
LI-3000A Portable Area Meter

LI-3050A Belt Conveyor

**Instruction
Manual**

LI-COR®

LI-3000A Portable Area Meter

**LI-3050A Transparent Belt
Conveyer**

Instruction Manual

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How to Use This Manual

This manual contains the operation instructions for both the LI-3000A Portable Area Meter and the LI-3050A Transparent Belt Conveyer Accessory. If you purchased an LI-3000A but not an LI-3050A, you may wish to skip Section VI which contains information on the LI-3050A.

If you already own an LI-3000A and have purchased only an LI-3050A, you will want to skip directly to Section VI which has the LI-3050A operation instructions.

If you want to operate the LI-3000A console with an LI-3100 Area Meter you will want to read Section IV to learn how to connect the LI-3000A to the LI-3100 and then read Section III for instrument operation instructions.

If you have purchased the 3000A-01 Readout Console to upgrade an older LI-3000A Portable Area Meter, you will want to read Sections II and III. If your sensor head has not been calibrated to your console you should also read the sensor head calibration information in Section V.

Printing History

New editions of this manuals will incorporate all material since the previous edition. The manual printing date indicates its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates which are incorporated at reprint do not cause the date to change.)

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WARRANTY

OBTAINING SERVICE FOR YOUR INSTRUMENT

Section I

General Information

System Description

The LI-COR Model LI-3000A Portable Area Meter utilizes an electronic method of rectangular approximation to measure leaf area on intact plants of many species. The LI-3000A has two components, the Scanning Head and the Readout Console. Area data is logged by the Readout Console as the Scanning Head is passed over the leaf.

The LI-3000A console replaces the LI-3000 Portable Area Meter readout console. The scanning heads on both instruments are the same. The LI-3000A has the following features:

- Displays leaf length, average width, and maximum width in addition to area and accumulated area.
- Readings can be summed in a secondary summing register at the user's command. The previous reading added to the register can be subtracted from it.
- Readings can be stored in the console, and later output to a computer or printer (RS-232C interface).
- The console can be connected to any LI-3000 Portable Area Meter scanning head. The console will self-calibrate heads with serial numbers 197 and above. Heads with serial numbers PAM196 and below require a specially configured console which does not self-calibrate.
- The console can be used with either the LI-3050A Transparent Belt Conveyer Accessory, or the LI-3100 Area Meter (requires a minor modification of LI-3100's with serial numbers LAM652 and below).
- A rechargeable sealed lead acid battery provides power for portable operation. The battery life is approximately 15 hours.

The LI-3000A has been designed for field use. Operate and store it with care similar to that required for a camera. The 3000A-02 Carrying Case is recommended.

The optional accessories for the LI-3000A include the 3000A-02 Carrying Case, the LI-3050A Transparent Belt Conveyer Accessory, the 3000A-03 Interface Cable (for LI-3100 to LI-3000A), the 6000-03B RS-232C printer,

and the 3000A/SM Service Manual. Replacement and service items are listed in Section V.

Theory of Operation

The method by which the LI-3000A measures area is best understood by examining the technique for manual area measurement. Manual area measurement requires tracing the outline of the sample on graph paper and methodically counting the squares where the sample covers fifty percent or more of the area of an individual grid cell.

The 50% criterion for the acceptance or rejection of grid cells is necessary to maintain linearity in the measured area. In other words, if the grid cells with fifty percent or more area covered were not counted, the result would be inconsistent data on repeated measurements. Similarly, if a sample were cut into pieces and the individual pieces summed, the results would likely not equal the measurement of the whole sample (unless the 50% criterion was used).

The width of the sample at a given point is determined by the number of grid cells covered across a row. The number of grid cells covered in a column determines the length. The resolution of this measurement technique is a function of the area represented by each grid cell.

The function of the LI-3000A Portable Area Meter is to use electronic methods to simulate a grid pattern on the leaf. The scanning head uses a row of 128 narrow band, red, light-emitting diodes (LEDs), spaced on 1 mm centers, to examine 128 grid cells across the width of the leaf. The LEDs are sequentially pulsed (only one LED is lit at a time) to examine a particular grid cell in the row. The LEDs are located along a line 0.62 cm (0.25 in.) from the edge of the upper section of the scanning head.

The base of the scanning head contains a lens-photodiode system which responds only to the collimated, pulsed LED light. This design makes the measurements insensitive to other light sources. These narrow-band red LEDs and associated digital circuitry provide measurements which are unaffected by leaf transmission properties.

After each grid cell in the row is scanned, it is necessary to advance to the next row. Electronically, this is accomplished by pulling the length encoding cord. After each 1 mm of cord travel, a new scan is initiated in which each of the 128 LEDs are sequentially pulsed. The scanning process begins only when the length encoding cord is pulled.

Since 1 mm of cord travel is equivalent to the side of a grid cell, it is apparent that the length encoding cord must be pulled perpendicular to the row of 128 LEDs.

When the LED light is blocked by a sample, the unit area (1 mm^2) is accumulated on the display. For example, if a $20 \times 100 \text{ mm}$ sample is being measured, 20 LEDs will be masked for 100 scans resulting in a display of 20.00 cm^2 .

LEDs which are only partially blocked are also accounted for. The calibration adjustment potentiometer (CAL ADJ) on the side of the console is adjusted at the factory so that 1 mm^2 of area is accumulated on the display when the LED light is diminished by 50% or more.

The scanning head accurately measures irregularly shaped leaves or leaves with holes from insect damage. As a hole in the leaf passes through the scanning head, the photodiodes sense LED light, and that LED location does not contribute to the area accumulating on the display until the LEDs are once again masked when the hole has passed.

The important aspect of this electronic measurement technique is that it requires that the light emitted from each of the 128 LEDs be uniform in intensity so that the 50% acceptance/rejection threshold is consistent for each grid cell. This is accomplished by the autocalibration software during the calibration process.

Instrument Calibration

The scanning head is calibrated to the readout console at the factory using the LI-3000A's built-in autocalibration routine (Section V). If a different scanning head is to be used, the autocalibration routine must be performed to calibrate the head to the console. The autocalibration routine computes how much current each of the 128 LEDs requires in order to achieve a constant brightness. These calibration values are retained as a table in the memory of the console.

IMPORTANT: Scanning heads with serial numbers PAM196 and below require a specially configured LI-3000A. Consoles so configured should NEVER be used with heads having serial numbers PAM197 and above. Damage to these heads could result. Similarly, standard consoles should NEVER be used on heads with serial numbers PAM196 and below. The only exception to this is if the area meter head with serial number PAM196 or below has been updated by LI-COR. It would then be treated as having a serial number greater than PAM196 and could then be used on a standard console.

THE CAL ADJUST POTENTIOMETER

The calibration accuracy is effected by the "CAL ADJ" potentiometer as described in the theory section. This potentiometer is adjusted at the factory to provide $\pm 2\%$ accuracy for measurements with the scanning head, or the scanning head with a transparent sheath. **The "CAL ADJ" potentiometer is adjusted by the user only when the LI-3000A is used with the LI-3050A Transparent Belt Conveyor Accessory.** This adjustment is discussed in Section VI.

If the "CAL ADJ" potentiometer has been adjusted for use with the LI-3050A, and it is also desired to use the LI-3000A in a portable mode (without the LI-3050A), it is not necessary to adjust the CAL ADJ potentiometer. For a typical scanning head, the accuracy difference between the factory setting of the CAL ADJ potentiometer and the adjusted setting used for the LI-3050A will introduce an error of 0.4 to 0.6%. The measurement errors ($\pm 2\%$ accuracy) in portable mode are much more significant. (Measurement errors in portable mode include not pulling the length encoding cord perpendicular to the line of LEDs, and the error introduced by not measuring the portion of the leaf that is between the edge of the scanning head and the row of LEDs.)

Section II

Preoperation Procedures

Operational Check

The following procedure can be used to connect the scanning head to the readout console and verify that the LI-3000A is working properly.

- 1) Connect the scanning head to the readout console while the ON/OFF switch is OFF, and then switch the ON/OFF switch to ON.

A start-up message (Section III) indicates which scanning head is calibrated to the console. If the scanning head serial number does not match the serial number given in the start-up message you will need to calibrate that head to the readout console using the built-in autocalibration routine (Section VI).

If the symbol "Lo" appears on the display (see Recharging the Battery) when the readout console is turned on, the internal battery needs charging. The low battery message is displayed when 1 hour of operational capacity remains in the battery. If your battery is low, skip down to the information on recharging the battery found later in this section.

If the message "CALIBRATION LOST PRESS ANY KEY" is displayed when the instrument is turned on, the calibration table has been deleted because of a power interruption to the memory (RAM). The scanning head can be calibrated to the console as described in Section V.

