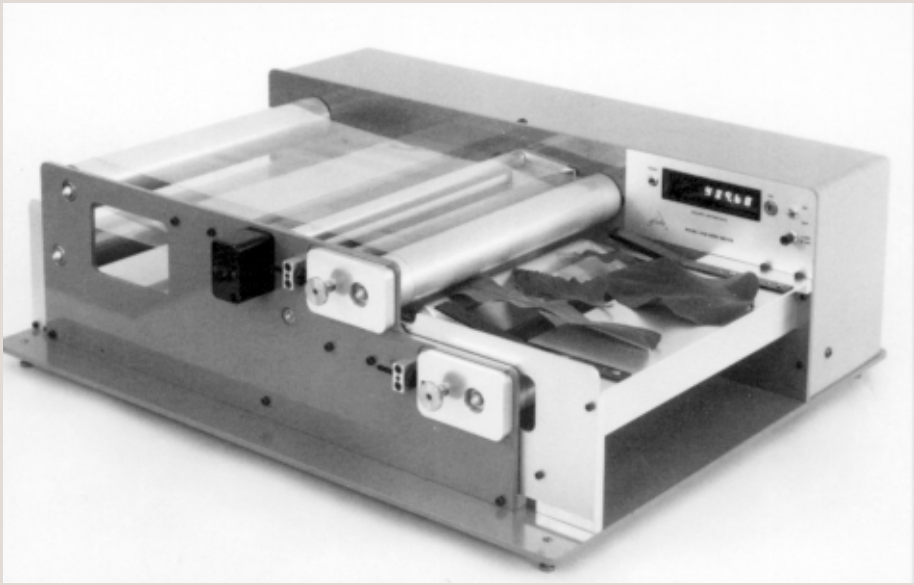
LI-3100 Area Meter

Instruction Manual



LI-COR

LI-3100 Area Meter
Instruction Manual

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Section I
General Information

1.1 Instrument Function

The LI-3100 Area Meter is designed for biological or industrial applications requiring rapid, precise projected area measurements. Samples are placed between the guides on the lower transparent belt and allowed to pass through the instrument. As items travel under the 15 watt fluorescent light source, the image is reflected by a system of three mirrors to a solid state scanning camera within the rear housing.

Object width is sensed by the scanning camera. Length information is provided by the current frequency as related to the belt velocity.

Area integration is accomplished by components of the main printed circuit board mounted on the instrument rear plate (Figure 1).

Data is presented on the light emitting diode (LED) display. Decimal location on the display is changed to suit the 1.0 or 0.1 mm^2 resolution requirement (Section IV). Alternately data can be collected, displayed, and stored using the LI-3000A console (Section VII).

1.2 Operational Features

An instrument with interchangeable 1.0 mm^2 and 0.1 mm^2 resolution capability is furnished with a 25 mm and 8.5 mm lens. A 25 cm wide sample guide is provided for the 1.0 mm^2 resolution configuration. The 7.5 cm wide sample guide is associated with the 0.1 mm^2 resolution capability.

The upper belt assembly can be removed for operations hindered by the upper belt. Sample thickness can then be increased to 2.5 cm (Section VI.)

Section II
Preoperation Procedure

The following procedures must be performed before using the LI-3100 for the first time.

- Tighten the transparent belts
- Install the 15 watt fluorescent tube.
- Install the camera lens.
- Set the voltage selector at the proper position and check to see if the correct fuse is installed.

Each of these procedures is discussed below.

2.1 Rear Housing Removal

The rear housing must be removed in order to adjust the belt tension and to install the fluorescent tube. Using the 5/32" (4 mm) hexagonal key provided, remove the four retaining screws (one at each end, one at the center front edge on top, and one at the center bottom edge at the rear). Lift the housing from the instrument.

2.2 Transparent Belt Tension Adjustment

Perform the following steps to tighten the transparent belts.

- Loosen the large knurled knobs located on each sliding pulley bearing block. Rear sliding bearing blocks are visible in Figure 1. Front sliding bearing blocks are visible in Figure 2.

- Coarse adjustment is performed by simultaneously sliding both bearing blocks for one pulley. The knurled knobs can be tightened sufficiently

by rotating them with the thumb and index finger while holding tension on the bearing block with the remaining fingers of the same hand.

Fine adjustments are performed by twisting the block adjustment screw to push the sliding bearing block. The knurled knobs located on the pulley bearing blocks must be loosened to allow block movement.

