

Figure 1 KELK Instrumentation Panel (KIP)

1. DESCRIPTION

Crop Optimization System improves yield by optimizing the trimming of transfer bar head and tail ends in a Hot Strip Mill. Depending on the configuration, the Crop Optimization System can provide four key functions:

- Imaging of head and tail ends
- Optimum cut line determination
- Tracking of optimum cut line into crop shear
- Controlling the crop shear to make the optimized cut

KELK Crop Optimization Systems are available in three different configurations depending on the installation location:

- Rougher Exit
- Coil Box Entry
- Crop Shear Entry

2. BENEFITS

The ACCUBAND Crop Optimization System improves yield in hot strip mills by optimizing the cropping of the transfer bar head and tail ends.

- The crop optimization process will return significant cost savings that can be estimated in dollar value based on mill production capacity and current steel price.
- The KELK Crop Optimization System can be installed without the removal of the existing system.
- Reliable system performance with low maintenance requirements.
- Highly flexible system allows for customization of system configurations and installation locations.
- Supports fast rolling pace for maximum productivity.

3. FEATURES

- Crop images, shape classifications, statistics and cut lengths are all displayed on a user friendly, highly customizable operator's interface.
- Allows for optimized cuts, fixed length cuts, skipped cuts, continuous cuts and manual cuts.
- Compatible with rotary shears and crank shear.
- Outline positions can be manually adjusted by mill operators when required.
- Optional KELK Database for logging and analyzing crop system data allows users to monitor and fine tune performance.
- A comprehensive diagnostic system monitors the operation of the system and status signals are provided to the mill host computer. Additional diagnostics can be accessed by service personnel through a maintenance interface accessible over an Ethernet network.
- Accurate control of crop shear position and velocity while maintaining positive torque on shear motor helps minimize backlash in drive train.
- Pre-existing crop control systems may be retained.

4. SYSTEM LEVELS

There are three levels of KELK's ACCUBAND System depending on the system function:

ACCUBAND System Function	Three (3) System Levels		
	Imaging System	Imaging & Tracking System	Closed Loop System
Imaging of head and tail ends	✓	✓	✓
Optimum cut line determination	✓	✓	✓
Tracking of optimum cut line		✓	✓
Controlling the crop shear			✓

Imaging System

- Provides Accurate images of both head and tail ends of the transfer bar.
- The Head and tail ends shapes are classified by crop criteria as; fishtail, dog bone, or asymmetric and as percentage of strip width.
- Optimized cut length is established, referenced to the tip of transfer bar.
- The tracking of cut lines and control of the crop shear is to be provided by others.
- Can be installed at Rougher Exit, Coil Box Entry or Crop Shear Entry.