- 2) Open the scanning head by pressing on the thumb lever which is part of the upper section (Figure 2, Section III). Hold the scanning head inverted and look into the long narrow window near the edge of the head. Pull the length encoding cord out and retract it. You should be able to see the LEDs as they rapidly pulse.

IMPORTANT: Retract the cord by holding the knob and allowing the cord to draw into the head by its own force. *The cord should not be allowed to snap back into the head.* Also, do not push the cord and cause slack; internal backlash may result.

If you have been holding the head open while pulling the encoding cord, you will notice that numbers are being accumulated on the display. This is because the photodiodes will only accept the collimated light from the LEDs when the components are positioned properly. This characteristic was designed into the instrument to prevent stray light from affecting normal data collection. With the scanning head open, the LEDs and the photodiodes are out of alignment so area is recorded as the length encoding cord is moved. If the cord is drawn or retracted at a rate greater than 1 m/second, an error message is displayed as described in Section III. (The error message can be cleared by pressing the **CLEAR X** key.)

- 3) Clear any logged area data by pressing the white reset switch located on the scanning head handle.

Recharging the Battery

The LI-3000A uses a sealed lead acid battery. This battery is rechargeable, and gives about 15 hours of use. The symbol "Lo" appears on the display (as shown below) when approximately 1 hour of battery life remains.

AREA	0.00	X
0 Lo	0.00	Y

After automatic shutdown, enough power remains in the battery to maintain the memory for about 3 months. *To prevent memory loss the battery should be recharged every 3 months during storage.*

To charge the battery, slide the voltage selector on the readout console connector panel to the proper voltage. Connect the power cord to the readout console and plug the cord into an AC source (115-230 VAC, 50-60 Hz).

The battery should normally be charged overnight. An automatic charging cutoff is provided to prevent overcharging. The instrument may be operated while it is charging; however, the time needed to fully recharge the battery will be increased.

The LI-3000A's battery will not be harmed by continuous operation with AC power.

There is no internal backup battery, so if the main battery is disconnected for more than 20 seconds, all memory in the instrument will be cleared.

Using the Waist Strap

A waist strap has been provided so that the readout console can be worn around the waist for portable operation. The waist strap is connected to the console using the screws found on the right and left sides of the console.

For maximum comfort, the waist strap should be positioned so that the strap is about the same level as a belt on a pair of pants. In this position the weight of the console will rest on the pelvic bones and not on the "fleshy" part of the back.

Section III

Instrument Operation

Power On

Before turning on the LI-3000A, make the connections to the scanning head, LI-3050A Transparent Belt Conveyor Accessory, or LI-3100 Area Meter. At power up, the console will automatically sense whether a scanning head or an LI-3100 is connected.

Basic Operation

WHAT THE DISPLAY MEANS

When first turned on, the display of the LI-3000A will be as follows:

LI-3000A 01.00	X Y	Briefly displays the software revision number (1.00 in this example).
Calibrated for Head #1611	X Y	Briefly displays scanning head serial number calibrated to the console.
<div>AREA 0.00</div> <div>0 0.00</div>	X Y	<div>Label = AREA Value = 0.00</div> <div># Samples = 0 Accumulator = 0.00</div>

The value displayed on the upper line of the display (the **X** line) can be **AREA** (cm²), **LEN** (length of sample in cm), **AV WD** (average width in cm), or **MX WD** (maximum width in cm). The label on the left side of the **X** line identifies the value on the right side. The value displayed is selected by pressing the **AREA**, **LEN**, **AVE WIDTH**, or **MAX WIDTH** keys.



Figure 1. The LI-3000A front panel.

The area is computed as the length multiplied by the average width:

$$\text{AREA} = \text{LEN} \times \text{AV WD}$$

The **X** value on the right of the display is the instantaneous value. This value changes in real time as a sample is measured. The **Y** value is an accumulator that you can use if you wish. **X** values can be added to the **Y** value by pressing **ADD**. (Pressing the scanning head button twice in rapid succession has the same effect as pressing the **ADD** key.) The **SUB** key removes the last value entered from the **Y** register (useful if **ADD** is mistakenly pressed). Note that this "last value" is not necessarily the currently displayed **X** value, and that the last value cannot be removed more than once.

AN EXAMPLE

- 1) Put a small piece of paper in the scanning head, pull the string out a several centimeters, and let it back. The display will change to something like

AREA	158.92	X
0	0.00	Y

- 2) Press **LEN**.

LEN	27.4	X	Sample length was 27.4 cm.
0	0.00	Y	

- 3) Press **AVE WIDTH**.

AV WD	5.8	X	Average sample width was 5.8 cm.
0	0.00	Y	

- 4) Press **MAX WIDTH**.

MX WD	5.8	X	Maximum sample width was 5.8 cm.
0	0.00	Y	

- 5) Press **AREA** to return to the normal display. Now add the **X** value to the **Y** value by pressing **ADD**. The display will change to

AREA	0.00	X	Cleared after ADD. 1 value now in the accumulator.
1	158.92	Y	

Note that the **X** value clears after pressing **ADD** (this feature can be disabled, and is discussed later), and that the sample counter on the bottom left increments by one.

6) Pull the string again to measure another sample.

AREA	120.06	X	The new sample.
1	158.92	Y	

7) Add the new **X** value to the **Y** value by pressing **ADD**.

AREA	0.00	X	2 values in the accumulator.
2	278.98	Y	

8) Pull the string again to measure a third value.

AREA	21.46	X	The third sample.
2	278.98	Y	

9) Subtract the last value added to the **Y** register by pressing **SUB**.

AREA	21.46	X	The third sample is still displayed.
1	158.92	Y	Note that 120.06 was subtracted.

Since the last value added was 120.06, that was what was removed from the **Y** value. The **X** value remains unchanged. If you press **SUB** again, it will have no effect, since the last entered value has already been removed.

SCANNING HEAD BUTTON

The white button on the LI-3000A scanning head has 2 uses. Pressing once will clear the **X** register (same as pressing **CLEAR X**). Pressing the button twice in quick succession adds the **X** value to the **Y** value, just like pressing **ADD**.

PULLING THE STRING TOO FAST

If you ever pull the string too fast, the message

PULLING TOO FAST PRESS CLR X	X Y
---------------------------------	--------

will be displayed. When **CLEAR X** is pressed, the **X** value will be cleared, and normal operation will resume. Maximum string speed is about 1 meter per second.

Making Measurements

When using the scanning head on attached leaves, observe the following 2 important principals:

- Pull the length encoding cord at the same rate the sample is being pulled through the scanning head. This is accomplished by holding the length encoding knob against a stationary object (stem, etc.) as the scanning head is drawn over the sample.
- Pull the length encoding cord straight out from (perpendicular to) the front plane of the scanning head (an angle of 11.5 degrees will cause a 2% error).

AREA MEASUREMENT OF ATTACHED LEAVES

- 1) Move the ON-OFF switch to ON.
- 2) Open the scanning head and position it over a leaf. The leaf does not have to be detached from the plant to be measured.

- 3) Close the scanning head over the petiole so that the leaf base is in the scanning head but not between the LED and photodiode (detector) windows. For plants such as corn, position the head as near to the leaf base as possible.
- 4) Draw the length encoding cord to some location where it can be held steady. The knob can be held against a stem (Figure 2), or in the case of broadleaf plants, the knob can be held firm by clasping it together with the petiole between the second and third fingers
- 5) Press the scanning head button once to clear the **X** register before starting the measurement.
- 6) Draw the closed scanning head over the leaf while the length encoding knob is held stationary. Drawing speed need not be constant.
- 7) After the scanning head has passed over the leaf, let the length encoding cord slowly rewind itself back into the scanning head.

Figure 2. Operation Techniques.

Open the scanning head and place it over the leaf. The length encoding knob is held against a stationary object such as a stem.



Close the scanning head at the leaf base. Reset the instrument by pressing the scanning head button once.



Draw the closed scanning head over the leaf apex to pass through completely. Drawing speed need not be constant.

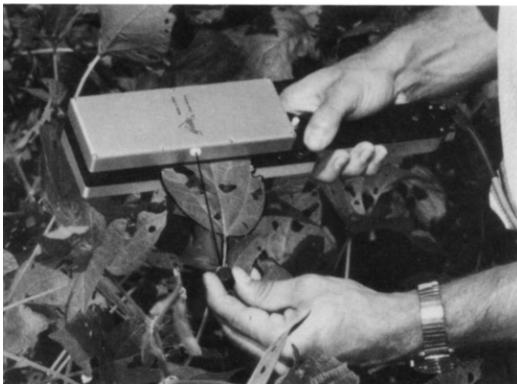


Figure 3. Soybean Measurement.

