the control algorithm (speer pattern, span and height) desired. It also allows you to start the cut by pressing the “Start” button.

ibaPDA data logger must be running in the background and it can be used to display real time and save the results of the Simulate cut for future reference.

The procedure for tuning the cut regulator starts with placing the System Selector switch in the customer position, not the KELK position. The position regulator must be tuned before you can tune the cut regulator. Also, make sure the bar velocity limits are set corectly in the Configuration manager - accr3_limits node.

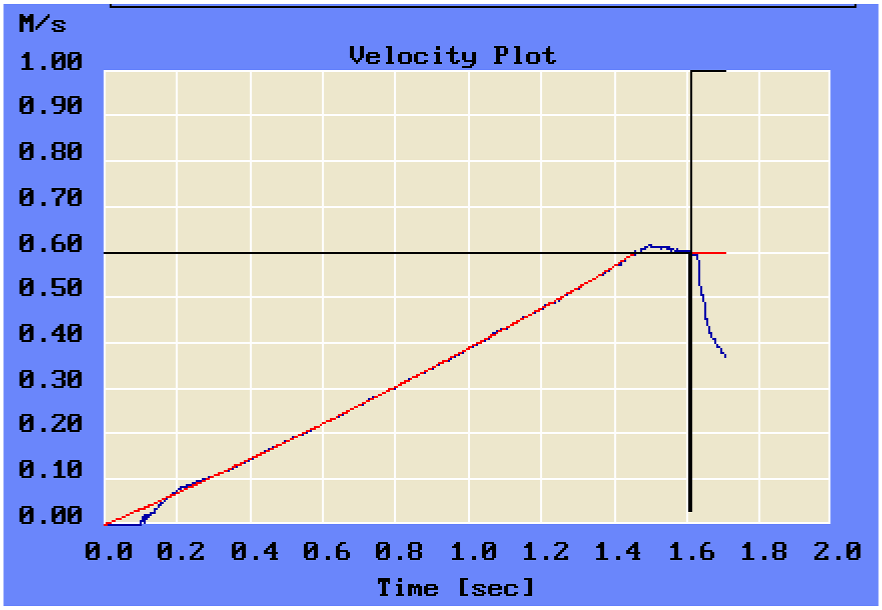
- Open Maintenance interface - Test mode tab and enter Test mode.
- Position regulator controller must be Enabled.
- Move System Selector switch to the KELK position. The shear should move to the Head park position
- In the Simulate Cut window set the parameters as follows:
  - Simulate = Head radio button (this is the default selection)
  - Bar velocity = 1 m/sec
  - Speed patern = Constant and Span & Height = 0 (this is the default selection)

Press the “Start” button and when the warning windows pops up select “Yes”. The shear must accelerate and simulate a cut with 1 m/s cut speed and then go to park postion. If the shear becomes unstable be prepared to disable the controller by selecting the “Disable” radio button.

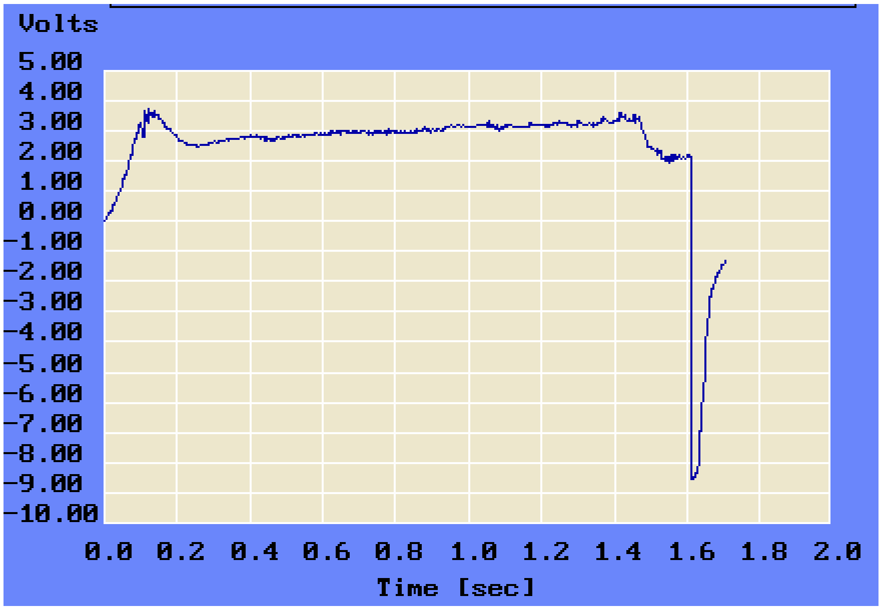
Watch the Simulate cut test results on the ibaPDA viewer and compare the shear predictor and response (current and speed) you see on the ibaPDA display with the following graphs and make the necessary adjustments to the Cut regulator gain and time constant (integration) parameters.

Repet the Simulate cut test until the Cut regulator is properly tuned for the 1 m/s bar speed. Then modify the “Bar velocity” parameter to the Minimum and then to the Maximum speed the shear motor can handle. Make sure the bar velocity limits are set corectly in the Configuration manager - accr3_limits mode. Make the necessary fine adjustments to the Cut regulator gain and integration parameters until the entire speed range is covered.

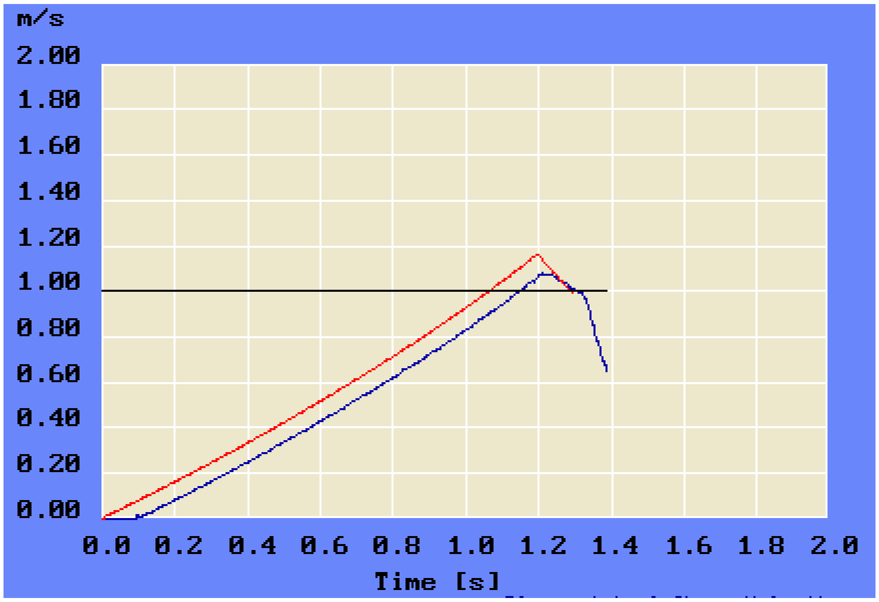
9.20.3 Properly tuned Cut regulator: Velocity plot