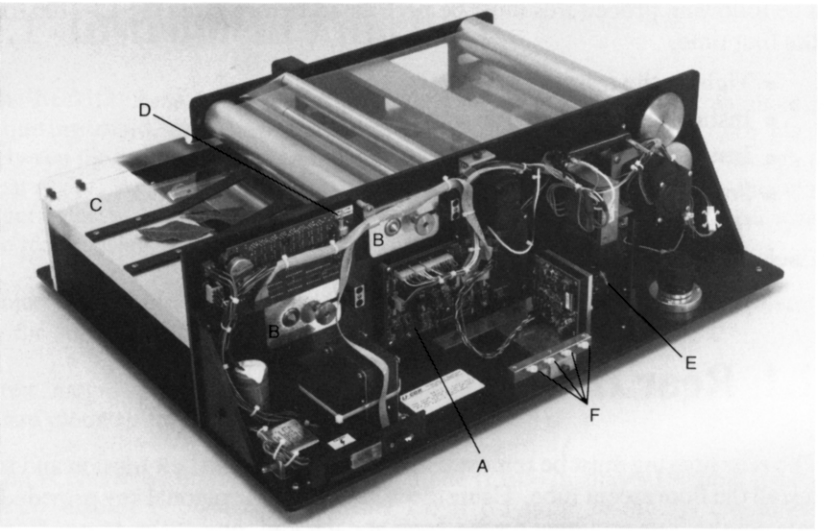

Figure 1. Area Meter with Rear Housing Removed. (A) Main printed circuit board, (B) rear sliding bearing blocks, (C) sample guides (7.5 cm) for 0.1 mm^2 resolution, (D) decimal selector switch in the 1.0 mm^2 operation, (E) 25 mm lens in place for 0.1 mm^2 operation, (F) screws on the outer camera pressure rail.

2.3 Fluorescent Tube Installation

- Remove the rear tube connector housing by loosening the two recessed mounting screws (Figure 3).

- Hold the tube vertically and gently tap it to cause any internal debris to collect at one end. Internal debris can cause spurious counting.

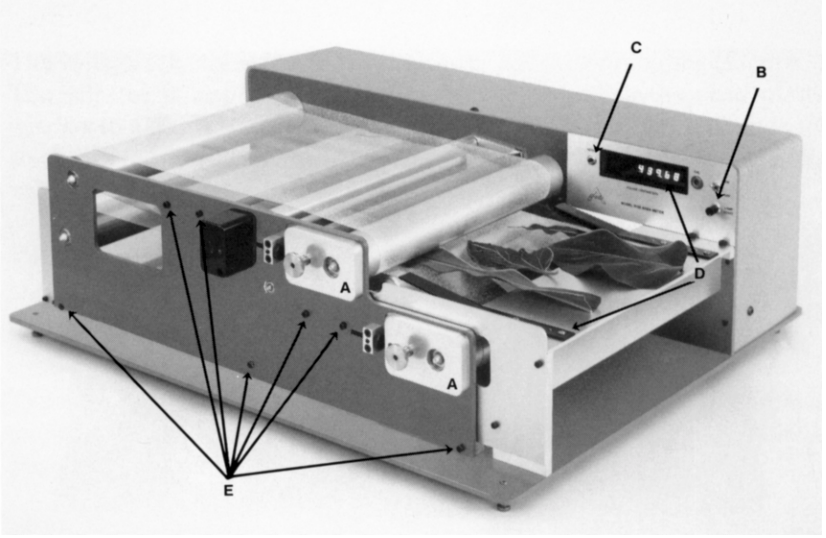

Figure 2. Area Meter in 1.0 mm^2 Resolution Configuration. (A) Sliding bearing blocks, (B) "Lamp Start" switch, (C) "Reset" button, (D) display decimal and sample guides in the 1.0 mm^2 configuration, (E) screws to be removed in order to detach the front panel.

- Slide the tube into the exposed hole in the instrument rear plate. As the tube is pressed into the front connector, the pins should be vertically arranged as shown in Figure 3. Do not twist the tube at this time.

- Mount the rear connector housing over the exposed tube end.

- Gently twist the tube into the connector by grasping the tube at each edge of the upper belt. The rotation should be 1/4 turn.

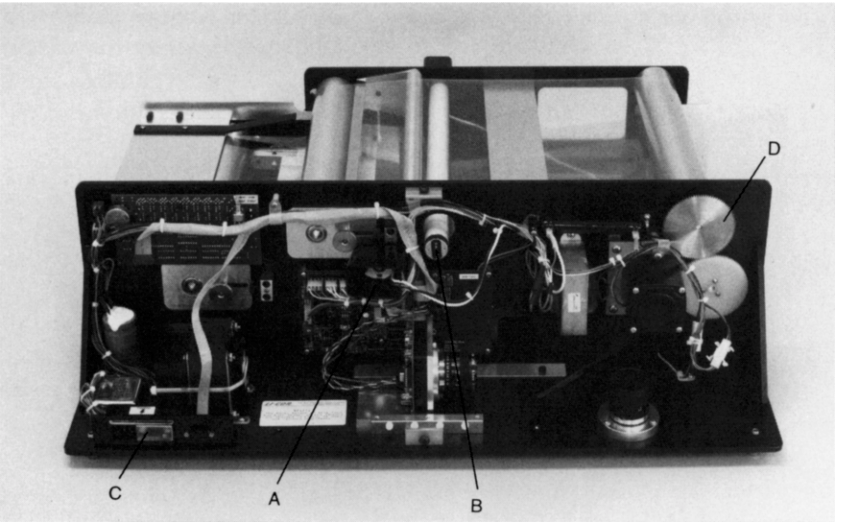

Figure 3. Area meter with fluorescent tube connector housing removed. (A) Fluorescent tube connector housing. (B) Fluorescent tube with pins in vertical position. The tube is twisted 1/4 turn for proper connection after the tube connection housing is installed. (C) Slide this window to the left to inspect the voltage selector. (D) Upper drive pulley gear.