USING A TRANSPARENT SHEATH

A transparent sheath (user supplied) can be used to measure detached leaves and other objects that require sample support (Figure 4). In order to gain proficiency using a transparent sheath, measure several objects of known area, such as graph paper cutouts.

If detached leaves are to be measured with a sheath, make the measurements as soon as possible after harvesting with the samples kept moist to prevent shrinkage or curling of the leaf margins.

Measurements with a transparent sheath can be accomplished using the following steps:

- 1) Make sure the sheath is clean and then measure the empty sheath to be certain that know spurious area is measured.
- 2) Place an object in the sheath about 6 cm from one end.
- 3) Open the scanning head and place the sheath in the head with about 4 cm protruding from the left edge and allow the head to close.



Figure 4. Use of the Transparent Sheath

- 4) Grasp the length encoding knob with your left-hand thumb and forefinger and hold it stationary against the sheath (Figure 4).
- 5) Press the scanning head button once to clear the **X** value on the display. Draw the sheath through the scanning head, simultaneously drawing out the length encoding cord.

HINTS FOR VARIOUS LEAF TYPES

Many types of leaves cannot be measured without additional support to guide them through the scanning head. Techniques for several leaf types are discussed below.

- Compound leaves can be measured by either scanning each leaflet, as with the soybean trifoliate in Figure 3, or by enclosing the entire intact leaf in a transparent sheath.
- Tender leaves such as those developed under low light conditions sometimes will not easily slide through the scanning head and may actually tear because of adherence to the instrument surfaces. In this case a transparent sheath can be placed over the leaf for support and protection.
- Insect damaged leaves which have protruding fragments or naturally dissected leaves having fine lobes usually require support by a transparent sheath.
- Small leaves such as those of alfalfa and small grasses can be removed from the plants and placed in a transparent sheath.
- Elongated, narrow leaves (grasses, etc.) are most accurately measured if they are passed through the scanning head at an angle to the line of LEDs (instead of perpendicular).

In many cases the LI-3050A/4 Transparent Belt Conveyer Accessory (Figure 5) will be the method of choice for measuring small objects and detached leaves. The combination of the LI-3050A/4 and LI-3000A provides greater accuracy ($\pm 1\%$) than the LI-3000A alone ($\pm 2\%$).

Storing Data In Memory

Readings can be stored in memory for later viewing or RS-232C output.

Stored readings can be any combination of the **X** register and the accumulated readings in the **Y** register. When data is stored, it automatically includes area, length, average width, and maximum width.

Stored data is in a file system. A file can be as large or as small as you wish. A file must be opened before any data is stored. Closing the file precludes adding any more data to that file. Associated with each file is some header information: a number (assigned by the system), a label (entered by the user), and the time and date the file was opened (as kept by the system).

When output, a file might look like this:

FILE: 1

REM:PLOT1

06 MAY 1990 14:22:30

ENTRY	COUNT	AREA	LENGTH	AV WIDTH	MX WIDTH
1	0	42.37	13.10	3.23	5.12
2	5	344.20	120.00	2.87	3.10
3	2	84.48	26.80	3.15	6.02

FILE: A sequential number assigned by the system that you use to reference the file.

REM: A remark entered by the user when the file is first opened.

ENTRY: Sequential numbers identifying records in the file.

COUNT: The number of samples represented in the record. When **X** values are stored, the count is always 0. **Y** values will always be an integer greater than 0. The count represents the number of **X** values that were added together before the accumulated **Y** value was stored in the file.

For accumulated values, the **AREA** value is the total leaf area of all samples, **LENGTH** is the total leaf length, **AV WIDTH** is the average width of all samples, and **MX WIDTH** is the maximum width of all samples.

The following sequence of events could have occurred to make the above file. It would be a good example to duplicate using your own console, as well.

- 1) Press **FILE** to open a file. The display will show

FILE	1	OPENED	X	Briefly displayed...
			Y	

ENTER REMARK:	X
_____	Y

- 2) The remark "PLOT1" is entered by pressing this sequence of keys:

P ↑ L ↑ O T ↑ SPACE 1 ENTER

To type the alpha characters in the lower left corners of the keys, just press the desired key. To type the alpha characters in the upper left corners, press ↑ first, then the key. Typing mistakes can be corrected using the back arrow key (←).

- 3) Now the display will show

AREA *	0.00	X	The * indicates that a file is open.
0	0.00	Y	

- 4) Measure a sample

AREA *	42.37	X
0	0.00	Y

... and store it by pressing **STORE X**. The display will briefly show

FILE	1	X
ENTRY	1_	Y

followed by

AREA *	0.00	X	Note the X value clears after pressing STORE X.
0	0.00	Y	

- 5) Take 5 readings, following each by pressing **ADD** (or by pressing the scanning head button twice).

AREA *	0.00	X	5 samples in Y register (accumulator).
5	344.20	Y	

Now press **STORE Y** to store the **Y** register readings in the file.

FILE 1	X	Displayed briefly...
ENTRY 2_	Y	

AREA *	0.00	X	Note the Y value clears on STORE Y.
0	0.00	Y	

- 6) Take 2 more readings, following each by pressing **ADD**. Then press **STORE Y**.

- 7) Close the file by pressing **FILE**.

FILE 1	X	Displayed briefly...
CLOSED	Y	

The file is now similar to that shown at the beginning of this example.

STRUCTURING FILES

Since you have a lot of flexibility on exactly what values to store in a file, it pays to exercise a little forethought on how to structure your files.

For example, suppose you wish to determine leaf area index in 10 different plots by measuring leaf areas on 5 plants in each plot. One way to proceed would be to use a file for each plot, so you'll have 10 files when done. Once a file is opened, measure all leaves on the first plant, pressing **ADD** (or

press the white button on the scanning head twice) after each leaf. When done with the plant, press **STORE Y**. Repeat for the other 4 plants on the plot. When done with the plot, press **FILE** to close the file. At that point, you will have 5 entries in the file, each one being the total leaf area of each of the 5 plants sampled. The COUNT column on each line would tell you how many leaves per plant were measured.

The file for one plot might look something like this:

FILE: 2
REM: TEST PLOT 2
08 MAY 1988 14:19:30

ENTRY	COUNT	AREA	LENGTH	AV WIDTH	MX WIDTH
1	7	246.68	45.10	3.23	5.12
2	5	125.20	35.60	2.87	3.10
3	4	84.48	26.80	3.15	6.02
4	9	344.20	120.00	4.67	6.10
5	5	140.69	47.32	3.56	5.72

Another approach would be to have one file per plant (giving you 50 files when done). When measuring a plant, press **STORE X** and **ADD** after each leaf measurement. After the last leaf on the plant is measured, press **STORE Y** to store the accumulated leaf area for that plant and then close the file. In order to know which plant goes with which plot, use the file remarks to record that information. The file for one plant might look like this:

FILE: 3
REM: PLOT 2 #5
09 MAY 1988 14:25:30

ENTRY	COUNT	AREA	LENGTH	AV WIDTH	MX WIDTH
1	0	42.37	13.10	3.23	5.12
2	0	44.20	12.90	2.87	3.10
3	0	24.48	9.78	3.15	3.67
4	0	29.50	10.20	2.83	2.98
5	0	34.86	11.50	2.32	2.76
6	0	19.33	8.60	2.14	2.56
7	6	194.74	66.08	2.76	5.12

Still another approach is to use one file for the entire data set. Begin each plot with a cleared **Y** and **X** register, and press **ADD** after each leaf. When done with a plot, press **STORE Y**. When done, your file will have

10 entries (one for each plot), and the COUNT for each entry will reflect the total number of leaves measured.

Before you decide on how to structure your data files, you may also want to consider the potential of losing some of your data. If the console is switched OFF, or if it automatically shuts itself off due to inactivity, the current **X** and **Y** values will be lost. Any data which is stored in a data file (the result of pressing **STORE X** or **STORE Y**) is safe, even if the data file is not closed. The greatest potential for loss occurs when a large number of measurements are added to the accumulator (**Y** register) before they are stored in a data file.

The configuration of the LI-3000A can be changed to facilitate rapid data storage. This is accomplished using the CONFIG REGISTERS routine that is discussed in the section titled Menu Key Routines.

VIEWING FILES ON THE DISPLAY

The **VIEW** key allows you to look at the contents of any stored file. When the **VIEW** key is pressed, you will be prompted for the file number of the file to be viewed:

VIEW FILE	X	
NUM: ____	Y	Enter the file number to be viewed.

If you enter a file number for which there is no file, the display will show

FILE NOT FOUND_	X	
	Y	

and return to the normal display. Otherwise, you will be shown the header of the selected file. For a typical file the display would show

FILE	1	(3)	X	File 1 has 3 entries.
REM: PLOT	1			Y	

Press the ↓ key to see the next part of the file header, which is the date and time when the file was opened.