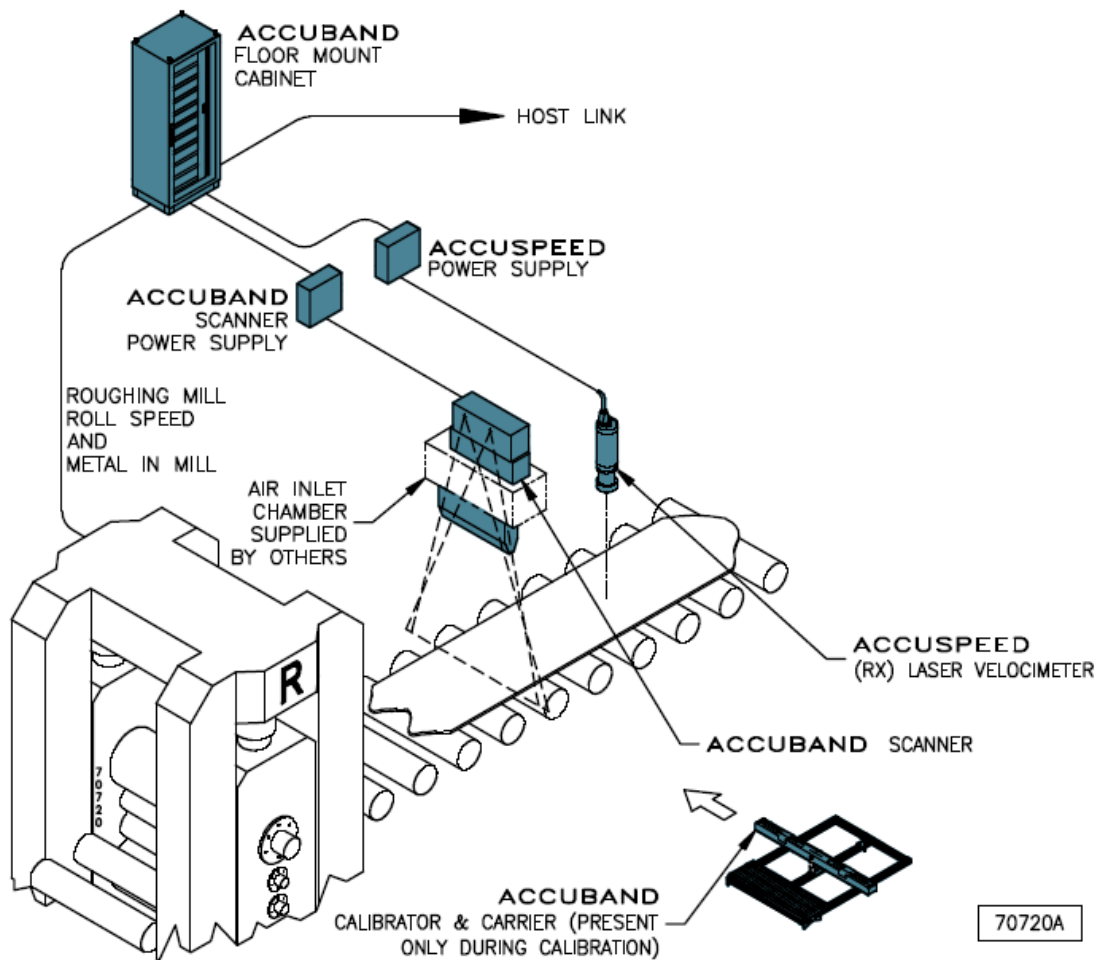


Figure 2 Rougher Exit Configuration

Imaging and Tracking System

- Imaging and Tracking System includes all functions performed in the Imaging Systems.
- Can be installed at Rougher Exit, Coil Box Entry or Crop Shear Entry.
- Optimum cut lines are tracked up to a Cut Initiate point in front of the shear.
- The KELK system issues a Cut Initiate pulse.
 - For Rougher Exit and Coil Box Entry systems, Cut Initiate is by HMD.
 - For Crop Shear Entry systems, Cut Initiate is by ACCUBAND Scanner.
- Control of the Crop Shear is by others.