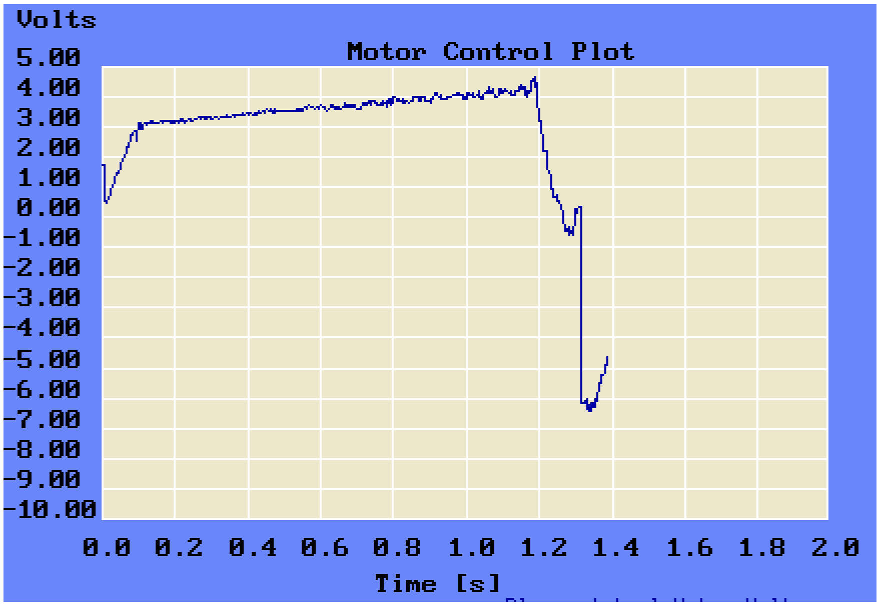
9.20.4 Properly tuned Cut regulator: Motor current plot



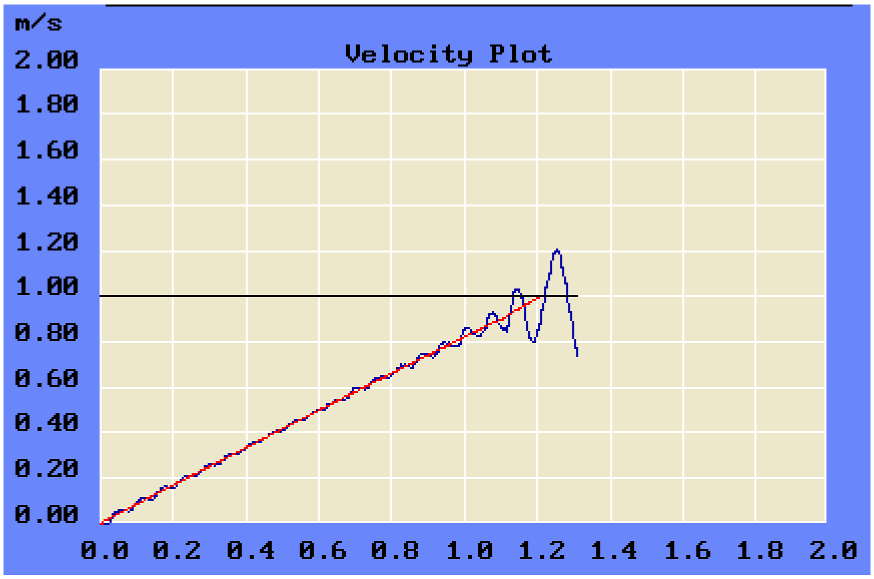
9.20.5 Integration too low: Shear velocity plot



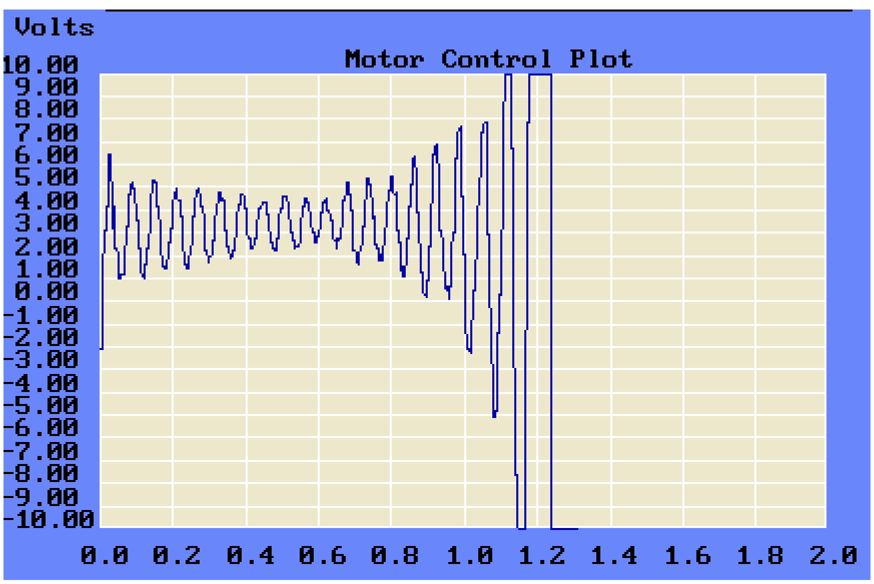
9.20.6 Integration too low: Motor current plot



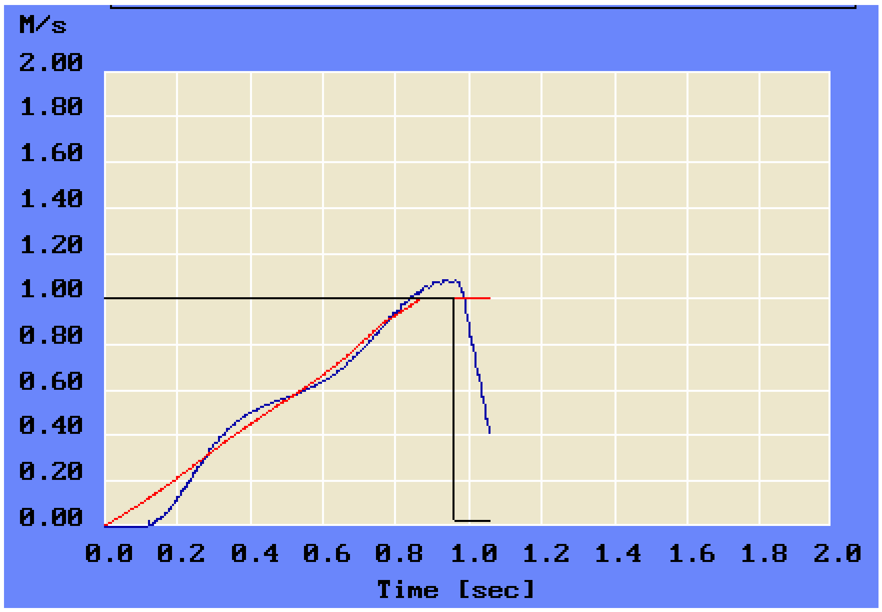
9.20.7 Integration too high: Shear velocity plot