06 JUN 1988	X
14:22:30	Y

Press the ↓ key again to view the first of the 3 entries.

1/	3	0	X	Entry 1 of 3 has 0 counts (e.g. it was stored from the X register).
AREA		42.37	Y	

The top line displays the ENTRY number (1), the total entries (3), and the COUNTS for that entry (0, indicating that it is an **X** value). The bottom line displays AREA, LEN, AV WD, or MX WD depending upon which has been selected using the **AREA**, **LEN**, **AVE WIDTH**, or **MAX WIDTH** keys. Try pressing these keys before proceeding.

Pressing ↓ again will change to the second entry:

2/	3	5	X	Entry 2 of 3 has 5 counts.
AREA		344.20	Y	

VIEW MODE KEY DEFINITIONS

While viewing a file, these keys will do the following things:

↑ and ↓ : Scroll up or down through a file.

VIEW: Will prompt for a new file to view.

DEL: Deletes the file that is currently displayed. When the **DEL** is pressed, the user is prompted:

DELE	1? N	X
↑, ↓, or ENTER		Y

To delete the file press the ↑ key to change the N to a Y, then press **ENTER**. To continue without deleting the file, just press **ENTER**.

AREA , LEN , AVE WIDTH , or MAX WIDTH : Selects the data column to be viewed.

All other keys will cause view mode to be exited.

DELETING A RANGE OF FILES

When **DEL** is pressed from normal operating mode (as opposed to the file view mode), the user is prompted for a range of files to delete:

DELETE FILES	X
FROM: _	Y

FROM: 10	X	If 10 were entered for the starting value. Enter the ending value.
THRU: _	Y	

Each file in the range that is deleted is shown on the display.

FILE 14	X	Counts through a range.
DELETED	Y	Or, resumes area display if not found.

If you wish to get out of the file delete routine, enter 0 (or press **ENTER** without making an entry) for either the FROM or THRU file numbers. (See also the discussion below on deleting all files.)

Menu Key Routines

The **MENU** key accesses a list of software routines.

MEMORY AVAILABLE	X
↑, ↓, or ENTER	Y

Use the ↑ and ↓ keys to scroll through the list, and press **ENTER** to perform any one. Press any other key to exit the menu list, and return to normal operation. The list of routines is:

Memory Available	Shows % of memory available for storage.
Set I/O	Configures the RS-232C port (baud rate, data bits, etc.).
Print Files	Outputs a user selected range of files to the RS-232C port.
Delete All Files	Deletes all stored files.
Config Registers	Can set auto clear on ADD, STORE X, and STORE Y.
Set Clock	Sets time and date.
3100 Resolution	Sets high or low resolution if using the LI-3100 Area Meter.

To exit MENU list, press any key except **ENTER** , ↑ ,or ↓ .

MEMORY AVAILABLE

100% REMAINING PRESS KEY

X	Displays % of available memory.
Y	Press any key to return to help menu.

The actual number of files or area entries that can be stored is highly dependent on how the data is stored as indicated in the table below. When the memory is full the message "NOT ENOUGH MEM" will be displayed when you try to store data into a file.

<u>Entries</u> <u>Per File</u>	<u># Files</u>	<u>Total #</u> <u>Entries</u>
1	674	674
2	526	1052
3	431	1293
4	365	1460
5	316	1580
10	190	1900
15	136	2040
20	105	2100
.	.	.
.	.	.
2385	1	2385

SET I/O

The SET I/O routine sequentially prompts for the following list of parameters:

BAUD = 4800 ↑, ↓, or ENTER	X Y	300, 1200, 2400, 4800, or 9600
-------------------------------	--------	--------------------------------

DATA BITS = 8 ↑, ↓, or ENTER	X Y	7 or 8
---------------------------------	--------	--------

STOP BITS = 2 ↑, ↓, or ENTER	X Y	1 or 2
---------------------------------	--------	--------

PARITY = NONE ↑, ↓, or ENTER	X Y	EVEN, ODD, or NONE
---------------------------------	--------	--------------------

DATA BITS = 8 ↑, ↓, or ENTER	X Y	7 or 8
---------------------------------	--------	--------

CHECK DTR = Y ↑, ↓, or ENTER	X Y	Y or N (Pin 20 high?)
---------------------------------	--------	-----------------------

XON/XOFF = N ↑, ↓, or ENTER	X Y	Y or N
--------------------------------	--------	--------

CHECK RTS = N ↑, ↓, or ENTER	X Y	Y or N (Pin 4 high?)
---------------------------------	--------	----------------------

CHECK DTR=Y Hardware pacing: DTR line. When set to 'Y' the LI-3000A will send data only when it sees pin 20 (DTR) of the I/O port

high (> 3V). This method of pacing is commonly used in printers (as is the case with the 6000-03B Printer from LI-COR).

XON/XOFF=N XON/XOFF software handshake. The LI-3000A will transmit data until an XOFF character (hex 13, ASCII DC3) is received. Data transmission will resume upon receipt of an XON character (hex 11, ASCII DC1). This is a fairly common handshaking protocol.

CHECK RTS=N Hardware handshake. When CHECK RTS is set to "Y", the LI-3000A will only send data when it sees pin 4 (RTS) of the I/O port high (> 3V). The 6000-03B Printer does not support this handshaking protocol (set CHECK RTS to 'N').

More information on transferring data to a computer or printer can be found in the Data Communications section.

PRINT FILES

This routine prompts the user for a range of files to be transmitted out the RS-232C port. Entering a 0 or just pressing **ENTER** in response to either the FROM or THRU prompts will abort this routine.

PRINT FILES	X
FROM_	Y

FROM: 10	X	If 10 were entered for
THRU:_	Y	the starting value

DELETE ALL FILES

DELETE FILES = N	X
↑, ↓, or ENTER	Y

Pressing ↑ (to change the N to a Y) followed by **ENTER** will clear all files from memory.

CONFIG REGISTERS

The user can choose whether the **X** value is automatically cleared when the **ADD** key is pressed (or the white button double pressed), when the **STORE X** key is pressed, or whether the **Y** value is automatically cleared when the **STORE Y** key is pressed.

CLR X ON ADD? Y	X
↑, ↓, or ENTER	Y

CLR X ON STORE? Y	X
↑, ↓, or ENTER	Y

CLR Y ON STORE? Y	X
↑, ↓, or ENTER	Y

These prompts are used to facilitate rapid data collection and storage. For example, if you wish to store only accumulated measurements of all leaves on a plant, set "CLR X ON ADD" to **Y** so that the **X** value is cleared after the area of each leaf is added to the **Y** value. This eliminates having to press the white scanning head button or the **CLEAR X** key in-between each leaf measurement.

Now assume that you wish to store the leaf area of each individual leaf and the total leaf area of the whole plant. Two operations need to occur after each leaf is measured; the individual leaf area data should be stored using the **STORE X** key and the individual leaf area data should be added to the **Y** value to collect the whole plant leaf area. To accomplish this, set the "CLR X ON STORE" prompt to **No** and the "CLR X ON ADD" prompt to **Yes**. This assumes that you will press **STORE X** before **ADD**. If you wish to press **ADD** before **STORE X** set "CLR X ON ADD" to **No** and "CLR X ON STORE" to **Yes**.

Normally it is advantageous to have the "CLR Y ON STORE" prompt set to **Yes**. However, you may find a need to store an accumulated value (such as whole plant leaf area) and continue to add new measurements afterward.

SET CLOCK

DATE=20 JUN 1988
NEW=DD MMM YYYY

X
Y

TIME=14:32:10
NEW=HH:MM:SS

X
Y

Pressing **ENTER** without making any entries will leave the data or time unchanged. To enter a new date or time, type in the appropriate characters to match the indicated NEW= format.

Valid entries for the months January through December are JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, and DEC respectively.

LI-3100 RESOLUTION

This allows the user to tell the LI-3000A which resolution is being used on the LI-3100. It has no effect on measurements with the LI-3000A scanning head.

3100 RES = LOW
↑, ↓, or ENTER

X	LOW or HI.
Y	

"LOW" is for 1.0 mm resolution and "HI" is for 0.1 mm resolution on the LI-3100.

Data Communications

Although each data file can be viewed on the display, an RS-232C interface has been provided to transfer data to a printer or computer for analysis or storage.

GENERAL INFORMATION

The RS-232C port is configured as Data Communication Equipment (DCE), so it transmits data on pin 3, and receives data on pin 2. When connecting to a device that is configured as Data Terminal Equipment (DTE), such as most serial printers and desktop computers, a straight-thru cable is all that is needed (included in the LI-3000A standard spare parts kit). To communicate successfully with another DCE device, a cable exchanging pins 2 and 3 (and perhaps 6 and 20 as well) would be needed.