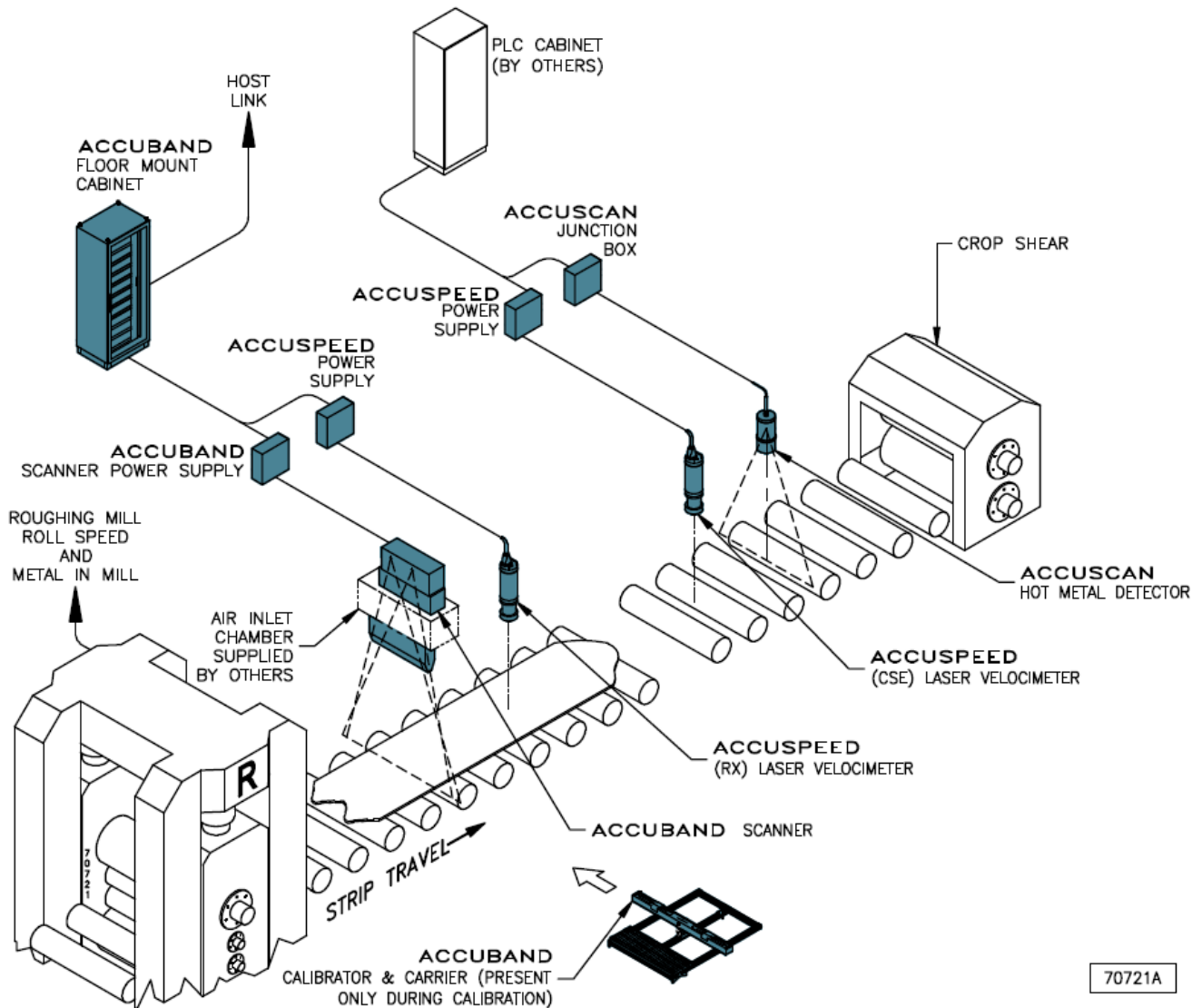


Figure 3 Rougher Exit Configuration

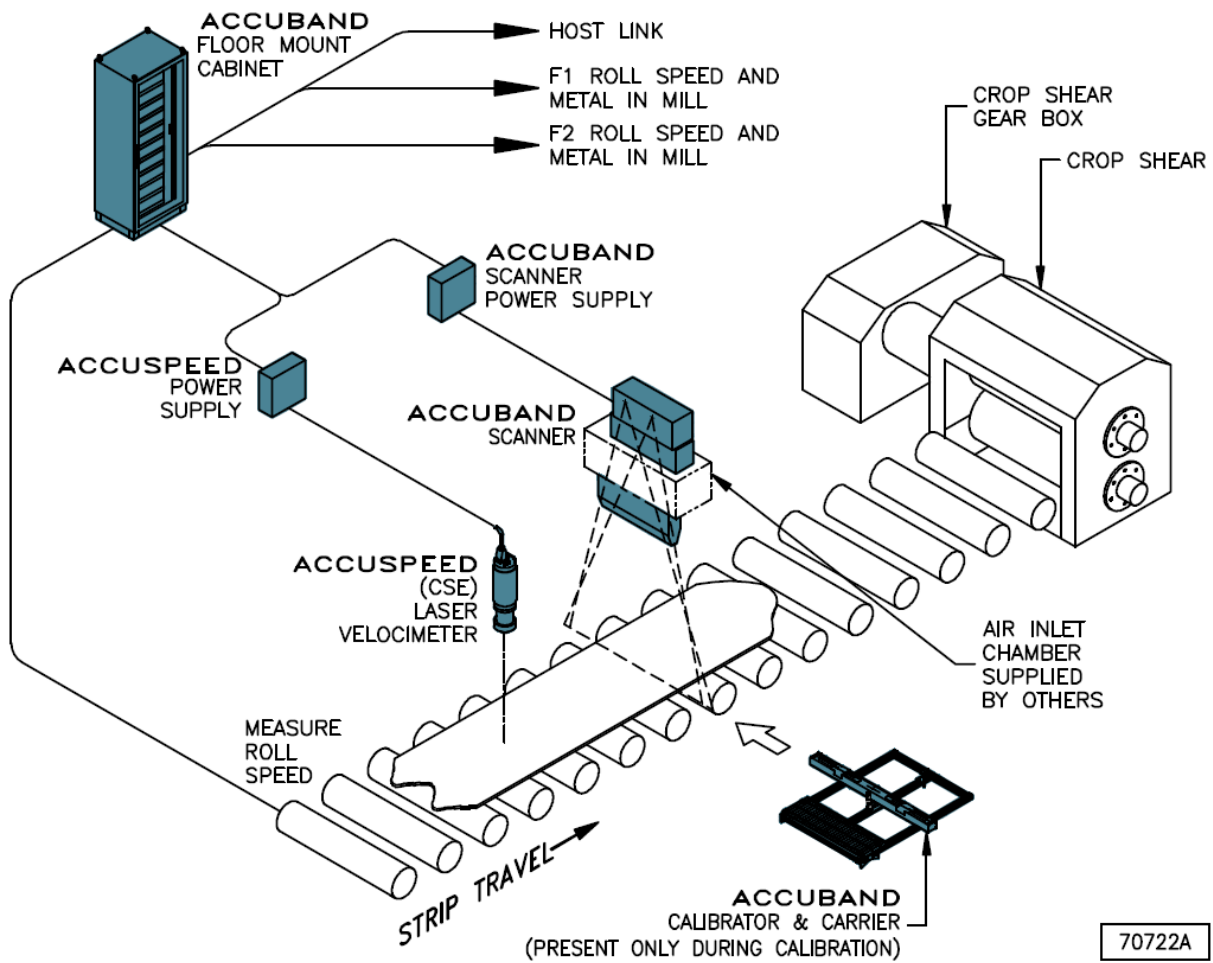


Figure 4 Crop Shear Entry Configuration

Closed Loop System

- Includes all functions performed in “Imaging System” and “Imaging and Tracking System”
- The Crop Shear is controlled by the KELK ACCUCROP Controller
- Scanner can be installed at Rougher Exit, Coil Box Entry or Crop Shear Entry
- Cut lines are tracked into the Crop Shear