2.4 Camera Lens Installation

- Remove the masking tape from the camera lens ring. Do not remove the black light shield tape adjoining the camera circuit board.
- Loosen the outer camera pressure rail screws (Figure 1).
- Install the lens appropriate to the resolution required. See Section IV and Figures 2 and 6.

2.5 Voltage Selector Operation and Characteristics

The voltage selector is located in the power connector molding (Figure 3). The selector is inspected for proper voltage by sliding the clear plastic window to a position over the power connector. The visible number on the small printed circuit board located under the fuse indicates the selected voltage as follows:
either 100 or 120 V for 105-126 VAC operation
either 220 or 240 V for 210-252 VAC operation

Notice that the visible number is not the actual operating voltage. The instrument will not function on 100 VAC.

The voltage selector is changed by sliding the circuit board outward from its mount and repositioning it so that a different number is visible as appropriate to the available voltage.

The frequency usually changes from 60 to 50 Hz when the voltage is shifted from 120 to 240 VAC. This will change the instrument calibration approximately 0.5%. An instrument calibration should be performed after changing the voltage (Section 3.4).

At locations with fluctuating main current frequency, calibration should be checked often during operation.

The proper fuse selection is:
105-126 V use 1 amp fuse
210-252 V use 1/2 amp fuse

Section III
Operating Instructions

3.1 Instrument Activation

After reading and performing the procedures of Section II, the following steps should be taken to activate the instrument.

Connect the supplied power cord to the power input connector at the rear of the instrument. A grounded three prong wall connector is required for electrical service.
Move the "ON/OFF" switch to "ON".
Press the "Lamp Start" button (Figure 2) firmly and release after holding for approximately 2 seconds. If the fluorescent tube does not illuminate, repeat the procedure.
Press the reset button to clear the display (Figure 2).

3.2 Display Response

The display will rapidly accumulate numbers when the "ON/OFF" switch is placed in the "ON" position. This accumulation will continue until the fluorescent tube is activated. If numbers continue to accumulate, then the calibration screw should be adjusted counterclockwise until the displayed numbers remain constant. Accurate or larger than actual calibration disk measurements are normal at this calibration screw adjustment. Data accumulation may continue to occur if the fluorescent tube output is not sufficient such as initial starting in extremely cold conditions. Excessively low line voltage is also a cause for continued rapid spurious counting. See Section IX.

3.3 Belt Tension and Tracking Adjustment

Belt tracking is adjusted by moving the sliding pulley bearing blocks (Figures 1 and 2). The belts likely will not maintain alignment without some adjustment. If a belt progresses toward one end of a pulley, then tighten that side of the belt. Fine adjustments are performed by twisting the block adjustment screw to push the sliding bearing block. The knurled knobs located on the pulley bearing blocks must be loosened to allow block movement.

3.4 Calibration

Calibration is performed by placing the appropriate calibration disk (50 cm^2 for 1.0 mm^2 resolution, or 10 cm^2 for 0.1 mm^2 resolution) between the sample guides on the sample tray. Reset the display and slide the disk onto the lower transparent belt and allow the disk to travel through the instrument. Turn the "Cal" screw clockwise to increase the displayed sample area. If the displayed area is too large, adjust the "CAL" screw counterclockwise. When the proper calibration has been achieved, subsequent measurements of the calibration disk should result in an error less than the accuracy stated in the specifications.

A warming period of 1-3 minutes may produce a calibration change of approximately 1% from that obtained at the initial starting. This is a fluorescent tube output response. To avoid this error, the calibration should be performed a few minutes after tube illumination.

3.5 Pressing Roller Adjustment

Curled leaves are effectively flattened and held rigidly between the transparent belts for more accurate measurements by use of the adjustable pressing roller. This is nearly essential for small grasses, legumes and aquatic plants.

In Figure 4, the front panel is removed to show mechanical details. The retracted position is for use with thick leaves. The fully raised position for use with the thinnest leaf types is shown in Figure 5.

To raise the pressing roller, the lower belt tension must be released to prevent stretching. To do this, simply loosen the knurled knobs on both sides of the sliding bearing blocks for the lower belt (Figures 1 and 2). Then loosen the knurled knobs on both sides of the pressing roller and raise to the desired position. After tightening the pressing roller, refer to Section 3.3 to adjust the lower belt to its proper tension and alignment.