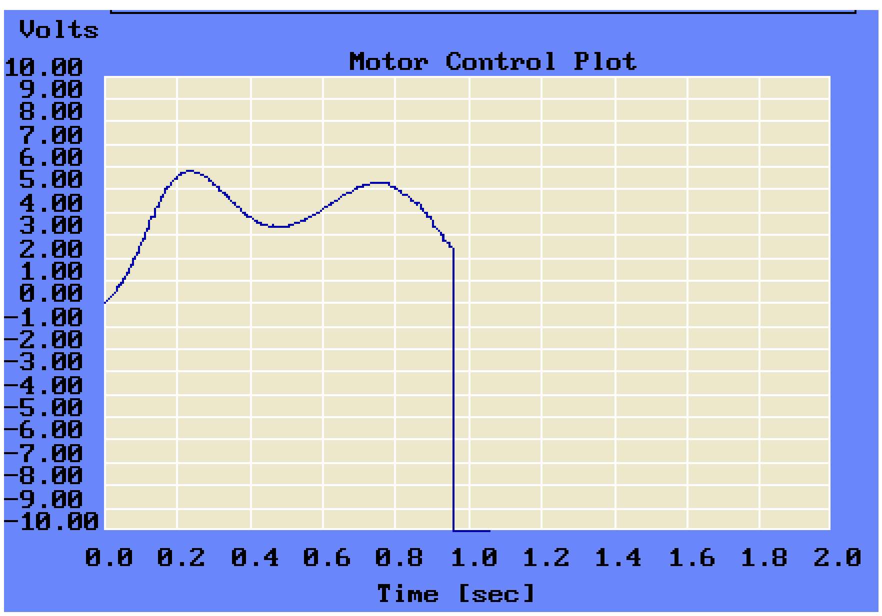
9.20.8 Integration too high: Motor current plot



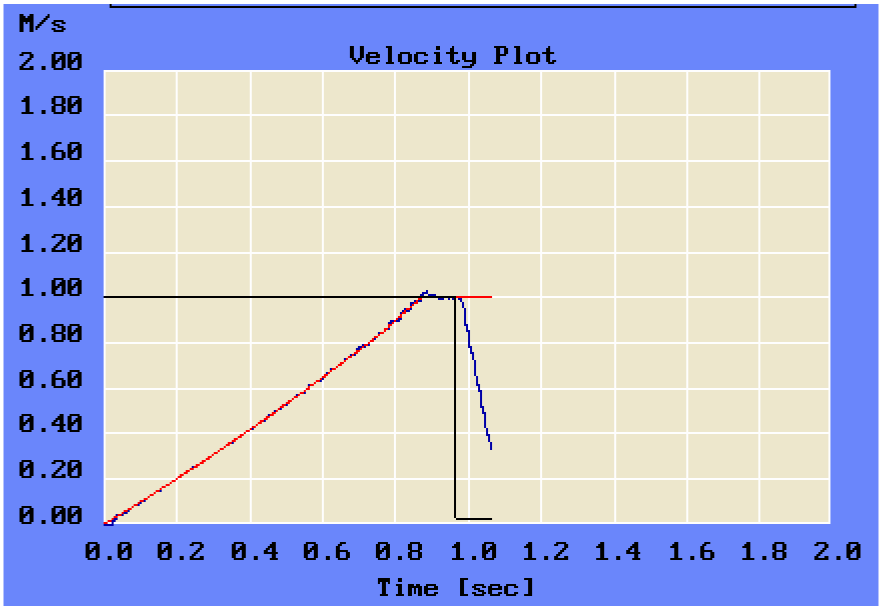
9.20.9 Gain too low: Shear velocity plot



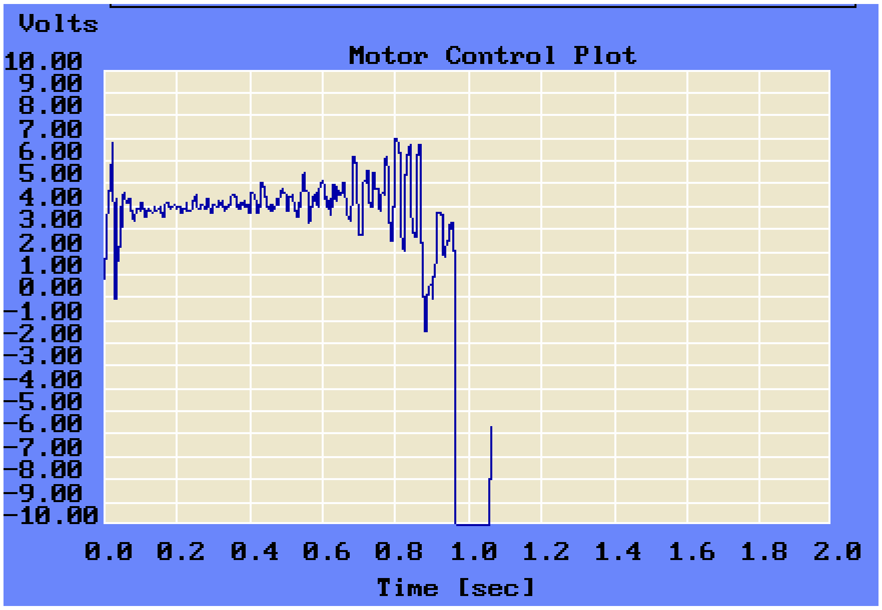
9.20.10 Gain too low: Motor current plot



9.20.11 Gain too high: Shear velocity plot



9.20.12 Gain too high: Motor current plot



9.21 Controller Units Adjustments

The final adjustment of these parameters should be made during normal rolling conditions when Accucrop is in Auto mode and receives real data from the mill sensors. The main purpose is to minimize the Cut position and speed error to improve the Accucrop general cut performance.

The Maintenance interface - Test mode tab - Controller units field can be used to configure the Controller units parameters. After entering a new parameter value, the Save button must be pressed to accept the change. By pressing the Restore button, the new value can be confirmed

- **Shear Linear Distance Cut-off:** When this limit (value) is reached, the Controller ignores accleration from the calculation of the time to cut parameter. The effects of this value are quite small. It is recommened that this value be set to approximately 100 mm to 200 mm.
- **Linear Velocity Prediction Time:** This parameter provides a method for balancing the cut position error and the velocity error. If this number is increased then the cut velocity error becomes very small at the expense of the position error. If this number is made very small the cut position error becomes very small and the velocity error increases.
- **Min. Significant Bar Acceleration:** The controller uses acceleration in the calculation of the predictor. Acceleration is a rather noisy parameter in a rolling mill environment due to the mechanical vibrations. This noise can be misintrepreted by the controller resulting in errors. This parameter sets a limit on what is considered acceleration. Any changes in acceleration below this value are not considered as acceleration and the controller sees this acceleration as zero. If this parameter is made too small the resultant control signal becomes too noisy under rolling conditions. It is possible that a noisy control signal will not adversely affect the cut results. This depends on the response of the shear drive and the amount of noise on the control signal. During the cut cycle the control signal should never go negative. The noise on the control signal should not be greater than 5 %. If the noise increases in the later stages of the cut cycle this parameter is too small. This noise will not be visible under simulated cut conditions because the simulated signal is constant and therefore contains no acceleration.
- **Min. Significant Predicted Velocity:** This is a threshold parameter. When the shear begins to move the controller does not attempt any control until the shear velocity reaches this limit. When the ibaPDA data for a Simulate cut is viewed, the predictor and the shear velocity graphs should start from the same point. If this number is too large then the shear velocity graph starting point is behind (lagged) the predictor. Use the Simulate cut feature and observe the starting point for both graphs in the ibaPDA. Decrease this parameter until the shear velocity starting point graph is closer to the predictor starting point.

PART 10 HARDWARE

10.1 Introduction

The Accucrop controller is constructed on a 19” card cage Compact PCI, 84HP/4U format, complete with 8 slot back-plane and a 180 W power supply. Three vertical fans installed at the bottom of the card cage provide cooling. Main board is a modular 3U CPU powered by an Intel Mobile Pentium processor with high PC computing performance. A carrier board 3U CPCI provide support for up to two I/O modules.