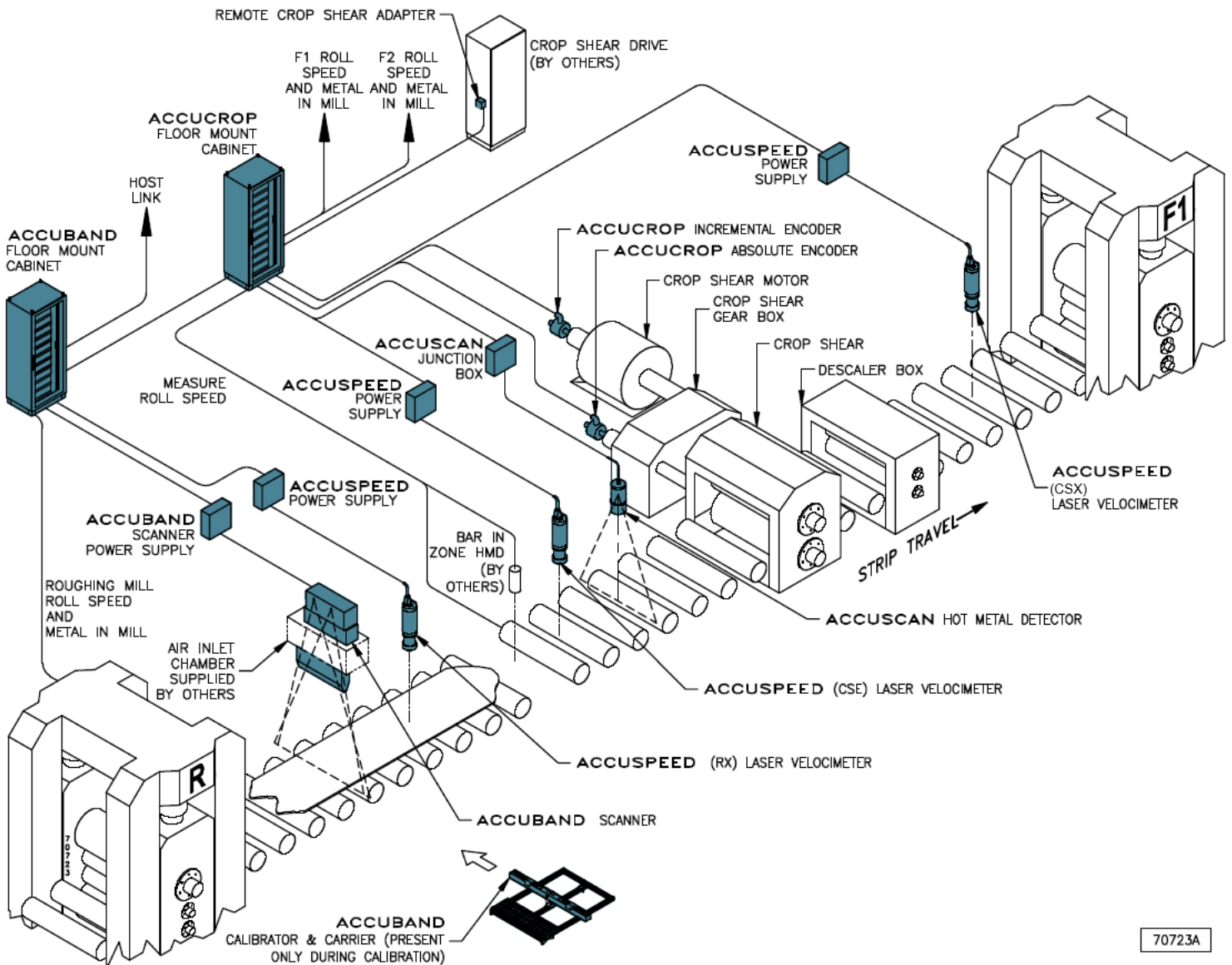


Figure 5 Rougher Exit Configuration

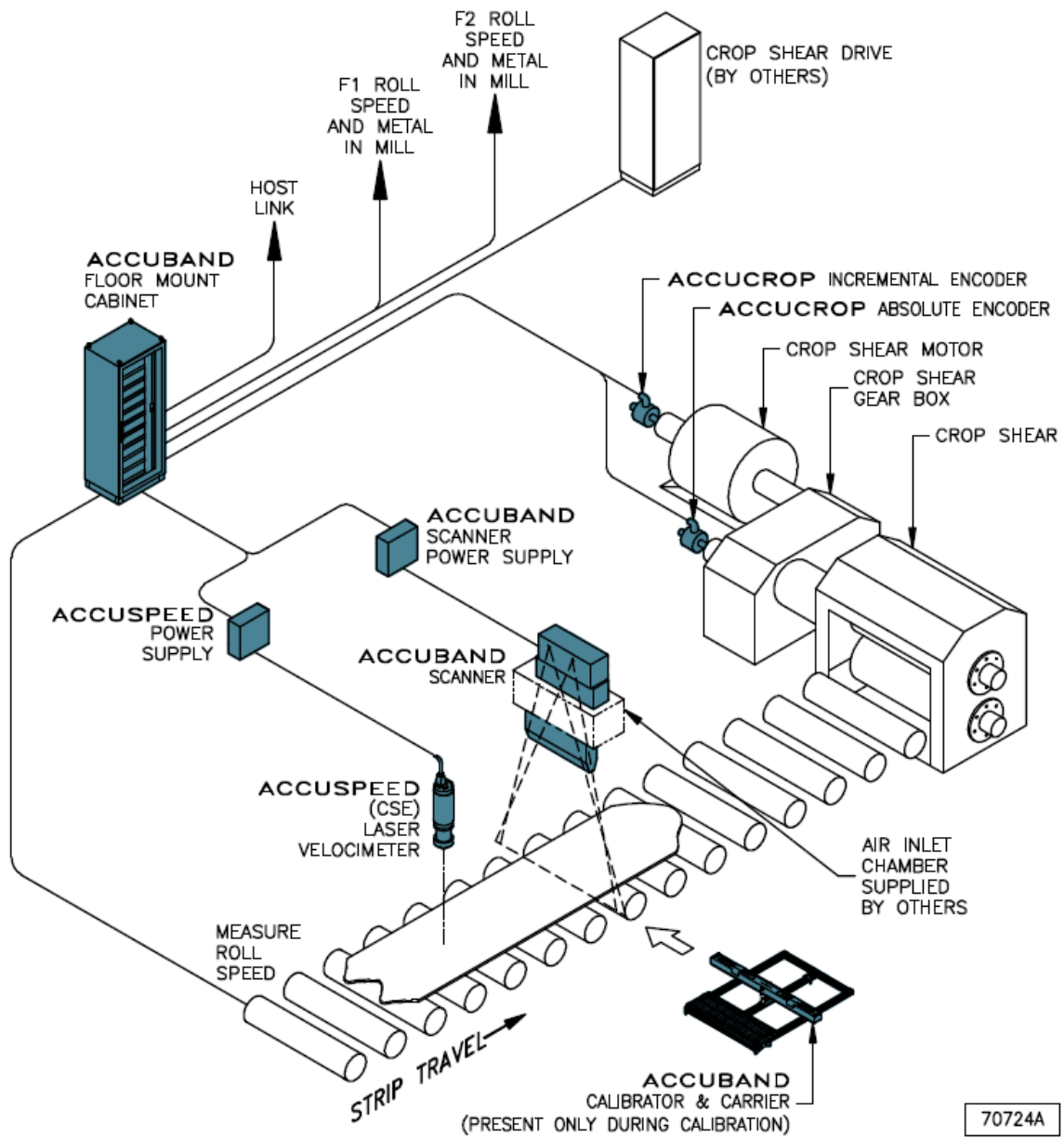


Figure 6 Crop Shear Entry Configuration

5. SCOPE OF SUPPLY

IMAGING SYSTEM

5.1 Standard Equipment

- **ACCUBAND** Width Gage System
- **ACCUSPEED** Laser Velocimeter System
- Discrete I/O kit for analog and digital I/O
- **ACCUBAND** Floor Mounted Cabinet
- Operator's PC (HMI) with KELK Instrumentation Panel (KIP)
- Network connections up to 100 m (328') via Cat5/6
- KELK host communications protocol, TS354

5.2 Optional Equipment

- Additional Operator's PC with KIP
- Maintenance PC with KIP
- KELK Database Software
- iba PDA Data Logger Software
- Media Convertors for Network connections longer than 100 m (328')
- Customization of host communications protocol

5.3 Recommended Spares

- **ACCUBAND** Width Gage System spares
- **ACCUSPEED** Laser Velocimeter System spares

5.4 Documentation

- Manuals
- Drawing package
- Installation checklist and commissioning documents
- Documentation provided in English and electronic format. Other languages may be available (consult KELK).

IMAGING AND TRACKING SYSTEM

5.5 Standard Equipment

- **ACCUBAND** Width Gage System
- **ACCUSPEED** Laser Velocimeter System(s)
- **ACCUSCAN** Hot Metal Detector System (Rougher Exit and Coil Box Entry Systems)
- Discrete I/O kit for analog and digital I/O

- **ACCUBAND** Floor Mounted Cabinet
- Operator's PC (HMI) with KELK Instrumentation Panel (KIP)
- Network connections up to 100 m (328') via Cat5/6
- KELK host communications protocol, TS354

5.6 Optional Equipment

- Additional Operator's PC with KIP
- Maintenance PC with KIP
- KELK Database Software
- iba PDA Data Logger Software
- Fiber Optic Media Convertors for communication connections longer than 100 m (328')
- Customization of host communications protocol

5.7 Recommended Spares

- **ACCUBAND** Width Gage System spares
- **ACCUSPEED** Laser Velocimeter System spares
- **ACCUSCAN** Hot Metal Detector System spares (Rougher Exit and Coil Box Entry Systems)

5.8 Documentation

- Manuals
- Drawing package
- Installation checklist and commissioning documents
- Documentation provided in English and electronic format. Other languages may be available (consult KELK).

