EXHIBIT D

(Part 3 of 5)

The method in which each half digit of the display is coded to represent a circuit board condition is by deleting a segment of the digit for a "good" or "bad" indication, or by displaying all segments if a board is not installed. This is shown in Figure 6-7.

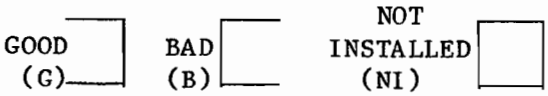


Figure 6-7. Coding of Display Digits for Self Test Result

As a result of the coding, the four digits in the display can be one of the characters shown in Figure 6-8 (an exception is shown in Table 6-7).

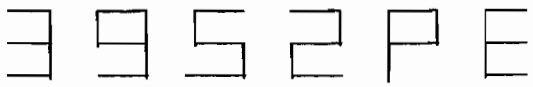
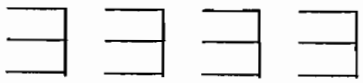


Figure 6-8. Characters Displayed in Self Test Result

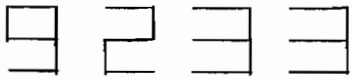
Table 6-7 shows all of the possible characters that could appear in each digit of the 4-digit Basic Panel Display. Any combination of these characters could make up the Self Test Result. Table 6-7 also indicates, within each half character, the circuit board number and its condition that caused the half character. The examples below show possible self test results and the meaning of each.

Example No. 1:



All boards installed and all good.

Example No. 2:



IEEE board not installed and Crosshead Control board bad.

Table 6-7. Characters Posssible in Self Test Result for Each Digit of Basic Panel Display

1st Digit	2nd Digit	3rd Digit	4th Digit
1 G 2 G	6 G 3 G	7 G *4	8 G 5 G
1NI 2 G	6NI 3 G	7NI *4	8NI 5 G
1 B 2 G	6 B 3 G	7 B *4	8 B 5 G
1 G 2 B	6 G 3 B	*(NOT POSSIBLE)	8 G 5 B
1NI 2 B	6NI 3 B	*(NOT POSSIBLE)	8NI 5 B
1 B 2 B	6 B 3 B	*(NOT POSSIBLE)	8 B 5 B

NOTES: 1. Numbers 1 through 8 represent console circuit boards.
2. Characters 3, 9, 5, 2, P and E result when indicated board is either Good (G), Bad (B) or Not Installed (NI). Also see text.
*3. Board No. 4 (Microcon Interface) is always displayed as "Good", so the characters 2, P and E are not possible in the 3rd digit.

6.6 SELECTING A LOAD CELL

The selection of a load cell is of primary importance when preparing for a materials test. A load cell of adequate capacity should always be used, and it should be selected in accordance with the characteristics of the material to be tested. Details for choosing a cell by calculating the approximate tensile strength of a specimen are contained in the Introduction to Testing (Appendix A of this manual).

As the load weighing system of the 4200 series instruments automatically ranges the load signal, setting load cell ranges before or during a test is not a concern of the user. This automatic ranging feature provides full scale load signal values at 100%, 50%, 20% and 10% of load cell maximum capacity.

The following general guidelines should be used when choosing a load cell:

a. The load cell capacity should be greater than the expected maximum testing loads.

b. If a choice is possible between two different cells because of overlapping ranges:

(1) Select a higher-capacity load cell whenever a minimum of deflection is desired. The system will range to lower full scale values of the cell.

(2) Select a lower-capacity load cell whenever a maximum long term balance or stability is desired. The system will range to higher full scale values of the cell.

The load cells and adapters recommended for use in tension and compression testing applications on a Model 4201 or 4202 are described and listed in Section 5.3.

6.7 INSTALLING A LOAD CELL

Testing on a 4200 series system is always done below the moving crosshead. A tension or a compression load cell is mounted in the crosshead and a grip or anvil is attached to the coupling extending below the crosshead. To install a load cell:

a. Before mounting the load cell, note the pattern of six threaded holes around its bottom flange. Install the cell into the center hole of the moving crosshead with its cable towards the rear (Figure 6-9). Align the two smaller threaded holes in the bottom of the cell with the captivated thumbscrews beneath the crosshead.