The Accucrop card cage is mounted inside the Accucrop Electronics Unit cabinet providing protection against the elements. All Accucrop interfaces are accessible via terminal blocks installed on rails inside the cabinet. The cabinet is customized for each job and contains filters, circuit breakers, fuses, ethernet switches, media converters and Discrete I/O assembly.

10.2 Scope

This chapter provides valuable information for maintenance personnel and those persons involved in specifying or maintaining spare parts. Here, users can find specific information regarding part specification, part descriptions, part numbers, and references to schematic and wiring diagrams, such as:

- Accuband Crop Optimization Electronics Unit Wiring Diagram
- Accuband Crop Optimization Interconnection Diagram
- Accuband Crop Optimization system services

There are a number of sensors that are connected to the Accucrop controller. This chapter provides a basic description of these items including a description of the interfaces with the Accucrop model ACP1X1-RX V3.0.

10.3 Hardware Description

The Accucrop Hardware components are customized for each job to meet the customer and site specific requirements. Please always refer to the drawing package supplied for the job including the Accuband/Accucrop Electronics Unit Wiring Diagram for the correct part numbers of the hardware components.

10.3.1 Accucrop 19” Card Cage, CPCI, 4U

Name:	Card cage CPCI
KELK P/N:	*07097
Function:	Provides physical support, power and interconnection through CPCI bus for the Accucrop Main boards (CPU, Carrier module and I/O modules). Three fans installed at the bottom provide the cooling.
Inputs:	99 - 264 V AC, 50-60 Hz
Outputs:	+ 3.3 V, + 5.1 V, + 12 V, -12 V; 180 W (Power supply)
Operation:	The Card cage rack has a 4U format, 84 HP, and is EMI protected. It is made of anodized aluminium complete with 8 slot back-plane and a Power supply CPCI 3U which provides automatic input voltage selection (110 / 230 V AC). Space for mounting one or more drive assembly kits is available.

10.3.2 Power Supply - Accucrop card cage, CPCI, 3U

Name:	Power supply CPCI 3U
KELK P/N:	*07454
Function:	Provides power supply to Accucrop 19” Card cage CPCI.
Inputs:	99 - 264 V AC, 50-60 Hz
Outputs:	+ 3.3 V, + 5.1 V, + 12 V, -12 V; 180 W
Operation:	Power supply has plug-in compatibility into the Accucrop 19” Card cage backplane. Automatic input voltage selection (120 / 230 V AC), output over-voltage protection, current limitation, over-temperature protection and LED power indication is provided.

10.3.3 Accucrop CPU, CPCI, 3U

Name:	CPU CPCI 3U
KELK P/N:	*07605
Function:	It is a CompactPCI system controller board which combines the performance of Intel’s Mobile Pentium processor with a high integration cipset and I/O controller Hub.
Inputs:	PC general ports (Ethernet & Serial ports, Video, Keyboard, Mouse, USB), Power and I/O data interface with CPCI bus
Outputs:	PC general ports and I/O data interface with CPCI bus
Operation:	The modular computer CPCI 3U format board demonstrates high PC computing performance in a first-rate resistant construction.

10.3.4 Carrier Board for M-Modules, CPCI, 3U

Name:	Carrier, CPCI, 3U, M-Modules
KELK P/N:	*07862
Function:	The carrier board has provision for two I/O M-Modules and provides the I/O data interface with the CPCI bus. It allows high flexibility in applications such as data acquisition and process control.
Inputs:	I/O M-Modules and CPCI backplane bus
Outputs:	Interface between I/O M-Modules and CPCI backplane bus
Operation:	The carrier board is slightly higher than standard 3U format, providing enough space for two M-Modules while staying compatible with CPCI housing through special guide rails (included). M-Modules are screwed tightly on the board and require no separately mounted transition panel.

10.3.5 Analog Voltage Output Module

Name:	Analog voltage output board (M-Module format)
KELK P/N:	063000
Function:	Converts digital signals from the high speed CPCI backplane bus (via carrier board) to ±10 Volt analog signals used for crop shear control. Two of these four outputs are used to generate a ±20 volt differential signal which is the reference to the current controller of the crop shear drive.
Inputs:	I/O data from CPCI bus via carrier module
Outputs:	Voltage DC between -10V and +10V.
Operation:	The Analog voltage output board utilizes an opto-isolated 4 channel, 12 bit D/A converter to provide 4 separate voltage outputs, each is capable of driving a 1k ohm load. The outputs are isolated, and share a common ground reference.

10.3.6 Encoder Interface Module

Name:	Encoder Interface (M-Module format)
KELK P/N:	063400
Function:	The board provides an isolated interface to the incremental and the absolute encoder. The board is equipped with the neccessary logic to process the encoder signals and to generate event interrupts. In addition it has six high speed opto isolated digital inputs, one of which is connected to the HMD 2048 and used as the input that starts the cropping process (Cut mark signal).
Inputs:	RS-422/485 with fault detection receiver, 5V differential push-pull, 6 fast isolated inputs with universal voltage range (0-1 VDC = low, 5-24 VDC = High, 10 MHz)
Outputs:	100 kHz + ABS encoder reading controls, 5V differential

Operation: The encoder interface module decodes the signals from the absolute and incremental encoders to provide information relating to the shear's absolute position and its incremental velocity. The signals from the incremental encoder are applied to a counter / register arrangement which is latched and read every 4 millisecond. The absolute encoder is a serial device. This encoder interface outputs 14 cycles at a 100 kHz every four milliseconds. The resultant serial data is received, processed and loaded into a register, which the CPU reads.

10.3.7 Power supply: 24 V DC

Name: Power supply 24 V DC
KELK P/N: *07007
Function: Provides 24 V DC power supply to Accucrop auxiliary components installed inside the Accucrop Electronics unit cabinet like ethernet switches, media converters, analog output isolation modules, Discrete I/O etc. Also, provides 24 V DC power supply to the main sensors like: absolute and incremental encoders and HMD 2048.
Inputs: 85-264 V AC, 45-65 Hz, 0.4-0.8 A
Outputs: 24 V DC, 1.5 A
Operation: Primary switched-mode power supply, 24V DC / 1.5 A, DIN rail mountable unit. Can be connected in parallel for redundancy and increased capacity.

10.3.8 Power supply: +/- 15 V DC

Name: Power supply +/- 15 V DC
KELK P/N: *07454
Function: Provides +/- 15 V DC power supply to Cropshear Remote adapter. Ensures that Cropshear drive control and Accucrop are galvanic isolated.
Inputs: 85-264 VAC, 45-65 Hz, 0.5-1 A
Outputs: +/- 15 V DC, 1 A
Operation: Primary switched-mode power supply, 2 x 15 V DC / 1 A, DIN rail mountable unit. Can be connected in parallel for redundancy and increased capacity.

10.3.9 Ethernet Switch

Name: Ethernet switch
KELK P/N: *07238
Function: Provides ethernet interconnection between the Accucrop hardware components and with external devices.
Inputs: 18-30 V DC, 0.2 A
Outputs: 8 x 10/100 TX, RJ-45 ports

Operation: Unmanaged switch, auto-negotiation, auto-crossing. Signal LEDs for data receive and link status. Status LEDs for Us1 and Us2 redundant voltage supply.