The communication parameters (baud rate, parity, etc.) of the LI-3000A can be set to match the receiving device using the SET I/O routine in the Menu Key functions. The LI-3000A can handshake in any combination of three ways: it can look at pin 20 (DTR), pin 4 (RTS), and it supports XON/XOFF.

SENDING DATA TO AN IBM PERSONAL COMPUTER

In order to transfer data to an IBM PC (or compatible), two things are needed: the proper cable(s) and software that writes the incoming data into a data file.

The LI-3000A is connected to a serial port on the standard IBM PC using the provided interface cable and the female to female gender changer. If you are using an IBM AT or an AT compatible, you may need a 25-pin to 9-pin conversion cable which you should be able to find at a local computer store.

For data transfer software, any program which can write incoming ASCII data into a data file will suffice. Most commercially available communication packages perform this type of data transfer. Several inexpensive programs and their manufacturers are listed below.

Program Name: ProComm
Datastorm Technologies, inc.
P.O. Box 1471
Columbia, MO 65205

Program Name: PC-Talk
Freeware
P.O. Box 862
Tiburon, CA 94920

TRANSFERRING DATA TO THE APPLE®, MACINTOSH™

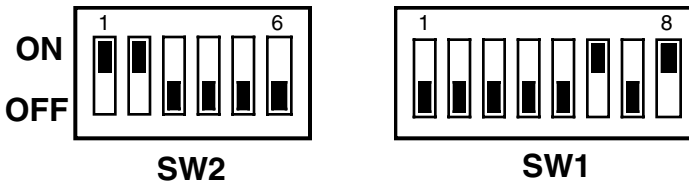
Connecting the LI-3000A to the Macintosh requires the provided interface cable, the female to female gender changer and a Hayes compatible modem cable for the Macintosh.

For data transfer software, a number of programs are commercially available. One such program is Red Ryder which is available from the Freesoft Company at a nominal cost. Their address is given below.

Program Name: Red Ryder
The Freesoft Company
150 Hickory Drive
Beaver Falls, PA 15010

PRINTING DATA ON THE 6000-03B PRINTER

The 6000-03B serial port configuration is determined by two banks of DIP switches located on the serial interface board. They are set at LI-COR for 2 stop bits, parity odd and disabled, flag positive, and 4800 baud. The dip switches should be set as shown below.



To configure the printer for a different baud rate, consult the EPSON Serial Interface Manual for complete information on the dip switches.

The LI-3000A can be connected directly to the 6000-03B using the provided interface cable.

The LI-3000A communication parameters are set using the SET I/O routine on the **MENU** key. For the 6000-03B, they should be set as follows:

BAUD = 4800
DATA BITS = 8
STOP BITS = 2
PARITY = NONE
CHECK DTR = Y
XON/XOFF = N
CHECK RTS = N

Files are printed using the PRINT FILES routine which is accessed by pressing the **MENU** key and scrolling to the desired software routine.

SOLVING COMMUNICATION PROBLEMS

Below are a few of the common communication problems and a few things to check in order to facilitate solving the problem.

PROBLEM

WHAT TO CHECK

Nothing Happens

Proper Cable? Connections tight?
Printer on-line?

All characters are wrong

Check baud rate.

Some characters are wrong

Check data bits, stop bits, or parity.

Section IV

Operation with the LI-3100 Area Meter

The LI-3000A console can be connected to the LI-3100 Area Meter using the following procedure.

- 1) Turn both instruments off.
- 2) Connect the 3000A-03 Interface Cable (9 pin connectors on each end) to the LI-3100 and to the LI-3000A as shown in Figure 5 below. The LI-3000A console can be connected directly to LI-3100's with serial numbers LAM653 and above. For units with serial numbers LAM652 and below, the 3000A-04 Interface Kit is available (includes the 3000A-03 Interface Cable). NOTE: The 3000A-04 Interface Kit requires an electronics technician for installation, or it can be installed at LI-COR by returning your instrument.
- 3) Disconnect the LI-3000A scanning head.

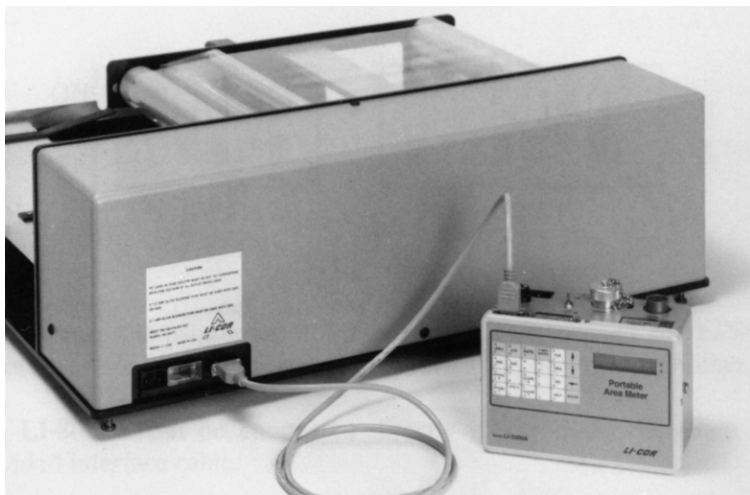


Figure 5. LI-3000A console connected to the LI-3100.

- 4) Turn both instruments on.

IMPORTANT: The LI-3000A console "senses" during power on whether the scanning head or the LI-3100 is connected. It is important that the interface cable be connected to both instruments before the LI-3000A is powered on.

- 5) After the start-up messages (see Basic Operation, Section III) you should set the LI-3100 resolution as explained at the end of Section III.

The LI-3000A console will now collect and display data as described in the Section III, with the exception that the reset switch on the LI-3100 now has the same effect as pressing the **CLEAR X** key.

NOTE: The LI-3100 output signal is a digital signal which is in a form that can be interpreted by the 3000A-01 Console. *The digital output is not an RS-232C output and should not be connected to an RS-232C device.*

Section V

Maintenance and Calibration

Cleaning the LED and Photodiode Windows

As debris collects on the scanning head windows (insects, dirt, pollen, etc.), spurious numbers will accumulate on the display when the length encoding cord is drawn. This is detected by moving the cord when no sample object is located in the scanning head. Clean the quartz windows with a moist paper towel or cloth. Wiping the windows with a finger is usually adequate for field use.

Cleaning the Length Encoding Cord Guide

A dust trap is located within the length encoding cord guide (the plastic grommet through which the cord passes). This trap reduces dust passage into the scanning head as the cord is retracted. The cord guide should be unscrewed from the upper scanning head section and the felt trap cleaned or replaced. The service frequency should be determined by experience under the most prevalent usage conditions. The interval will range from seldom under laboratory conditions, to daily in dusty or heavily pollinating crops.

Length Encoding Cord

If the length encoding cord becomes lodged, the problem is likely backlash. This seldom occurs even if the cord is released and allowed to retract rapidly. If the operator tends to "push" the cord into the head more rapidly than the system will retract, then a slack cord occurs and backlash is more probable. This is corrected by loosening the cord guide and removing the seven screws on top of the scanning head. The upper section housing is then raised straight upward. The cord is rewound and threaded according to Figure 6. When the upper section housing is replaced, **do not use force.**

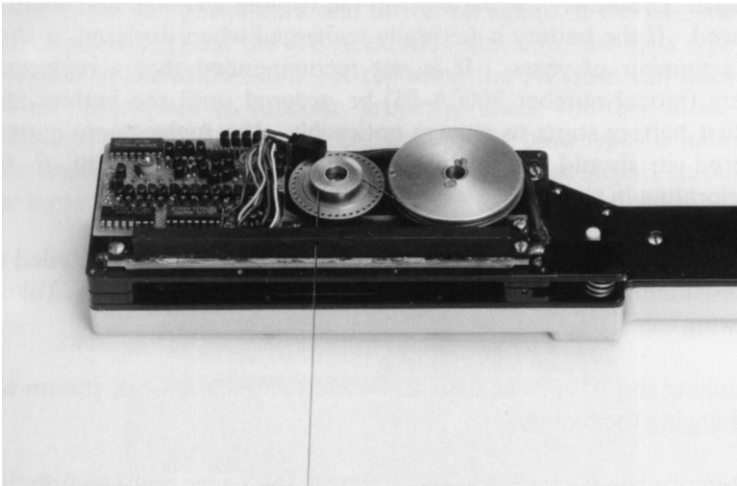


Figure 6. The length encoding cord passes from the take-up reel around the encoding wheel.

Warning: When replacing the upper section housing do not allow contact with the protruding edge of the LED scanner. High temperature vacuum grease is used as a seal between the upper section housing and the base plate. The grease is forced into the joint after the cover is attached.