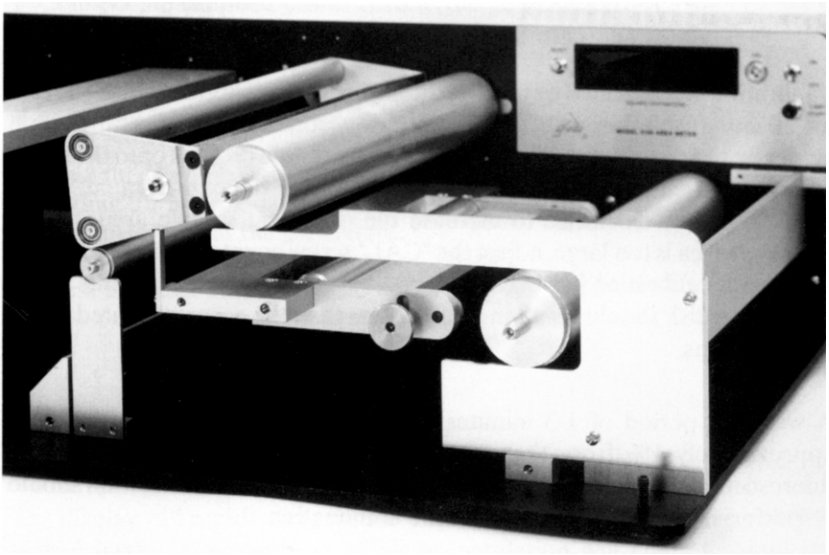

Figure 4. Adjustable press roller in the retracted position.

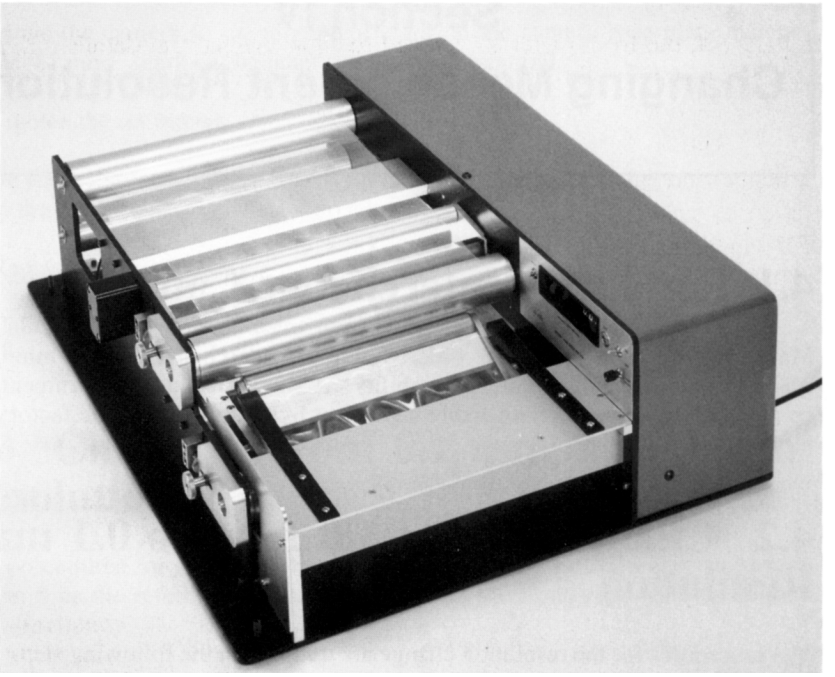

Figure 5. Press roller in position for use with thin leaves.

Section IV
Changing Measurement Resolution

4.1 Resolution Interchange Capability

Many LI-3100 Area Meters are ordered with the interchangeable 1.0 mm^2 and 0.1 mm^2 area sensing resolution capability. A single resolution instrument can be converted to the interchangeable capability by returning it to the factory for modification.

4.2 Changing from 1.0 mm^2 to 0.1 mm^2 Resolution

The procedures for the resolution change are outlined in the following steps with Figure 1 as a reference.

- Disconnect the power.
- The sample tray with 25 cm spaced sample guides is used for 1.0 mm^2 measurement. Remove this tray by unfastening the four retaining screws (two located at each end of the tray). Install the tray which has 7.5 cm sample guides.
- Remove the rear housing by removing the four retaining screws.
- Move the decimal selector switch to the 0.1 mm^2 position (labeled near the switch). This switch is located at the top right corner (as viewed from the rear of the display circuit board.
- Loosen all four set screws on the outer camera pressure rail.

- Remove the 8.5 mm lens from the lens mounting ring (unscrew it, this is not a bayonet type lens). Install the 25 mm lens. No lens adjustment is possible. The lenses are permanently fixed at the proper settings.
- Move the camera so the alignment mark on the camera base plate matches the 0.1 mm^2 mark on the inner camera alignment rail.
- Tighten the set screws.
- Be sure that the lens cover has been removed and that no other obstruction is in the optical path.
- Replace the rear housing.
- Calibrate the instrument using the 10 cm^2 calibration disk.

4.3 Changing from 0.1 mm^2 to 1.0 mm^2 Resolution

The procedures for resolution change are outlined in the following steps with Figure 6 as the reference. Figure 2 illustrates the front view in the 1.0 mm^2 configuration.

- Disconnect the power.
- Remove the sample tray which has the sample guides set at 7.5 cm width.
- Install the tray which has the 25 cm sample guide spacing.
- Remove the rear housing.
- Move the decimal selector switch to the 1.0 mm^2 position.
- Loosen all four set screws on the outer camera pressure rail.
- Remove the 25 mm lens and install the 8.5 mm lens.
- Move the camera so the alignment mark on the camera base plate matches the 1.0 mm^2 mark on the inner camera alignment rail.

- Tighten the set screws.
- Be sure the lens cover has been removed and that no other obstruction is in the optical path.
- Replace the rear housing.
- Calibrate the instrument using the 50 cm^2 calibration disk.