10.3.10 Media converter/switch DIN rail

Name: Media converter/switch
KELK P/N: *07447
Function: Provides media conversion between fiber and RJ-45 ports. Ensures ethernet interconnection between Accucrop hardware components and external devices. DIN rail mountable.
Inputs: 24 V DC, 0.25 A
Outputs: 1 x 100FX (Fiber SC), 2 x 10/100 TX (RJ-45 ports)
Operation: Multimode fibre connection up to 2 km. Copper maximum length is 100m. Both copper ports are auto-sensing for speed and duplex, adjusting to the connected device automatically . Indicators LEDs for power, 10/100, full/half-duplex and link/act.

10.3.11 Media converter/switch desktop

Name: Media converter/switch
KELK P/N: *07446
Function: Provides media conversion between fiber and RJ-45 ports. Ensures ethernet interconnection between Accucrop hardware components and external devices. Desktop mount with external power supply.
Inputs: 100-240 VAC, 47-63 Hz
Outputs: 1 x 100FX (Fiber SC), 2 x 10/100 TX (RJ-45 ports)
Operation: Multimode fiber connection up to 2 km. Copper maximum length is 100m. Both copper ports are auto-sensing for speed and duplex, adjusting to the connected device automatically. Indicator LEDs for power, 10/100, full/half-duplex and link/act.

10.3.12 Discrete I/O Wago modules

Note: The Discrete I/O modules are customized according to customer requirements for each job. Always refer to Accuband/Accucrop electronics unit cabinet wiring diagram and drawing package supplied with the job.

Name: Fieldbus coupler module
KELK P/N: *07205
Function: This buscoupler allows connection of the Wago I/O System as a slave to the ethernet filedbus. It supports all the I/O modules.
Inputs: 24 V DC - 300 mA power, ethernet port
Outputs: Wago bus data, ethernet port
Operation: The buscoupler automatically configures, creating a local process image which may include analog, digital and specialty modules. Analog and

specialty module data si sent via words and/or bytes, digital data is sent bit by bit.

Name:	Digital output module, 8CH
KELK P/N:	*06999
Function:	The Digital output module provides 8 channels optically isolated.
Inputs:	Wago bus data
Outputs:	8 channels, Max. current 0.5 A, Max. switching rate 2 kHz
Operation:	All outputs are electronically short-circuit-protected. Each output is electrically isolated from the bus by use of optocouplers.

Name:	Supply module
KELK P/N:	*07088
Function:	Power supply for other Discrete I/O Wago modules (Digital input, Frequency counters)
Inputs:	24 V DC via power jumpers and fuse
Outputs:	24 V DC power jumper contacts
Operation:	Fuse holder is included. Status voltage supply and error fuse blown LEDs.

Name:	Digital input module, 4 CH
KELK P/N:	*06998
Function:	The digital input module receives control signals from digital field devices (sensors).
Inputs:	4 CH digital inputs
Outputs:	Wago bus data
Operation:	Each input has a noise-rejection filter. An optocoupler is used for electrical isolation between the bus and the field side. Signal voltage: -3...+5 V DC = Low, +15...+30 V DC = High.

Name:	Analog input, 2CH, +/- 10 V
KELK P/N:	*07001
Function:	The analog input module receives standardized values of +/- 10 V DC.
Inputs:	2 CH analog inputs, Power supply from Wago bus
Outputs:	Wago bus data
Operation:	The input signal is electrically isolated and will be transmitted with a resolution of 12 bits to the Wago bus.

Name:	Frequency counter module (optional)

KELK P/N: *07763

Function: The counter module measures the period of the 24 V DC input signal at the input CLOCK and converts it into a corresponding frequency value.

Inputs: 24 V DC pulses from tachometer

Outputs: Wago bus data

Operation: The measurement is enabled if the input GATE is an open circuit input or 0 V. To recognize low frequency or near zero frequency signals, the maximum time between two data updates is parameterizable. Status LEDs for GATE, CLOCK and output channels is provided. An optocoupler is used for electrical isolation between the bus and the field side.

Name: End Fieldbus module

KELK P/N: *07002

Function: The End Fieldbus module completes the internal data circuit and ensures correct data flow.

Inputs: Wago bus data

Outputs: Wago bus data

Operation: The End module is located at the end of the Discrete I/O Wago assembly. One is required for each buscoupler.

10.3.13 Cropshear Remote Adapter

Name: Remote Adapter

KELK P/N: PL050154

Function: The remote adapter provides the interface between the differential analog output of the Accucrop controller and the single ended input of the shear drive control. This device provides the following functions:

- Differential to single ended converter
- Rate of change limiter
- Galvanic isolation
- System selector relay

Inputs: ± 20 volt differential signal, ± 15 V DC power

Outputs: ± 10 volt single ended output @ 20 mA with respect to Gnd

Operation: The analog output from the Accucrop is a differential signal. The remote adapter converts this signal from a differential signal to a single ended signal. This single ended signal is then applied to a rate of change limiter. It also provides the galvanic isolation between the KELK system and the customer’s shear drive. Lastly, there is a relay on the output which allows either the Accucrop output or the customer’s existing control system to be applied to the shear drive control.

10.3.14 Absolute Encoder

Name: Absolute Encoder
KELK P/N: *07005
Function: This device measures the position of the shear blades
Inputs: It has power input, control inputs and a SSI (RS-422/485) interface as follows:

- 24 Vdc.
- a 100 kHz clock with RS422/485 - 5V differential levels.
- a direction input that sets the relationship between the direction of rotation and the direction of the encoder counts, up or down.
- The zero input is not used

Outputs: 13 bits of data RS422/485, 5V differential (0 to 8191 counts / revolution)
Operation: The absolute encoder is a 13-bit encoder and as the name implies, it provides a count value between 0 and 8191 indicating the absolute position of the crop shear's motor shaft. The encoder is mounted in such a place (usually crop shear drum shaft) that there is a one to one rotational relationship between itself and crop shear drum / blades. The serial interface on the absolute encoder greatly reduces the number of lines required for interfacing. Only two sets of lines (differential signals) are required, one set for clock signal and the other set for encoder data. The encoder intelligently uses the clock signals for enabling and disabling its interface. Please refer to the Hardware Interface chapter for signal wave forms and for connector signal assignment information.

10.3.15 Incremental Encoder

Name: Incremental Encoder
KELK P/N: *06363
Function: This device measures the velocity of the shear blades.
Inputs: 24V power,
Outputs: Quadrature output, two pairs of RS422, 5V differential signals that are 90 degrees out of phase.
Operation: The encoder is mounted in such a place (usually shear motor shaft) that there are multiple turns of this encoder for one turn of the shear blades. The resolution of this device is 6000 pulses per revolution. By using both the rising and falling edges of the incoming quadrature signals, the incremental encoder interface doubles this resolution to 12000 pulses per revolution. Please refer to the Hardware Interface chapter for signal wave forms and for connector signal assignment information.

10.3.16 Crop Operator's Panel

Name:	Crop Operator's Panel
KELK P/N:	See System Services Drawing for specific job
Function:	The crop panel contains the necessary physical switches and buttons which provide the desired crop operator's interface.
Inputs:	Push buttons and two position switches
Outputs:	Dry contacts that are powered with 24V from the Accucrop electronics unit.
Operation:	This panel of switches provide the operator with access to features of the system in a traditional manner. This feature require the positive feedback associated with a physical movement.