Knob Separation from the Length Encoding Cord

The length encoding cord will retract completely into the scanning head if the knob is removed. The cord is retrieved by opening the upper housing.

Avoid continuous application of sharp angles at either end of the scanning head cord.

Battery Replacement

As the internal battery ages, the battery life will diminish (15 hours is normal). Eventually the battery will fail to hold a charge and should be replaced. If the battery is faithfully recharged when depleted, it should last a number of years. It is not recommended that a replacement battery (model

number 3000A-05) be ordered until the battery life of the first battery starts to change noticeably. If a replacement battery is ordered it should be installed immediately to prevent it from deteriorating in storage.

To perform the change, you will need the 3/16" nut driver included with the instrument, a standard screwdriver, and a long nose pliers. Take the following steps.

- 1) Unplug the AC power cord and use an anti-static work station while changing the battery.
- 2) Remove the 4 screws on the edges of the cover and carefully lift it off. Disconnect the keypad cable from the circuit board.
- 3) Remove the 4 hex screws from the 25 pin RS-232C connector and the 9 pin LI-3100 connector.
- 4) Remove the 4 outermost screws on the bottom (outside) of the box.
- 5) Slide out the circuit board assembly.
- 6) Unplug the battery and quickly plug in a new one.

CAUTION: If the battery is unplugged for more than 20 seconds, the data, date, time, and calibration may be lost.

- 7) Unplug the other connections on the circuit board assembly and separate it from the box.
- 8) Remove the 2 battery bracket screws from the bottom (outside) of the box.
- 9) Install the battery bracket on the new battery.
- 10) Reassemble by performing the above steps in the reverse order.

Internal Fuse

If nothing happens when the LI-3000A is turned on, turn the instrument off, plug in the AC power cord and turn it on again. If the LI-3000A is still unresponsive, check the AC fuse (AGC 0.5 amp, fast blow type) on the outside of the instrument. If replacing the AC fuse still does not cause the instrument to function properly, check the fuse inside the instrument. The interior fuse (AGC 2 amp, fast blow type) is mounted on the lower circuit board as shown in Figure 7. Use steps 1 through 5 under battery replacement to disassemble the case.

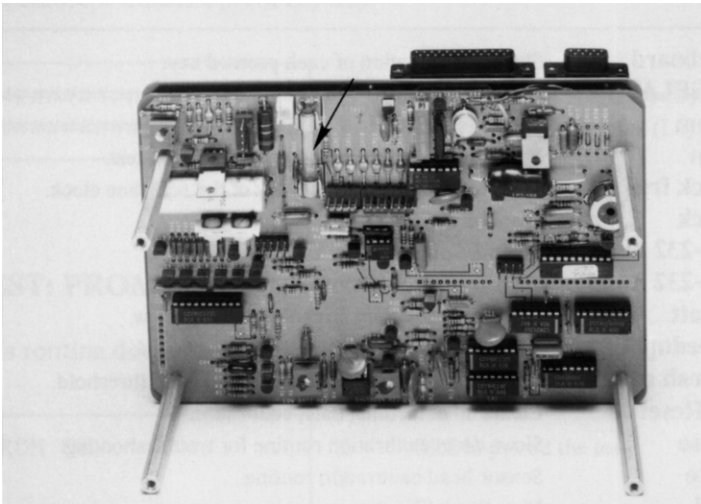


Figure 7. Location of the internal fuse.

Instrument Storage

The internal battery should always be fully charged before storage. For long term storage the battery should be recharged every 3 months to prevent memory loss.

The LI-3000A should be stored in an area that is within the temperature range -20 to 55 #C and has a relative humidity of 0 to 90%.

Test Menu

The **TEST** key accesses a list of technician test and calibration routines.

TEST: keyboard ↑, ↓, or ENTER

X
Y

These routines are generally used during the technician check-out of the LI-3000A. The list does, however, contain the calibration routine used to calibrate a scanning head to the LI-3000A console.

Test:keyboard	Shows grid location of each pressed key.
Test:DISPLAY	Cycles through the character set.
Test:prom	Tests the EPROM.
Test:ram	Shows memory size, and does a checksum test.
Test:clock freq	Used to measure the accuracy of the real time clock.
Test:clock	Displays date and time continually.
Test:RS-232 out	Tests the output of the UART.
Test:RS-232 inout	Tests the input and output of the UART.
Test:lobatt	Displays low battery symbol if battery is low.
Test:speedup	Allows checking of U3 on the analog board.
Test:thresh comp	Allows checking of the comparator (U11) threshold.
Master Reset	Clears all data, time, date, calibration.
Cal Pause	Slows down calibration routine for troubleshooting.
Calibrate	Sensor head calibration routine.
View Cal	View the calibration.
Cal Edit	Used to change the calibration data.
Print Cal	Output the calibration to the RS-232C port.

To exit the TEST menu press any key except **ENTER** , **↑** , or **↓**.

TEST: KEYBOARD

The message 'keytest' is momentarily displayed, then the display will be blank. When you press a key, the display will show the row number and the column number of the pressed key. The **↑** key is 0,0 and the **STORE Y** key is 3,5.

2 4	X 3rd row down, 4th from the right.
	Y This is the "6" (or V) key.

To exit this mode, press any key three times, or press all of the keys.

TEST: DISPLAY

The console will cycle through the display's character set. If you want to quit before it finishes, press any key.

#####	X Note that the first symbol displayed is
#####	Y the low battery symbol (Lo).

TEST: PROM

This routine does a checksum test on the EPROM.

PROM OK	X Y	PROM passed the test.
---------	--------	-----------------------

Press any key to return to the menu.

TEST:RAM

This routine shows the size of the memory, and gives it a test.

32K RAM OK	X Y	32K bytes memory. Displayed after a few seconds.
---------------	--------	---

Press any key to return to the menu.

TEST: CLOCK FREQ

This test is used to check the accuracy of the real time clock.

ADJUST FREQUENCY	X
PRESS KEY	Y

The frequency on Pin 1 of component U24 (6242) should be 64.00000 hertz as measured by a frequency counter. Any error from 64 Hz is directly proportional to the error that will be seen in time.

<u>Freq. Measured</u>	<u>Error</u>
64.01000	+ 7 min/month
64.00100	+ 40 sec/month
64.00010	+ 4 sec/month
64.00001	+ .4 sec/month

As a part of the clock frequency test, the real-time clock is set to zero. At the end of the test the user is prompted to enter the current date and time.

TEST: CLOCK

20 JUN 1988	X	Displays current date and time.
15:27:33	Y	

Press any key to return to the menu.

TEST: RS-232 OUT

This test transmits the character set out the RS-232C port. A printer must be connected. Press the ← key to abort the test if problems occur.

TEST: RS-232 INOUT

This test sends a space (ASCII decimal 32) and expects or receive a space (a loopback connector must be installed). The data sent should match the data received.

Press **ENTER** to start the test. Any of the following results may occur

<div>TEST:RS232 inout ↑,↓, or ENTER</div>	X	Test passed. The data received
	Y	matched the data transmitted.
<div>RECEIVER ERR</div>	X	No data was received. (A loopback
	Y	connector was not used).
<div>RECEIVE DATA ERR</div>	X	Data received did not match
	Y	transmitted data.

The "receive data err" message can occur if an EPSON RX-80 printer is connected. The RX-80 continually sends XOFF characters.

TEST:LOBATT

The low battery symbol will appear if the battery is low.

<div>Lo LOWBATT TEST</div>	X
	Y

Press any key to return to the menu.

TEST:SPEEDUP

S	SPEEDUP TEST	X	S (slow) or F(fast).
		Y	

Tests component U3 on the analog board. When the string is being pulled faster than 1/2 meter/second, then an F (fast) should appear. When the instrument is in fast mode it no longer tries to update the display. Instead, it concentrates only on counting area. The data is still 100% reliable and the newest data will be displayed once the string speed slows down.

TEST: THRESH COMP

This test sets the comparator threshold voltage so it can be measured.

THRESH COMP = CAL	X	TP30 = voltage set by calibration
↑, ↓, or ENTER	Y	potentiometer on analog board (≈0.5V).

THRESH COMP = 0.7V	X	TP30 = 0.7V.
	Y	

THRESH COMP = 0.9V	X	TP30 = 0.9V.
	Y	

THRESH COMP = 1.0V	X	TP30 = 1.0V.
	Y	

MASTER RESET

Clears all data, the time, date, and scanning head calibrations. This test is equivalent to unplugging the battery. It should be used if a new software program (EPROM U4, digital board) is installed.

CAL PAUSE

Used to slow down the calibration routine for troubleshooting.