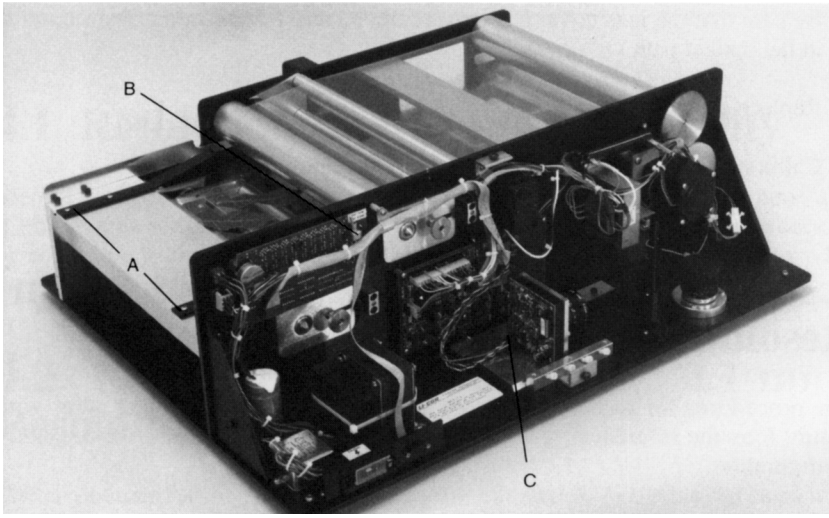

Figure 6. LI-3100 configured for 1.0 mm^2 operation. (A) Sample guides 25 cm wide, (B) Decimal selector switch at the 1.0 mm^2 position, (C) Camera position with 8.5 mm lens.

Section V
Maintenance

5.1 Changing the Fluorescent Tube

- Grasp the tube near each end by the edges of the upper transparent belt. Twist the tube 1/4 revolution to loosen it in the connectors.
- Remove the rear tube connector by loosening the two recessed mounting screws (Figure 3).
- Draw the tube out through the hole in the instrument rear plate.
- Install the replacement tube as described in Section 2.4.

5.2 Changing the Transparent Belts

5.2.1 Removing the Belts

The following steps are used to remove the transparent belts. An alternate technique is outlined below.

- Disconnect the power.
- Remove the rear housing (Section 2.2).
- Loosen the transparent belts (Section 2.3).
- Remove the fluorescent tube (Section 5.1).
- Separate the fluorescent tube power cord connector located near the instrument front plate and under the belt drive pulleys. This connector may remain mated if the front plate can rest near the instrument without straining the cord (Figure 7).

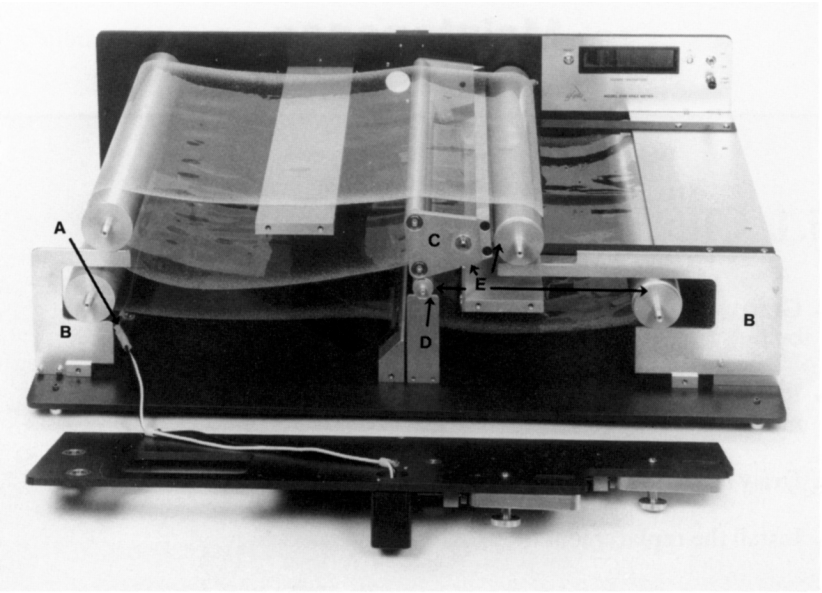

Figure 7. LI-3100 with front plate removed. (A) Fluorescent tube power connector, (B) pulley support brackets, (C) upper belt rocking idler, (D) lower belt idler, (E) proper location of pulley peripheral end grooves, lower belt idler peripheral end groove, and the end plate notch.

- Remove the hexagonal socket screws (7 total) which are directly contacting the instrument plate (Figure 2). Other similar screws are visible on the front of the instrument which fasten the pulley support brackets (Figure 7). Do not loosen those screws.

- Remove the front plate slowly. Be certain that all pulleys and idlers remain in place, resting on the support brackets. This is accomplished by repeatedly pressing the pulleys and idlers back into their rear plate bearings.

Caution: Do not allow the upper belt rocking idler or the lower belt idler to drop onto the mirror located directly beneath these components.

- Draw the upper belt rocking idler and the lower idler outward to remove them.