10.3.17 Crop Operator's PC

Name:	Crop Operator's PC
KELK P/N:	See System Services Drawing for specific job
Function:	Visual display of the process events, results and access to operation parameters, Maintenance interface and Configuration utility.
Inputs:	Computer Keyboard and mouse
Outputs:	Video display, Ethernet connection
Operation:	These features are detailed in the Accucrop User's Interfaces Chapter

PART 11 HARDWARE INTERFACES

11.1 Introduction

There are a number of sensors that are connected to the Accucrop controller. This section provides a basic description of these items including a description of the interfaces with the Accucrop model ACP1X1-CBE V3.0. All Accucrop interfaces are accessible via terminal blocks installed on rails inside the cabinet. The cabinet is customized for each job so please refer to the drawing package supplied with the equipment.

11.2 Scope

This section provides valuable information for maintenance personnel. Here you can find specific information regarding the Accucrop interfaces and references to schematic and wiring diagrams. This includes connection to the KELK supplied sensors and to existing customer's equipment.

11.3 Interfaces Description

The Accucrop Hardware interfaces are customized for each job to meet the customer and site specific requirements. Please always refer to the drawing package supplied for the job including the Accuband/Accucrop Electronics Unit Wiring Diagram.

11.3.1 Absolute Encoder Interface

The absolute encoder interface consists of two sets of differential lines: 1 set for Clock, and the other for Data. The differential signals are converted to single ended TTL signals using a RS-422/485 with fault detection receivers. In addition, the interface has 24 V DC power for the absolute encoder, one control line for encoder direction, and one for power check. Refer to the Interconnection diagram for more details.

Every 4 ms the encoder interface card sends 14 cycles at 100 kHz clock signal to the absolute encoder. This pulse train is converted into fourteen falling edges & fourteen rising edges. The Absolute encoder uses the first falling edge of the clock as an enable for the interface and then at every next 13 falling edges it sends one bit of data.

The incoming serial data into the encoder card is latched using the rising edges of the internal clock. Note that the data received at the first rising edge is ignored as it is invalid. The next 13 rising edges are then used to transfer the 13-bit position data from the sbsolute encoder to an internal register. The absolute position data is then processed depending on the encoder type (gray code or binary) and made available for CPU use.

Refer to Table below for Absolute Encoder Pin Assignment:

Pin	Signal	Description
A	Takt +	Clock +
B	Data +	Data +
D	Vcc (10-30 Vdc)	Power Input
F	0 V GND	Power Input Common
G	Takt -	Clock -
H	Data -	Data -
I	CW/CCW (notes)	Encoder Direction
J	SCRN	Shield

Note: Encoder pin “I” changes the direction of the internal counter. The input can either be connected to 0 V GND or +24 V DC in order to get the correct setting for your installation.

11.3.2 Incremental Encoder Interface

Incremental encoder outputs two differential pair signals, A and A’, and B and B’ that are 90 degrees out of phase to each other. One pair is used to measure the velocity the other pair is used as a reference to determine direction. Refer to Figure 11.1 for incremental encoder signals.

The RS-422/485 pulses from the incremental encoder are first isolated and converted to TTL single ended signals. Then the signal is applied to an edge detector that converts rising and falling edges to pulses. These pulses are applied to a counter. Every 4 milliseconds the counter is latched and read. By finding the difference between two successive readings, the Accucrop controller can calculate the instantaneous velocity of the crop shear’s shaft.

The resolution of the incremental encoder is 6000 pulses per revolution. By converting the rising and falling edges to pulses, the resolution is increased to 12000 pulses per revolution.

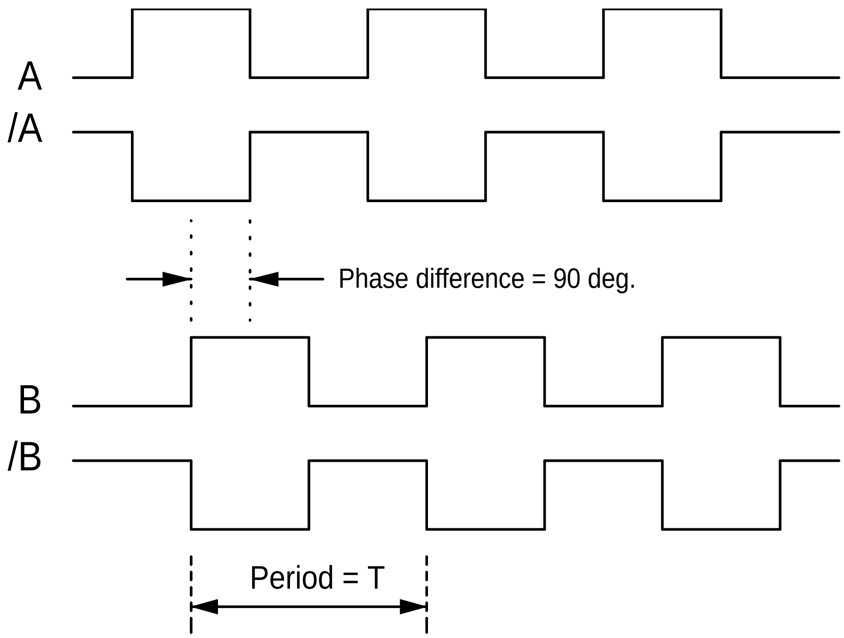


Figure 11.1 Incremental Encoder Signals

Refer to table below for Incremental Encoder Pin Assignment**:**

Pin	Signal	Description
A	B+	Phase Signal B+
B	A+	Phase Signal A+
C	M+	Not Used
D	Vcc (10-30 Vdc)	Power Input
E	Vcc sense	Power sense (OK)
F	0 V GND	Power Input Common
G	Screen	Shield
H	B-	Phase Signal B-
I	A-	Phase Signal A-
J	M-	Not Used

11.3.3 Remote Adapter Interconnection

The reference signal path to the input of the customer's current regulator must be modified to introduce the Remote Adapter. The output of the speed regulator is disconnected from the input of the existing current regulator and re-routed into the remote adapter. The output of the remote adapter is then connected to the input of the current controller. Refer to Figure 11.2.