CLOSED LOOP SYSTEM

5.9 Standard Equipment

- **ACCUBAND** Width Gage System
- **ACCUSPEED** Laser Velocimeter System(s)
- **ACCUSCAN** Hot Metal Detector System (Rougher Exit and Coil Box Entry Systems)
- Discrete I/O kit for analog and digital I/O
- **ACCUBAND** Floor Mounted Cabinet
- **ACCUCROP** Floor Mounted Cabinet with ACCUCROP Controller
 - Incremental Encoder
 - Absolute Encoder
 - Remote Crop Shear Adapter
 - Operator's Crop Control Panel

- Operator's PC (HMI) with KELK Instrumentation Panel (KIP)
- Maintenance PC with KIP & iba PDA Data Logger Software
- Network connections up to 100 m (328') via Cat5/6
- KELK host communications protocol, refer to TS354
- Drive Modification by customer, refer to TS511

5.10 Optional Equipment

- Additional Operator's PC with KIP
- Additional Maintenance PC with KIP
- KELK Database Software
- Fiber Optic Media Convertors for communication connections longer than 100 m (328')
- Customization of host communications protocol

5.11 Recommended Spares

As specified individual Description and Specifications of

- **ACCUBAND** Strip Width Gage
- **ACCUSPEED** Laser Velocimeter
- **ACCUSCAN** Hot Metal Detector

For **ACCUCROP** Controller

- Encoder, Incremental
- Encoder, Absolute
- Analog Output Module
- Encoder Interface Module
- Remote Crop Shear Adapter
- M-Module Carrier
- Power Supply, +/- 15V, 1A
- Power Supply for 3U CPCI, 200W
- CPU, CPCI, 3U, c/w flash card

5.12 Documentation

- Manuals
- Drawing package
- Installation checklist and commissioning documents
- Documentation provided in English and electronic format. Other languages may be available (consult KELK).

6. SYSTEM COMPONENTS

The main components of KELK Crop Optimization System are:

- **ACCUBAND** Width Gage System
- **ACCUSPEED** Laser Velocimeter System(s)
- **ACCUSCAN** Hot Metal Detector
- **ACCUCROP** Crop Shear Control

6.1 ACCUBAND Width Gage

The ACCUBAND system includes an optical width Gage used to measure the width of the material. The Imaging System utilizes width measurements from the ACCUBAND system, combined with velocity measurements from the ACCUSPEED system and generates crop image, shape classification, statistics and an optimized cut length for the head and tail ends of the bar. For further details of the ACCUBAND system, please refer to description and specifications document DS.ACB.854.1.

6.2 ACCUSPEED Laser Velocimeter

The ACCUSPEED system includes a laser Velocimeter used to measure the velocity of the material. Depending on the configuration selected (Rougher Exit or Crop Shear Entry) up to three ACCUSPEED systems may be used to provide accurate, reliable velocity measurements. For further details of the ACCUSPEED system, please refer to description and specifications document DS.ASPD.887.7

6.3 ACCUSCAN Hot Metal Detector

The ACCUSCAN system consists of a line scan hot metal detector used to initiate tracking, The ACCUSCAN system is not required for the Crop Shear Entry System. For further details of the ACCUSCAN system, please refer to description and specifications document DS.HMD.868.4

6.4 ACCUCROP Controller

The ACCUCROP controller provides accurate closed loop control of crop shear position and velocity while maintaining positive torque to the crop shear motor, thereby reducing wear on both the motor and gear box. The ACCUCROP has a loop time of 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 controller is compatible with single-bladed rotary shears, double-bladed rotary shears and crank shears.