- Slide the belts outward to remove them (Figure 8).

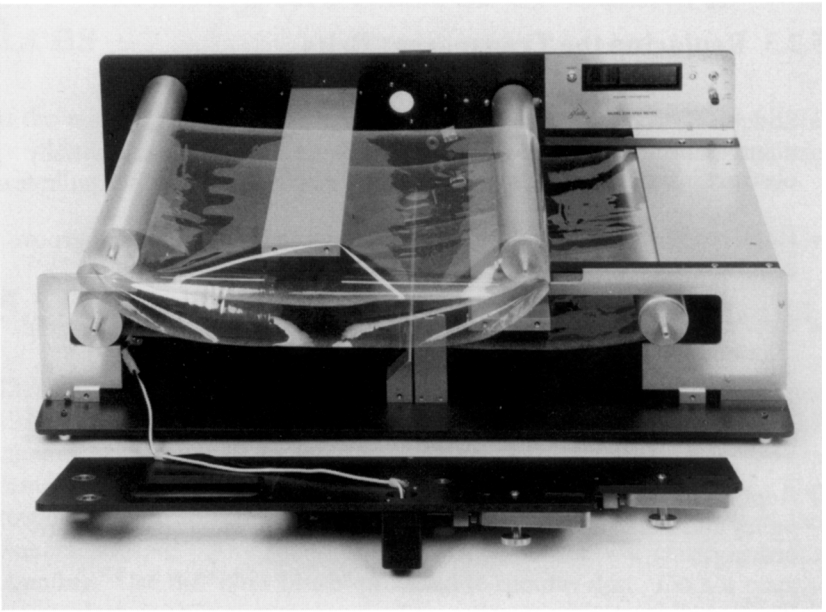

Figure 8. Upper belt rocking idler and lower belt idler removed. To remove the belts, draw them outward.

Caution: Do not exert excessive upward pressure on the drive pulleys as the belts are removed. This will bent the gear shaft which extends through the rear plate bearing.

5.2.2 Alternate Belt Removal Technique

Follow steps in Section 5.2.1 and then proceed with the following two steps.

- After the upper belt rocking idler and lower belt idler are removed, then the upper and lower pulleys near the sample tray can be removed (do not remove the drive pulleys). Grasp each pulley near each end when they are being removed because they are heavy. Dropping one end may cause severe damage.

- After the belts are placed over the drive pulleys, slide the upper and lower pulleys through the belts and insert the pulley shaft into the rear plate bearing. Be sure that the peripheral end groove is toward the front and that it rests in the pulley support bracket (Figures 7 and 8).

5.2.3 Replacing the Transparent Belts

- Slide the lower belt onto the pulleys. This requires repeated manipulation at the support brackets because these brackets partially obstruct installation. Then slide the upper belt onto the upper pulleys.

- Replace the lower belt idler. Be certain that the peripheral end groove is toward the front and rests on the idler support bracket (Figure 7).

- Replace the upper belt rocking idler. Be certain that the notch on the idler end plate rests on the rocking idler support post (Figure 7).

- Connect the fluorescent tube power connector if it was separated when the belts were removed.

- Replace the front plate. This requires repeated manipulation at the pulley and idler shafts to insure proper alignment into the front plate bearings.

- Replace all front plate screws.

- Install the fluorescent tube (Section 2.4).

- Tighten the transparent belts (Section 2.3).

5.3 Cleaning the Transparent Belts

Clean the belts with water and a cloth or absorbent paper. A detergent may be used for persistent contamination but do not allow detergent to fall on the mirrors. Any scrubbing of the mirrors to remove detergent spots may damage the mirror surface. Access to the lower belt is facilitated by momentarily activating the "ON/OFF" switch to rotate the belt so that you can clean the portion of the belt that is near the sample tray. The inner surfaces are cleaned by reaching into the access ports in the front plate. Loosen the belts to facilitate cleaning the pulley surfaces.

5.4 Cleaning the Mirror or Camera Lens

If the mirror or the camera lens have to be cleaned, use the "blow brush" provided with the instrument. If persistent dirt remains on the mirror, use water and a soft absorbent paper such as lens paper.

5.5 Cleaning the Interior of the Camera

Cleaning within the camera is not a frequent requirement. Remove the lens. Loosen the screws on the outer camera pressure plate (Figure 1) and lift the camera from the rails to more easily inspect the interior. The camera remains connected so do not apply tension to the connection.

The rectangular sensitive device (Reticon) is visible at the interior rear of the camera housing. Any speck of dirt on this sensor will cause spurious counting. Use the "blow brush" provided to remove dust. Do not place a moist cloth within the camera. The adhesive dust retaining surface surrounding the Reticon and printed circuit board would be damaged.

Section VI
Removing the Upper Belt Assembly

6.1 Purpose

Some sampling requirements are better served by single belt operation. Under some conditions, the upper belt pressure may damage samples, or the upper belt rocking idler may cause undesirable mechanical pressure. Removing the upper belt pulley, drive pulley, and rocking idler will provide a more obstruction-free path through the sensitive area. The fluorescent tube must remain in place so sample thickness is limited to 2.5 cm (increased from 1.9 cm with upper belt assembly intact).