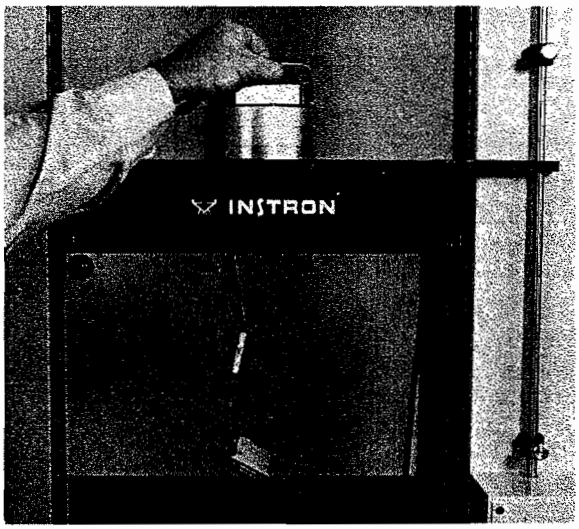


Figure 6-9. Installing a Load Cell

b. Fasten the load cell in place using the two captivated thumbscrews. If installing a compression cell, fasten it using the captivated thumbscrews or the four socket head cap screws provided with the cell as follows:

1. When installing the compression load cell rated at 50 N (10 lb, 5 kg), Catalog No.

2512-227, or the cell rated at 500 N (100 lb, 50 kg), Catalog No. 2512-228, secure the cell in the crosshead using the two captivated thumbscrews (fingertighten only) located beneath the crosshead. DO NOT use any other mounting screws for these types of cells.

2. When installing a compression load cell rated above 500 N capacity (Catalog No. 2512-229 or -230), use the mounting screws provided with the cell and tighten the screws to 50 in-lb (5.7 N-m).

c. Insert load cell cable plug into load signal cable connector on rear of crosshead.

6.8 INSTALLATION OF GRIPS AND FIXTURES FOR TENSION AND COMPRESSION TESTING

6.8.1 Selecting Grips and Fixtures

The use of proper grips and grip faces for testing materials in tension is crucial to obtaining meaningful results. Appendix A to this manual contains guidelines for the selection of grips and faces in relation to certain types of materials. In many cases it is trial and error that solves a particular gripping problem.

It is of particular importance that the rated loading capacity of the grips exceed, with a reasonable safety factor, the loading expected during a test. Appendix C contains information on many of the Instron grips and fixtures that are suitable for use with a 4200 series system.

When compression testing, usually the specimen is placed on a table, and the loading is applied by an anvil coupled to the load cell. In this case, the diameter (or area) of the anvil is important as well as its maximum loading capacity. Table 5-3 lists the compression anvil assemblies that are available for use with the 4200 series of load cells.

6.8.2 Installing Grips for Tension Testing

The standard method for mounting grips is by the use of an adapter coupling for attaching the upper grip to the load cell, and by the use of a base grip adapter for attaching the lower grip. The tension coupling options available for use with the 4200 series load cells are listed in Table 5-2.

To install the upper grip, attach a coupling to the load cell using the retaining pin provided with the cell. Then attach the upper grip to the coupling using the pin provided with the coupling. This type of double-pin mounting allows the upper grip to be self-aligning.

The base grip adapter supplied with a 4200 series instrument includes a retaining pin and a compression (preload) spring. The spring supports the weight of the lower grip which prevents a discontinuity in the initial loading applied to a specimen. For best results, always ensure the spring is in place. When installing the lower grip (Figure 6-10), push down to compress the spring and then insert the retaining pin.

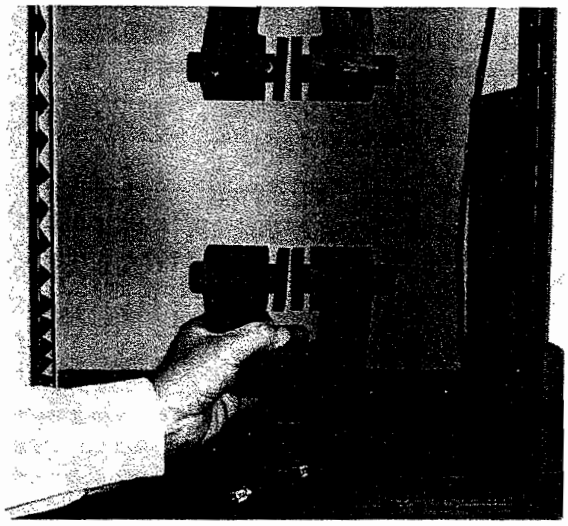


Figure 6-10. Installing Grips

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NOTE

The installation of Instron pneumatic grips, requires additional procedures for mounting an Air Kit. Complete instructions are included with the kit.