Cal Pause	X
↑, ↓, or ENTER	Y

Press **ENTER** to start the routine.

Cal Pause = N	X	This will pause the calibration after all LED values are determined.
↑, ↓, or ENTER	Y	

Press ↑ and then **ENTER** to set the pause prompt to Yes (Y).

Cal Pause = Y	X	This will pause the calibration after each LED value is determined.
↑, ↓, or ENTER	Y	

Press **ENTER** to exit the routine.

CALIBRATE

The calibration routine must be done if a different scanning head is to be used with the LI-3000A. Read the warning under the INSTRUMENT CALIBRATION heading in Section I of this manual.

Before proceeding with this test, make sure the scanning head is cleaned, and that nothing is blocking any of the LEDs.

ENTER HEAD SR NO	X	Enter the sensor head serial number.
	Y	

The serial number entered at this prompt is used in the start-up message ("Calibrated for Head #xxxx") given when the LI-3000A is turned on.

ENTER REMARK	X
	Y

PRECAL LED# 15	X	Shows the LED that is currently being calibrated (0 to 127, #15 shown).
	Y	

The PRECAL procedure is a first pass to approximately adjust the LED values.

CAL LED# 15	X
	Y

The current of each LED is increased until its brightness provides a 1.0 volt signal. Each LED is calibrated 4 times and then averaged.

At this point an error message will be displayed if a problem occurred during calibration. Error messages are discussed below.

CAL DONE PRESS KEY	X	The calibration was successful and it passed its performance check.
	Y	

Error Messages

If an error message occurs, power the LI-3000A off, then back on. Re-check the scanning head to be sure it is cleaned and free of any debris. Then do the calibration routine again. **If the error message persists, contact LI-COR.**

There are three error messages as listed below.

2 LEDS FAILED	X
PRECAL: CONT? N	Y

2 LEDS FAILED	X
CALIBRATION	Y

WARNING: NOISY	X	Some of the LEDs dipped below 0.7 volts during the performance check.
OR LOW LEDS	Y	

NOTE: The following information applies to calibrations for scanning heads with serial numbers 196 or below.

Read the note in the calibration discussion in Section I.

These heads require a specially configured console (a jumper is changed) and cannot automatically be calibrated by the console. Instead, their original calibration must be used. With instruments having serial numbers 196 and below, calibration is controlled by the head. With instruments having serial numbers 197 and above, calibration is controlled by the console.

Do a calibration using the special LI-3000A console. The LED values will all be 2's. The console will think it has just calibrated the head, but in reality the original head calibration is used.

VIEW CAL

LI-3000A	X	Use ↑ and ↓ to scroll through the file.
CALIBRATION	Y	

1: 55 37	X
2L 41 29	Y

The first LED is using a current level corresponding to 55 (approximately 55 mA). The possible range is 0 to 255. "37" is the base 16 equivalent to 55.

The ↑ and ↓ keys will scroll through the 128 calibration values. Press any key to return to the menu.

EDIT CAL

The Edit Cal routine allows the scanning head calibration data to be changed. Normally the calibration should never need to be manually changed. This routine may be of use in special cases if the head fails the autocalibration routine and the user wants to temporarily get the instrument working. If the instrument fails the autocalibration routine, then it does have a problem and should be returned to LI-COR for repair.

The only time it is desirable to change the calibration data is when the scanning head has a weak LED that cannot be lit to the same intensity as the other LEDs. The autocalibration routine will completely turn that LED off (its calibration value will be 0). Thus 1 mm² of area will always be counted for each millimeter of string travel for each LED that is off. By editing that LED to some nonzero value from 1 to 255, the LED may be made bright enough so that it no longer causes counts to appear when the string is pulled with an empty head. A typical value for the edited number may be about 100 (0 is off, 255 is brightest).

The accuracy of the instrument will generally be degraded after the calibration file is edited. This is especially true if the edge of the leaf is near the edited LED. (See to the Theory of Operation. The leaf/no leaf decision will no longer be at 50% for that LED).

The access code to get into this routine is FP5. This code is the same for all LI-3000As. Once a number is edited, an "e" will appear next to that number in the table. The edited calibration data can only be used until the instrument is turned off. A "CAL FILE LOST" message is displayed if the

instrument is turned off and back on, and the autocalibration routine must be used to recalibrate the head.

PRINT CAL

The calibration file is printed (via the RS-232C port) using this function.

PRINTING	X
	Y

A sample calibration table is shown on the following page.

On the 5th line of the header (noise at 0.9V is 0/12800 cnts), the 0 indicates that none of the LEDs dipped to 0.9V (1.0V is optimum). A non-zero number indicates that the head may have a few weak leads. On the 6th line if this number is non-zero, then the calibration either failed or probably would fail if run again.

If you encounter communication problems during printing, press the ← key to abort the routine.

Maintenance and Calibration

LI-3000A Calibration (Sample)

HEAD SR #1611

REMARK: XXX XXX XXX

3 MAY 1988 15:42:39

NOISE AT 0.9V IS 0/12800 CNTS

NOISE AT 0.7V IS 0/12800 CNTS

CAL MAX VAL: 80

CAL MIN VAL: 42

LED	DEC	HEX	LED	DEC	HEX	LED	DEC	HEX
LED	DEC	HEX						
1:	70	46	33:	46	2E	65:	47	2F
2:	49	31	34:	54	36	66:	52	34
3:	49	31	35:	52	34	67:	47	2F
4:	43	2B	36:	51	33	68:	46	2E
5:	48	30	37:	55	37	69:	47	2F
6:	47	2F	38:	47	2F	70:	46	2E
7:	48	30	39:	44	2C	71:	48	30
8:	48	30	40:	48	30	72:	52	34
9:	57	39	41:	54	36	73:	47	2F
10:	49	31	42:	53	35	74:	62	3E
11:	47	2F	43:	45	2D	75:	58	3A
12:	42	2A	44:	44	2C	76:	59	3B
13:	46	2E	45:	50	32	77:	66	42
14:	42	2A	46:	48	30	78:	54	36
15:	43	2B	47:	48	30	79:	52	34
16:	51	33	48:	56	38	80:	64	40
17:	47	2F	49:	54	36	81:	57	39
18:	46	2E	50:	58	3A	82:	67	43
19:	45	2D	51:	46	2E	83:	50	32
20:	47	2F	52:	48	30	84:	49	31
21:	60	3C	53:	52	34	85:	60	3C
22:	52	34	54:	43	2B	86:	48	30
23:	44	2C	55:	50	32	87:	46	2E
24:	58	3A	56:	48	30	88:	57	39
25:	49	31	57:	46	2E	89:	48	30
26:	46	2E	58:	50	32	90:	56	38
27:	54	36	59:	49	31	91:	48	30
28:	44	2C	60:	48	30	92:	54	36
29:	45	2D	61:	46	2E	93:	52	34
30:	50	32	62:	52	34	94:	62	3E
31:	50	32	63:	58	3A	95:	54	36
32:	56	38	64:	48	30	96:	58	3A
						127:	82	34
						128:	67	43

Section VI

LI-3050A Transparent Belt Conveyor Accessory

Setup and Adjustment

Loosen the knurled knobs (1a, Figure 8) on both sides of the upper pulley assembly. Leave the upper pulley in the down position and slide a transparent belt onto the assembly from the front. Lift the knurled knobs and tighten them when the desired belt tension is obtained.

Support the weighted lower most pulley (1b, Figure 8) with a piece of foam rubber to hold it in a maximum upward position. Slide a transparent belt onto the lower pulley assembly from the front. Remove the foam support and center the belt while lifting the lower pulley manually. When the belt is centered, release the lower pulley. The weight automatically provides adequate tension. Mounting the lower belt can be simplified by placing a sheet of paper under the lower surface of the upper belt to prevent cohesion as the lower belt is put into place.

IMPORTANT: Place the belts so that the edges and seems of one are slightly misaligned with the other. When the edges are aligned, background counts can occur.

Turn the knurled knob on the front of the lower pulley assembly (1c, Figure 8) counterclockwise to lower the scanning head support blocks. Open the scanning head and slide it into the LI-3050A (Figure 9). When the scanning head is inserted so that about 1/8" is protruding from the front of the LI-3050A, raise the scanning head support blocks by turning the knurled knob (1c, Figure 8) clockwise against the right hand stop.

Do not lower the scanning head support blocks while the belts are moving. Only lower scanning head support blocks when the scanning head is about to be removed.