6.2 Removal Procedure

- Disconnect the power.
- Remove the rear housing (Section 2.2).
- Loosen the transparent belts (Section 2.3).
- Remove the fluorescent tube (Section 5.1).
- Separate the fluorescent tube power cord connector located near the instrument front plate and under the belt drive pulleys. This connector may remain mated if the front plate can rest near the instrument without straining the cord (Figure 7).
- Remove the hexagonal socket screws (7 total) which are directly contacting the instrument plate (Figure 2). Other similar screws are visible on the front of the instrument which fasten the pulley support brackets (Figure 7). Do not loosen those screws.

- Remove the front plate slowly. Be certain that all pulleys and idlers remain in place, resting on the support brackets (Figure 7). This is accomplished by repeatedly pressing the pulleys and idlers back into their rear plate bearings.

Caution: Do not allow the upper belt rocking idler or the lower belt idler to drop onto the mirror located directly beneath these components.

- Remove the upper belt rocking idler.

- Remove the upper pulley.

- Remove the upper belt.

- Remove the upper drive pulley gear (Figure 3). A 7/64" (.278 cm) hexagonal key is required for the socket set screw. This key is not provided with the instrument. Then remove the upper pulley.

- Replace the front plate, connect the fluorescent tube power connector and replace the fluorescent tube.

Section VII
Using the LI-3000A Readout

7.1 General Information

The readout console of the LI-3000A Portable Area Meter can be purchased as a separate item (part number 3000A-01) and interfaced to the LI-3100 using the 3000A-03 Interface Cable. The 3000A-01 provides the following features when used with the LI-3100:

- Displays the individual area, accumulated area, leaf length, average width, and maximum width.
- Readings can be summed in a secondary summing register at the user's command. Also, the previous reading added to the register can be subtracted from it.
- Readings can be stored in the console memory (32K bytes RAM) using a file system. Files can be viewed on the console or output to a computer or printer (RS-232C interface).
- Alphanumeric remarks (e.g., leaf#, leaf type, treatment, etc.) can be stored along with the data.

NOTE: LI-3100's with serial numbers PAM 653 and above can be interfaced to the 3000A-01 directly. For instruments with serial numbers PAM652 and below, contact LI-COR.

Instructions for operating the 3000A-01 with the LI-3100 are given in the LI-3000A instruction manual.

Section VIII
Malfunction Detection

The sections below define several potential problems and lists several possible causes and their solutions.

8.1 Continuous Spurious Data Accumulation

- Lens cover has not been removed from the camera. Remove lens cover.
- Camera is at the wrong location. Check the actual camera position against Sections 4.2 and 4.3.
- Fluorescent tube not illuminated. Press "lamp start" switch and hold for 2 or more seconds.
- Fluorescent tube is cold. Wait until it warms up.
- Low line voltage. Check it and provide proper voltage to the instrument.
- Calibration screw adjusted excessively sensitive. Turn the screw counterclockwise until the displayed numbers remain constant.
- Belts are excessively dirty. Clean belts (Section 5.3).
- Mirror, camera, or detector (reticon) need cleaning. Clean according to Sections 5.4, 5.5.
- Obstruction in the optical pathway. Inspect the pathway and remove the obstruction.
- Possible debris within the fluorescent tube. Remove the tube and perform the procedure in Section 2.4, step #2.

8.2 Belts not Tracking Properly

If a transparent belt travels to one side of the pulley during operation, then the sliding pulley bearing blocks must be adjusted. Tighten the side toward which the belt is moving.

8.3 Fluorescent Tube Fails to Illuminate

- Not properly twisted into the connector. Twist into the connector (Section 2.4).
- Front tube power connector is not mated. Mate the connector (Figure 7).

8.4 Excessive Data Variability

- Improper camera location. Check Sections 4.2 and 4.3 against the actual camera position.
- Intermittent obstruction causes spurious counting. See section 8.1.
- Portions of the sample protrude beyond the sensitive zone as defined by the sample guides. Be sure that samples remain within the sensitive zone.
- Static electricity may be causing movement of dry samples. Wipe the belts with a damp cloth. Enclose the samples in a transparent sheath.
- Samples are not pressed adequately by the upper belt. Enclose samples in a transparent sheath. See Section 3.5.
- Low ambient temperature. Readings should stabilize within 1-2 minutes of instrument activation.
- The lens must be rotated to the entire extent of the screw threads. Attempt further rotation to insure proper mounting.
- A loose lower belt may not support the sample at the correct position. Check to see that the lower belt contacts the lower idler but does not sag on both sides of the idler.

- If the instrument is operated with the rear cover removed, an intense stray light beam may focus on the reticon sensor. In order for this to occur, an unlikely series of reflections must occur after light enters through some location on the camera housing.

- Decimal switch is in the wrong position. See Sections 4.2 and 4.3.

8.5 Miscellaneous Malfunctions

Various types of problems occur if any of the connectors throughout the instrument loose contact. Inspect the connectors and press them together for better contact if necessary. Avoid reverse installation of connectors. Pin #1 is marked for installation into socket #1 of each connector.