6.8.3 Installing Fixtures for Compression Testing

The optional compression anvils listed in Table 5-3 include a locknut and a tommy bar. Before installing an anvil on a 4200 series load cell, thread the locknut completely onto the anvil. Install the anvil in the load cell coupling using the retaining pin provided with the cell. Turn the locknut firmly up against the coupling in order to tighten the connection. This will remove any discontinuity in loading caused by a loose pin. When removing the anvil after testing, use the tommy bar to loosen the locknut if it becomes jammed.

To mount the optional compression table (part no. T506-44), remove the base grip adapter: On the Model 4201, remove the socket head cap screw (M10) from the center of the adapter; on the Model 4202, remove four socket head cap screws (M10) from the adapter flange. Remove the rubber mat, then place the table in the center of the base and rotate it until the aligning pin engages the mating hole.

NOTE

When installing the base grip adapter for use in tension testing on the Model 4201 or 4202, torque the mounting screw(s) to 40 ft-lb (54 N-m).

6.9 SELECTING OPERATING UNITS

6.9.1 Switching Units

The operating units (English, metric, S.I.) in use in a 4200 series system is controlled by the position of the Units Selection switch (S4) located internally on the console motherboard. This switch should normally be set for the choice of units before powering up the system. When power is applied, the choice will be shown by the units indicator on the Basic Panel. If this switch has been changed since the last time the system was powered up, the Basic Panel Display will show "LOSS". This indicates that nonvolatile memory is reset to the default state and stored test data is lost. Load and strain channels must be recalibrated and electronic limits reset.

To gain access to the units selection switch, remove the corner panel from the left rear of the console by rotating the latch $^1/_4$-turn and pulling the panel straight back. This will expose the switch location (Figure 6-11).

NOTE

There are no dangerous voltages accessible by the user when the rear corner panel of the console is removed.

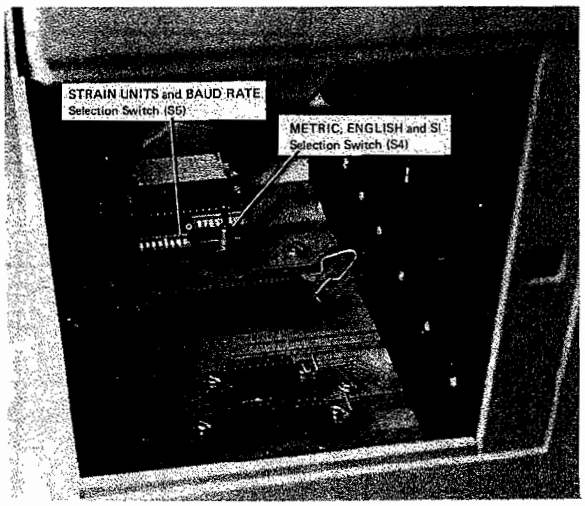

Figure 6-11. Location of Operating Units Selection Switch

The Units Selection switch has three positions, as viewed from the rear: to the left is METRIC; center is ENGLISH; and to the right is S.I. After setting the switch, install the corner panel and turn the latch to lock it in place.

If the units selection switch position is changed with power applied to a calibrated system, the front panel units indicator will not change. One of the following procedures must be performed to make the units change valid:

1. Cycle main power off then on;

2. Enter the system reset sequence: Press S1, then [0] and [ENTER] on the keypad; or,

3. Enter the "warm start" sequence: Press switch, S1, then [1] and [ENTER] on the keypad.

After switching units and performing one of the above procedures, the Basic Panel display will show "LOSS", indicating that nonvolatile memory is reset to the default state and stored test data is lost (see IMPORTANT NOTE).

IMPORTANT NOTE

After changing operating units for a calibrated system, the load and strain channels must be recalibrated and all limits reset (load, extension, strain 1 and 2).

6.9.2 Operating Units for Self Identified Load Cells and Loading Frames

The units that are used for load, extension and speed are listed in Table 6-8. These units provide the scaling for the Display Panel and recorder options, and are the units that appear on a printout of test results.