6.5 Incremental and Absolute Encoders

The Incremental encoder provides the shear velocity feedback. It is installed on the shear motor shaft and has a robust design with a stainless steel housing. The incremental encoder produces 6000 pulses per revolution The output driver is an RS422 line driver with a quadrature type signal.

The Absolute encoder provides the shear position feedback. It is installed on the shear drum shaft and has a robust design with a stainless steel housing. The absolute encoder is a 13bit serial device with an RS422 line driver output. One revolution of the shaft covers a count range of 0 to 8191.

6.6 Remote Crop Shear Adapter

The Remote Crop Shear Adapter, RCA, is a small electronic module installed in the shear drive control cabinet. The RCA receives the differential analog control signal from the ACCUCROP Controller and converts it to a single-ended analog signal. The analog output of the RCA is the torque reference which is fed to the crop shear drive current regulator input.

6.7 Operator's Crop Control Panel

The Operator's Crop Control Panel provides two physical switches and two physical push buttons.

- System Selector Switch: Customer / KELK
- Mode Selector Switch: Auto / Manual
- Immediate Cut push button
- Continuous Cut push button

6.8 Operator's PC and Maintenance PC

The Operator's PC is supplied with KELK Instrumentation Panel (KIP). The Maintenance PC is supplied with KIP, ibaPDA data logger and optional KELK Database. The KIP is user configurable.

6.9 KELK Database

The KELK Database supports logging of setup, measurement and event data. Statistics such as crop shapes and yield is provided. The database may be accessed by KELK software or customer's software for query and display. ODBC/JDBC compliant.

6.10 Data Logger

The ibaPDA data logger is accompanied with one license key and allows for 256 signals to be recorded and stored. Additional software packages and license keys are required to accommodate more than 256 signals.

6.11 Communication Protocol

The following level 2 communication protocols are available: Ethernet TCP/IP, EGD or Modbus TCP. Typical communication protocols include setup, real time process information, real time measurements and time synchronization messages.

6.12 Crop Shear Drive Modification

ACCUCROP is a self-contained close loop controller. The control output is an analog torque reference. The details of the Crop Shear drive modification are included in KELK TS511. This drive modification is provided by the customer.

7. WHAT USERS MUST PROVIDE

As specified individual Description and Specifications of

- ACCUBAND Strip Width Gage
- ACCUSPEED Laser Velocimeter
- ACCUSCAN Hot Metal Detector

Refer to the below table for ACCUCROP Controller

Installation	Mechanical	<ul style="list-style-type: none"> • Installation of ACCUCROP Floor Mounted Cabinet • Mounting of Incremental and Absolute Encoders • Mounting of Remote Crop Shear Adaptor inside crop shear drive control cabinet • Mounting of Operator's Crop Control Panel • Mounting of Operator's PC and Maintenance PC
	Electrical	<ul style="list-style-type: none"> • Power to the ACCUCROP Floor Mounted Cabinet • Installation of Network and Interconnecting Cables • Power to all Operator's PCs and Maintenance PCs • Implementation of Host Communication Protocol • Crop Shear Drive Modification, TS511

8. SPECIFICATIONS

Performance¹	Crop Line Determination	± 5 mm (0.2") at 2 sigma
	Tracking Accuracy	± 10 mm (0.39") at 2 sigma
	Cut Accuracy	± 15 mm (0.59") at 2 sigma
	ACCUCROP Controller Loop Time	4 milliseconds
Measurement Range¹	Material Width	As specified in ACCUBAND and ACCUSCAN Description and Specifications
	Material Edge Temperature	As specified in ACCUBAND and ACCUSCAN Description and Specifications
	Vertical Strip Movement	As specified in ACCUBAND and ACCUSCAN Description and Specifications
	Imaging Velocity	Up to 5 m/s (984 fpm)
	Tracking Distance	Up to 4 m (13.1')
	Cropping Velocity	Up to 1.5 m/s (294 fpm)
Communication	Mill Computer Interface	Physical layer: Cat5e, Fiber Optic Link layer: Ethernet Network layer: MODBUS/TCP

¹ For installations that fall outside of these values, consult KELK.



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