8.6 Laboratory Conditions

Do not allow exposure to corrosive vapor. Many laboratory procedures cause excessive corrosive vapor concentrations as indicated by corroded connectors and other visible parts on many instruments in such laboratories. Malfunction due to such corrosion is not covered by warranty.

LI-3100 Specifications

Resolution
LI-3100/1+.1: 1 mm^2 or 0.1 mm^2 (interchangeable).
LI-3100/1: 1 mm^2
Scanning Area
1 mm^2 Resolution: 1 mm × 1 mm.
0.1 mm^2 Resolution: 0.300 mm L × 0.33 mm W.
Accuracy
Sample Area

Resolution	10 cm^2	5 cm^2	1 cm^2	0.5 cm^2	0.25 cm^2
1 mm^2	+ 1%	+ 2%	+ 5%	+ 7%	--
0.1 mm^2	+ 0.5%	+ 1%	+ 1%	+ 1.5%	+ 4%

Precision was determined at the 99% level with irregular-shaped complex objects. Most applications will result in less error.
Display Capacity
1 mm^2 Resolution: 999,999.99 cm^2
0.1 mm^2 Resolution: 99,999.999 cm^2
Display: Full 8-digit LED (light emitting diode).
Sample Dimensions
Width: 1 mm^2 Resolution: 25.4 cm maximum; 1.5 to 3 mm minimum.
0.1 mm^2 Resolution: 7.5 cm maximum; 0.5 to 1.5 mm minimum.
Thickness: Up to 2 cm, expandable to 2.5 cm by the user.
Length: Unlimited.
Conveyer Belt Speed: 8.0 cm s^{-1} at 60 Hz; 6.7 cm s^{-1} at 50 Hz.
Transparent Belts: Rugged clear vinyl.
Light Source: 15 watt fluorescent tube.
Power Requirement: 108-126/216-252 VAC, 48 to 66 Hz, 100 watt max.
Operating Temperature: +15 to 55 °C.
Storage Temperature: -20 to 65 °C.
Size: 25.0 H × 60.0 W × 73.0 cm L (9.8" × 323.6 × 28.7")
Weight: 43 kg (95 lb.).

Warranty

Each LI-COR, inc. instrument is warranted by LI-COR, inc. to be free from defects in material and workmanship; however, LI-COR, inc.'s sole obligation under this warranty shall be to repair or replace any part of the instrument which LI-COR, inc.'s examination discloses to have been defective in material or workmanship without charge and only under the following conditions, which are:

1. The defects are called to the attention of LI-COR, inc. in Lincoln, Nebraska, in writing within one year after the shipping date of the instrument.
2. The instrument has not been maintained, repaired or altered by anyone who was not approved by LI-COR, inc.
3. The instrument was used in the normal, proper and ordinary manner and has not been abused, altered, misused, neglected, involved in an accident or damaged by act of God or other casualty.
4. The purchaser, whether it is a DISTRIBUTOR or direct customer of LI-COR or a DISTRIBUTOR'S customer, packs and ships or delivers the instrument to LI-COR, inc. at LI-COR inc.'s factory in Lincoln, Nebraska, U.S.A. within 30 days after LI-COR, inc. has received written notice of the defect. Unless other arrangements have been made in writing, transportation to LI-COR, inc. (by air unless otherwise authorized by LI-COR, inc.) is at customer expense.
5. No-charge repair parts may be sent at LI-COR, inc.'s sole discretion to the purchaser for installation by purchaser.
6. LI-COR, inc.'s liability is limited to repair or replace any part of the instrument without charge if LI-COR, inc.'s examination disclosed that part to have been defective in material or workmanship.

There are no warranties, express or implied, including but not limited to any implied warranty of merchantability of fitness for a particular purpose on underwater cables or on expendables such as batteries and lamps.

Other than the obligation of LI-COR, inc. expressly set forth herein, LI-COR, inc. disclaims all warranties of merchantability or fitness for a particular purpose. The foregoing constitutes LI-COR, inc.'s sole obligation and liability with respect to damages resulting from the use or performance of the instrument and in no event shall LI-COR, inc. or its representatives be liable for damages

beyond the price paid for the instrument, or for direct, incidental or consequential damages.

The laws of some locations may not allow the exclusion or limitation on implied warranties or on incidental or consequential damages, so the limitations herein may not apply directly. This warranty gives you specific legal rights, and you may already have other rights which vary from state to state. All warranties that apply, whether included by this contract or by law, are limited to the time period of this warranty which is a twelve-month period commencing from the date the instrument is shipped to a user who is a customer or eighteen months from the date of shipment to LI-COR, inc.'s authorized distributor, whichever is earlier.

This warranty supersedes all warranties for products purchased prior to June 1, 1984, unless this warranty is later superseded.

DISTRIBUTOR or the DISTRIBUTOR's customers may ship the instruments directly to LI-COR if they are unable to repair the instrument themselves even though the DISTRIBUTOR has been approved for making such repairs and has agreed with the customer to make such repairs as covered by this limited warranty.

Further information concerning this warranty may be obtained by writing or telephoning Warranty manager at LI-COR, inc.

IMPORTANT: Please return the User Registration Card enclosed with your shipment so that we have an accurate record of your address. Thank you.

LI-COR®

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