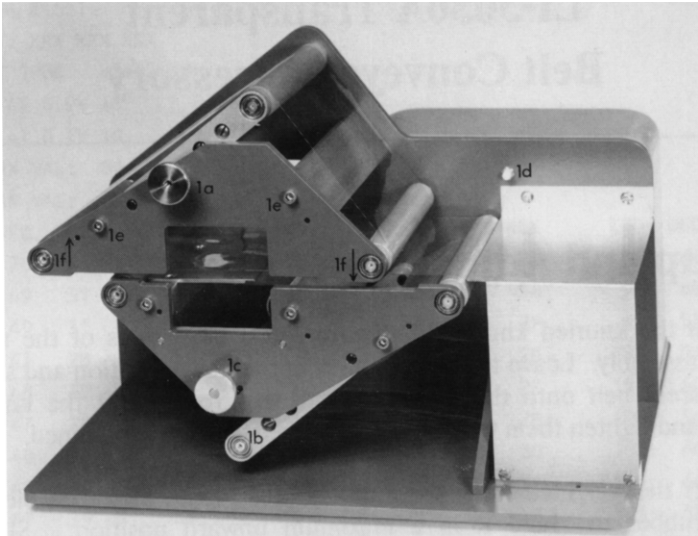


Figure 8. Transparent Belt Conveyor Accessory

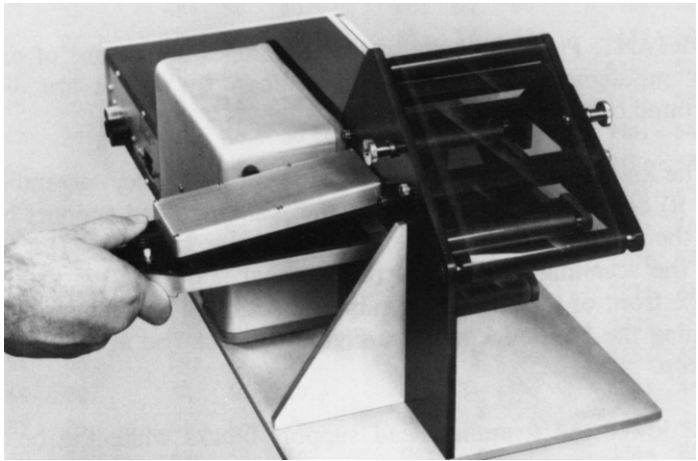


Figure 9 . Scanning Head Installation.

Connect the LI-3050A cord into LI-3050A connector on the side panel of the LI-3000A. **The LI-3000A must be turned off or unplugged during this step.** Check the 115/230 voltage selection switch before turning on the LI-3000A.

The LI-3050A is turned on and off by the power switch on the LI-3000A. There is not a separate power switch on the LI-3050A. Plug the LI-3000A into the proper AC source and turn on the instrument.

Reset the system by pressing the white button (1d, Figure 8) located above the LI-3050A sample hopper. Pressing the reset button has the same effect as pressing **CLEAR X** on the keypad.

Allow the 10 cm² (or 50 cm²) calibration disk to pass through the scanning head. Either catch the disk as it passes out of the system or place a pad on the instrument case. Failure to do this will eventually cause damage to the finish.

The calibration accuracy is adjusted by turning the "CAL ADJ" potentiometer on the console using a small screwdriver (see LI-3000A Theory of Operation). The resulting reading should be very near 10 cm².

The purpose of the "CAL ADJ" potentiometer is not to calibrate out spurious counts on a belt system, but rather to provide 1% accuracy on a clean belt. If the belt is dirty (resulting in spurious counts), it is preferable to clean the belt rather than to turn the "CAL ADJ" potentiometer.

If the belts do not track acceptably, loosen the hex screws (1e, Figure 8) on the front of the instrument and twist the upper pulley assembly. To produce inward belt travel, apply clockwise pressure to the upper pulley assembly (1f, Figure 8). The opposite procedure is used for the lower pulley assembly. Do not remove the screw. Loosen them only enough so that they remain finger tight. Probably no detectable movement will result as the rotation pressure is applied to the pulley assembly. Tighten the screw and observe the belt track. Adjust more as necessary.

Storage and Maintenance

When the LI-3050A is not in operation, place a block under one edge of the lower idler to remove tension from the lower belt. Release tension from the upper belt also. This prevents excessive belt stretching.

If the storage area is not very clean it is best to remove the belts prior to idle periods of more than a few days. Wrap the belts in paper (paper towels) in a manner that prevents cohesion.

The transparent belts can be cleaned with warm water and hand dish-washing detergent.

Do not lubricate the drive gears. This will interfere with the optical switch (part #141) which encodes the sample length.

Appendix A

LI-3000A Specifications

Resolution: 1 mm² (1 mm x 1 mm scanning area).

Accuracy: Within $\pm 2\%$ for samples $> 50 \text{ cm}^2$.

Display Capacity: Area: 9,999,999.99 cm², Length: 99,999,999.9 cm, Width: 12.8 cm

Display: 2 line x 16 character LCD

Keyboard: Sealed, 24 key tactile response.

Real Time Clock: Year, month, day, hour, minute, second.

Accuracy: ± 3 minutes per month (25 °C).

Internal Memory: 32K bytes RAM.

Memory Capacity: From 675 entries (675 files, 1 entry each) to 2385 entries (1 file, 2385 entries).

Communications: RS-232C hardwired Data Communications Equipment (DCE). Baud rates are selectable at 300, 1200, 2400, 4800, 9600.

Sample Dimensions

Width: 127 mm maximum, 1 mm minimum.

Thickness: 8 mm maximum.

Length: 1 meter maximum.

Scanning Speed: Length encoding cord drawing speed need not be constant. Error message indicates if encoding cord is drawn too fast ($> 1 \text{ meter s}^{-1}$).

Power Requirement: Rechargeable 6 V lead-acid battery; or 108-126/216-252 VAC, 48 to 66 Hz, 25 watt maximum.

Battery Capacity: 15 hours of continuous operation.

Recharging Time: 5-8 hours, instrument off. Charging circuitry built-in.

Battery Voltage Sensor: Automatically shuts instrument off when low battery condition exists. Also provides a low battery warning approximately 1 hour before shutdown. The remaining power maintains data stored in memory.

Operating Temperature: 0 to 55 °C, 0 to 80% RH (noncondensing).

Storage Temperature: -20 to 55 °C, 0 to 80% RH (noncondensing).

Scanning Head

LED Light Source: 6.4 mm from outer edge.

Size: 30.5 cm overall length (12.0 ").

Weight 680 g (1.5 lb.).

Readout-Control Unit

Size: 19.8 L x 15.5 W x 10.1 cm D (7.8" x 6.1" x 4.0").

Weight: 2.0 kg (4.4 lb.).

Appendix B

LI-3050A Specifications

Resolution: 1 mm² (1 mm x 1 mm scanning area).

Accuracy: Within $\pm 1\%$ for samples $> 10 \text{ cm}^2$.

Sample Dimensions

Width: 127 mm maximum, 1 mm minimum.

Thickness: 7.5 mm maximum.

Length: unlimited.

Conveyer Belt Speed: 6.3 cm s⁻¹ at 60 Hz; 5.4 cm s⁻¹ at 50 Hz.

Transparent Belts: Rugged clear vinyl.

Power Requirement: 108-126/216-252 VAC, 48 to 66 Hz.

Operating Temperature: 0 to 55 °C.

Storage Temperature: -20 to 65 °C.

Size: 27.9 H x 27.9 W x 38.1 cm L (11.0" x 11.0" x 15.0")

Weight: 7.7 kg (17.0 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.

Obtaining Service for Your Instrument

If, after following the operational and maintenance procedures in the instruction manual, you determine that your instrument is in need of service, you can help assure efficient servicing by following these guidelines:

- Some instrument problems can be resolved by discussing them with LI-COR on the telephone. If you would like to talk to someone about servicing your instrument before you return it, please give us a call at (402) 467-3576.
- If you have a electronic technician available, you may want to consider the 3000A/SM Service Manual for the LI-3000A. This manual contains the schematic diagrams, component layouts and designator lists for the

LI-3000A. It is designed to isolate electronic problems to the scanning head or to a specific board in the console. Contact LI-COR for information on ordering circuit board replacements.

- If you need to ship your instrument, use the original shipping carton or a package that provides adequate protection. The package should be insured for the value of the instrument against damage and loss. We recommend that you ship your packages air freight for the best protection (in the U.S. ship via air freight, parcel post, or United Parcel Service).
- For customers outside the U.S., contact your local LI-COR distributor or agent (if any) before returning your instrument.
- If you would like someone from LI-COR to contact you with a time or cost estimate before beginning your repair, please let us know by enclosing a letter with your instrument.
- Warranty repairs are invoiced at no charge (excluding customs fees in some countries). Other repairs are billed at an hourly rate for technician labor plus the cost of replacement parts. Recalibrations are billed at the standard prices indicated on the LI-COR price list. For repairs that are not under warranty, please include billing information when you return your instrument.



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