NOTE

When Area Compensation is not equal to 1.000, the load signal to the LOAD display and recorder are scaled by 1/AREA (normalized). A printout will show load units/Area (e.g, LB/A). (See Section 7.8.4.)

The units in use depend upon the selection of English, metric or S.I.

Table 6-8. Operating Units for Self Identified Load Cells and Frames

Parameter	English Units	Metric Units	S.I. Units
* Load	Pounds (LB) KLB (LB x 10^3) LB (LB x 10^0) MLB (LB x 10^{-3})	Grams Force (GF) KKGF (GF x 10^6) KGF (GF x 10^3) GF (GF x 10^0)	Newtons (N) KN (N x 10^3) N (N x 10^0) MN (N x 10^{-3})
Extension	Inches (IN) IN (IN x 10^0)	Millimeters (MM) MM (MM x 10^0)	Millimeters (MM) MM (MM x 10^0)
Speed	Inches/Minute IN/MIN	Millimeters/Minute MM/MIN	Millimeters/Minute MM/MIN

* Load values are scaled by 1/Area when Area Compensation is $\neq$ 1.000.

type, as described in Section 6.9.1. The units shown for load and extension appear only if the load cell and loading frame, respectively, are self-identified (see Section 6.9.3).

6.9.3 Operating Units for Non-Self Identified Load Cells and Loading Frames

If the load cell (or loading frame) were not self-identified, then the units for load (or extension and speed) would be printed as:

"LD" for Load

"EX" for Extension

"SP" for Speed

If a non-self identifiable load cell is used, the scaling of the load parameter for the LOAD display, recorder and printer options depend upon the full scale value of the cell. This is entered by the user during the calibration procedure. Also, if Area Compensation is not equal to 1.000, load is scaled by 1/Area and LD/A would be printed.

If the loading frame is not self identified, then the scaling of the extension parameter for the EXTENSION display, recorder and printer options and the speed parameter depend upon the units in use (inches or millimeters). The user must record this separately.

6.9.4 Area

There are no units associated with Area Compensation (AREA on the Basic Panel). A printout of test results always lists Area values. This feature is fully described in Section 7.8.4.

6.9.5 Energy Units

The units shown on a printout of Energy depend upon the current units used for load and extension (English, metric, S.I.). Also, energy units are printed as being divided by Area (1/A) whenever Area is not equal to 1.000.

Energy units consist of the combination X*Y Z/A, where:

X = units of Load (LB, etc.)

* = multiplication

Y = variable of distance (Extension or Strain)

Z = units of distance (IN, etc.)

/A = 1/Area (used when A $\neq$ 1.000)

Examples of Energy units printout:

English units	LB*EX IN/A
Metric units	KGF*EX MM/A
S.I. units	N*EX MM/A

6.10 CONNECTING ACCESSORIES

As part of the preparation for testing routine, the user should connect any cabling required for peripheral readout and control accessories before powering up the system. These accessories include a strain measuring device, a recorder, printer, Microcon II Data Processor, or a computer (IEEE-488). Any optional panels or circuit boards required to use these accessories would have been installed previously (see Chapter 4).

A printer and programmable computer connect directly to the rear panel of the console, using the cables provided with these options. A Microcon II cable is brought through the clamp in the rear panel when its related circuit board is installed.

The cables for a recorder and strain measuring device plug in to connectors on the console mother-

board (reference Figure 5-8). To install these cables, remove the corner panel from the left rear of the console by rotating the latch $^1/_4$-turn and pulling the panel straight back. Remove the screws holding the cable clamp, then feed the cable through the clamp and plug it into the connector (Figure 6-12.)