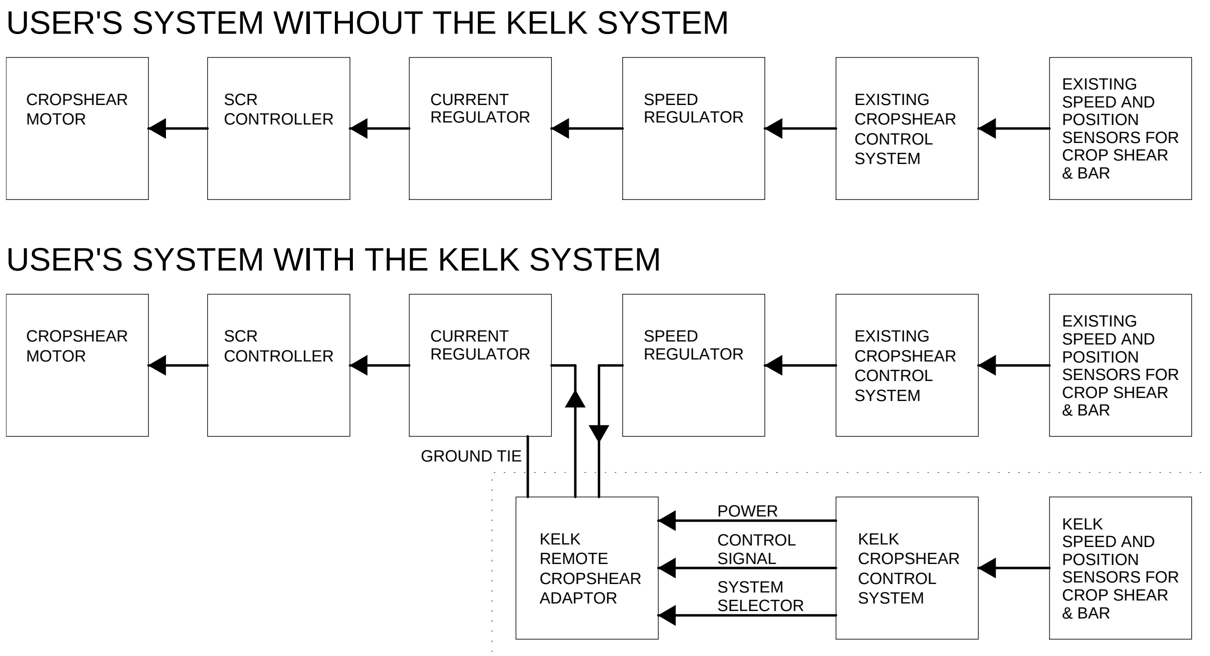


Figure 11.2 Remote Adapter Interconnection

The position of the Remote adapter output relay is controlled by Accucrop through one of the Discrete I/O's relay output channels (KELK system selected). If power to the Discrete I/O is turned off the relay drops out. This selects the control signal from the customer speed regulator as the input to the current regulator.

The ±15 V DC power supply voltage for the remote adapter is isolated from the Accucrop system. The ground connection shown is only connected to the floating power supply of the analog output that drives the remote adapter. The maximum differential input is ± 20 volts and the output with respect to common is ±10 volts. Refer to Figure 11.3.

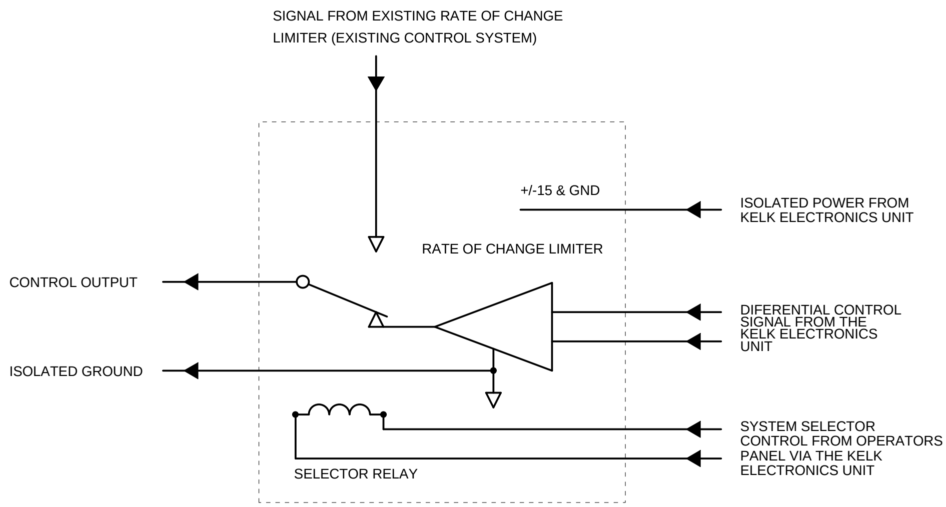


Figure 11.3 Remote Adapter Signals

11.3.4 Accucrop Fast Digital Input Interface

The encoder interface module 63400 located inside the Accucrop 19” card cage provides six fast digital inputs optically isolated. The default assignment uses only three of them leaving the rest as spares for different configurations:

- **HMD 2048 MIV** - Input 1 is reserved to the HMD 2048 *Material In View* (Cut mark received signal)
- **ABS encoder power OK** - Input 5 monitors the absolute encoder +24 V DC power supply
- **INC encoder power OK** - Input 6 monitors the incremental encoder +24 V DC power supply

These fast digital inputs are interrupt driven. When the interrupt occurs the software logs the time of occurrence. When the next 4 millisecond tick occurs the software uses this recorded time to calculate the exact position of the interrupt with respect to the 4 millisecond tick. This is effectively an interpolation between 4 millisecond ticks.

11.3.5 Accuspeed Interface

The Accucrop controller communicates with Accuspeed electronics unit via an Ethernet Modbus TCP protocol. The Accupeed electronics unit provides the following data on the Modbus registers map: velocity, length, status, and condition. Accucrop controller reads the modbus registers every 10 ms. The details of the Accuspeed Register Map (Modbus TCP) can be found in the Accuspeed user’s manual.

The Accuspeed Electronics unit is usually installed inside the Accucrop cabinet. There are a number of digital I/Os and analog output signals that interconnect with the mill system and they are available at terminal blocks installed on the Accucrop cabinet back-panel. Here is a brief description of them. Note that some digital I/Os are reserved or not used. Refer to Accuspeed user's manual for more details.

Accuspeed EU digital (relay) outputs

- **System ready** - The relay output is high when the Accuspeed is ready to take measurements
- **Head overheat** - If temperature inside the optics head exceeds the overheating valve then this digital output becomes high.
- **Data valid** - Velocity and length data must be valid to have this digital output energized
- **Laser on** - This digital output is high 5 seconds before the laser diode inside the Optics head is powered. It indicates that the laser diode inside the optics head is ON.

Accuspeed EU digital inputs

- **Interlock** - This digital input must be high to energize the Accuspeed laser.

Accuspeed EU analog outputs

- **Bar velocity** - Represents a DC voltage signal which is proportional with the measured velocity.

11.3.6 Discrete I/O Interface

The Discrete I/O assembly is controlled by the Accucrop controller using a proprietary UDP protocol. The Fieldbus coupler in the Discrete I/O is connected to the Accucrop controller via an ethernet link. The Discrete I/O kit can be installed either inside the Accucrop cabinet or remotely inside the PLC or other custom cabinet. All the analog and logic I/Os are updated every 10 ms.

Here is a description of the default Discrete I/O signals assignment and the interface with the mill controls. Always consult the drawing package supplied for the job including the interconnection diagram.

Digital inputs and interlocks:

All switches on the customer side must be dry contacts which are biased by a 24 VDC power supply inside the Accucrop cabinet (Discrete I/O assembly). A number of critical inputs are pre-assigned or reserved to certain channels. The rest of them can be changed and reassigned to different channels using the configuration utility. A closed relay contact close means the input is high and active. Some exceptions apply and they are described below.

Crop Operator's Panel digital inputs

Operator's panel consist of two selector keys and two push buttons. They allow operators to control the Accucrop main functions in a classic way. There are four digital inputs coming from the Operator's panel as follows:

- **Accucrop Enable** - This input is pre-assigned and enables the Accurop system and the Remote adapter. When input is high the KELK system controls the shear drive.
- **Auto / Manual Mode** - This input is pre-assigned. Operator can change operation mode between Auto and Manual. Contact closed = Auto mode, Contact open = Manual mode.
- **Immediate Cut** - This input is pre-assigned. Accucrop performs a manual cut when the button is pressed (input high).
- **Continuous Cut** - Accucrop continues to cut while this button is kept pressed (input high). Certain conditions must be met.

Accucrop digital inputs (from Mill)

Accucrop system requires inputs from the mill side in order to operate properly. Some of the inputs are used for interlocks and some of them to track the position of the bar. Below is their description.

- **Spot HMD interlock # 1** - It is a spot HMD (by customer) usually located 0.5 to 1 m in front of the HMD 2048 on the roll table. It is used as an interlock for the HMD 2048.
- **Spot HMD interlock # 2** - It is a spot HMD (by customer) usually located 0.5 to 1 m after HMD 2048 on the roll table. It is used as an interlock for the HMD 2048.
- **Shear drive ready** - This input is pre-assigned. Input high means the shear drive is ready to turn the shear. It is a fundamental input and must be high before Accucrop controller attempts any control. If this input is low, Accucrop becomes unhealthy and the KELK current reference to the drive is sent to zero.
- **Bar in zone (BIZ)** - It is a spot HMD (by customer) usually located about 10 m in front of the shear. It is used for bar tracking. This input is high as long as the bar is under the BIZ HMD.
- **BIZ healthy** - This input is used to validate the BIZ signal. If BIZ healthy input is low, than the BIZ input is ignored.
- **HMD 2048 healthy** - This input is pre-assigned and reserved. When this input is high (HMD 2048 is healthy) the MIV transitions (Cut mark received) are used by Accucrop to track the bar and initiate a cut. When this input is low then Accucrop ignores all MIV transitions from HMD 2048.
- **Cut inhibit (bar rocking)** - When this input is high, the HMD 2048 transitions are ignored and Accucrop operation is inhibited. It is used when the bar needs to be stopped or rocked in front of the shear. Certain conditions must be met when this input is made Low (0) to ensure Accucrop's proper operation.
- **Metal in mill F1** - This input is pre-assigned. It is high when material enters in F1 stand. It triggers the tail backup speed (F1 mill speed) calibration against the Accuspeed.

- **Metal in mill F2** - This input is used when F1 stand is put in dummy mode. This input is high when material enters in F2 stand. It triggers the tail backup speed (F2 mill speed) calibration against the Accuspeed.

Digital outputs and interlocks

All digital outputs from Accucrop (Discrete I/O) are using DPDT relays with dry contacts. When the digital output is active (high) the relay is energized. Usually the N/O (normally open) contact is used from the relay outputs, so when the power to the Discrete I/O is turned OFF, the contacts opens and the digital output is set Low.

Accucrop digital outputs

Accucrop system provides eight relay outputs that can be interconnected and used for the mill automation and monitoring system. Some of the outputs are used for shear drive logic and some of them for interlocks. Some critical outputs are pre-assigned or reserved to certain channels. The rest of them can be changed and reassigned to different channels using the configuration utility. Below is their description:

- **KELK system selected** - This digital output is pre-assigned. It is also called "System adapter enabled". It is high when KELK Accucrop system is selected.
- **Head cut complete** - When the head cut is completed, this digital output is energized for a configurable amount of time
- **Tail cut complete** - When the til cut is completed, this digital output is energized for a configurable amount of time
- **Shear parked** - This output will stay high when the shear is in the park position
- **Cut aborted** - When a cut is aborted, this digital output is energized for a configurable amount of time
- **Auto mode enable** - When Auto mode is selected, this digital output is energized.
- **Continuous cut in progress -** When Accucrop performs a continuous cut, this digital output is energized
- **Accucrop healthy** - This digital output will stay high as long as Accucrop is healthy (Shear drive ready input is high + Accucrop configuration is valid + Motor is not stalled).

Optional Digital outputs

The following digital outputs are optional and can be assigned using the configuration utility to one of the above channels:

- **Divide Cut Parking in progress -** This output is high when a divide cut has been made and the second half of the bar should be reversed. It will stay high until Accucrop cycles the shear to the tail park position. Certain conditions must be met. Refer to Accucrop System operation chapter for more details.
- **Accucrop ready to cut** - This output is high when Accucrop is ready to perform a cut (Auto or Manual mode). The following conditions must be met: System enable + Accucrop Healthy + Not Maintenance mode + Not Test mode + Controller enable.

Analog inputs

The Accucrop analog inputs are provided by Discrete I/O (Wago) analog inputs modules. There are two modules with two analog input channels each. The default channels assignment is as follow:

- **Finisher F1 roll speed** - This input is the F1 mill stand roll speed. It provides the tail backup speed.
- **Measuring roll or Cradle roll speed** - This input is the measuring roll speed (crop shear entry location). It provides the head backup speed.
- **Finisher F2 roll speed** - This input is the F2 mill stand roll speed. It is used when F1 is set in “Dummy mode”. It provides the tail backup speed.
- **Shear motor current feedback** - This input represents the shear motor current output from the drive. It is used for monitoring and logging into the IBA system.

Tachometer inputs (optional)

The Accucrop tachometer inputs (optional) are provided by the Discrete I/O Wago frequency counter modules (optional). There are three modules available with one input channel for each module. The tachometer signal must be quadrature type with a 24 V DC amplitude. The default channels assignment is as follow:

- **Finisher F1 roll tachometer** - This is the tachometer attached to the F1 mill stand motor shaft. It provides the tail backup speed.
- **Measuring roll or cradle roll tachometer -** This is the tachometer attached to the measuring roll motor shaft (Crop shear entry location). It provides the head backup speed.
- **Finisher F2 roll tachometer** - This is the tachometer attached to the F2 mill stand motor shaft. It is used when F1 is set in “Dummy mode”. It provides the tail backup speed.

11.3.7 HMD 2048 Interface

Inside the HMD 2048 junction box there is an RS 232/485 serial interface port configurable via jumpers. User Access program can communicate with the HMD via this serial interface. It is used for HMD configuration and fine tuning. Refer to the HMD 2048 User’s manual for more information.

The HMD 2048 relay outputs are available inside the Accucrop cabinet and they copy the status of the digital outputs located in the HMD Junction box. Two DPDT relays with dry contacts are used, and when the digital output is active (high) the relay is energized:

- **HMD 2048 Metal in view (MIV) -** The MIV digital output is energized when the bar is in the HMD field of view. This signal cam be used by the mill tracking system.

- **HMD 2048 Healthy -** This digital output validates the HMD 2048 MIV signal. When HMD is working properly this relay output is energized. If temperature inside the HMD goes above 55 C, then the HMD 2048 becomes unhealthy.

11.3.8 Accuband Scanner Interface

There is an ethernet link between the Accuband scanner and Accucrop controller. The Accuband crop imaging system uses this link to transfer information about the bar to Accucrop. This includes the bar ID, thickness and the notification of a divide cut together with the divide cut length.

There are KELK proprietary modules running in the Accuband crop imaging system and Accucrop system as well. They are interconnected and exchange data and status using KELK proprietary protocols. One of the modules is the Queue Manager which is running on the Accucrop system. It receives from Accuband crop imaging system the head and tail image information data together with the crop criterion, cut line type and cut length. This data is stored in queue based on the coil box mode status bit and is made available to Accucrop when requested.

Accuband and Accucrop also exchange status (healthy, fault, warning) information which ensures the proper operation of the entire closed loop system and helps operators and maintenance personnel to monitor and troubleshoot the system.

11.3.9 Crop OP PC Interface

Crop operator PC is connected to the Accucrop controller via an ethernet link. There are multiple applications running on this PC which are communicating with the Accucrop system. Several protocols are supported: Modbus/TCP, HTTP, Telnet and FTP. All protocols can be active simultaneously, however, the total bandwidth is fixed and care should be exercised not to overload the network.