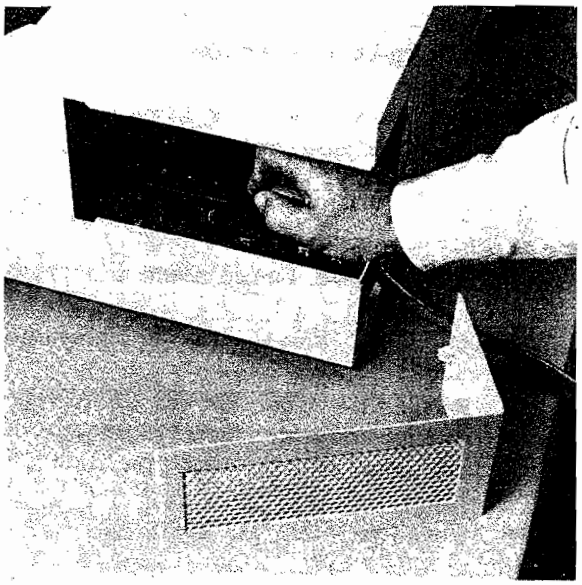

Figure 6-12. Installing Accessory Cables In Console

Plug a recorder cable into the jack labeled RECORDER-J9. Plug an A504-19 cable into STRAIN 1-J7 for a Strain Gage Extensometer, and into STRAIN 2-J8 for an Instron XL Extensometer or a type of extensometer using an LVDT. Position the cable(s) carefully in the clamp and secure it with the screws removed initially. Install the corner panel and turn the latch to its locked position.

6.11 SETTING PRELOAD LEVERS

The crosshead preload levers must be properly set before starting a test, as shown by the labels on the crosshead. The arrowheads on the labels indicate the direction of increasing load. For example, when tension testing the crosshead will move up for increasing load, so pull the left-hand lever towards the front (Figure 6-13) and push the right-hand lever towards the rear. Do not apply excessive pressure when setting the levers.

When the preload levers are properly set, the crosshead drive nuts impart motion to the crosshead with the initial turning of the leadscrews. The drive nuts are loosened for tension testing and tightened for compression testing.

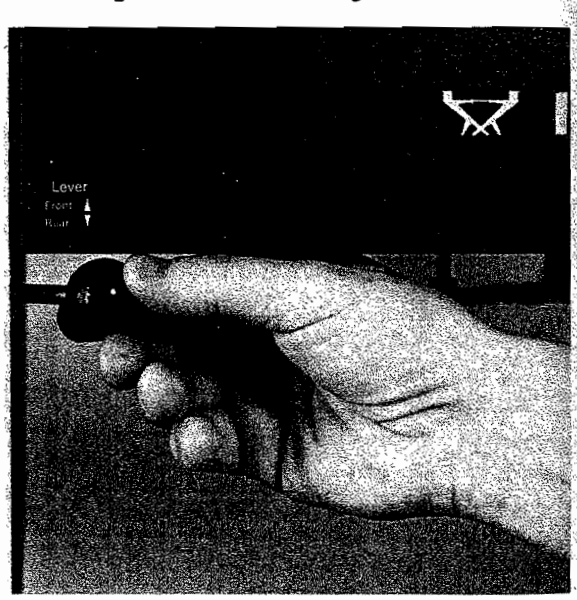

Figure 6-13. Setting Crosshead Preload Levers

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7.0 OPERATING A BASIC SYSTEM

7.1 OPERATING CONSIDERATIONS

This chapter describes how to set up and operate a Model 4201 or 4202 basic system. Chapter 8 describes how to set up and use the various options for the systems.

This chapter is arranged so the user can progress through the procedures involving pretest parameters common to all tests. Additional procedures for optional functions and equipment can be selected from Chapter 8. Thus, a test setup can be adjusted to the capability of a system - from basic to all options.

A typical test worksheet is included in Chapter 9 which will enable the user to preplan a test program. With the blank spaces filled in where applicable, the worksheet serves as a permanent record for future reference. This record is important even for repetitive testing routines during which parameters may remain unchanged for a period of time. Even though most parameters are stored in the nonvolatile memory (Section 6.3), these would revert to a default value if the system reset sequence, [S1] [0] [ENTER], was performed.

Appendix A to this manual provides essential information for the user who needs assistance in planning a materials testing procedure. A section on the introduction to testing contains details about determining load requirements, establishing gage length and choosing a testing speed.

Appendix B is a glossary of mechanical properties and tests for materials testing applications. This should be referenced by the user who requires knowledge of specific testing terms.

7.2 TURN INSTRUMENT ON: WARM-UP PERIOD

NOTE

Sections 6.6 through 6.11 describe pretest functions which may be done before applying system power. In some cases, however, grips and fixtures may have to be installed after calibration, depending upon the procedure used and the type of load cell installed.

To power a Model 4201 or 4202 instrument, set the main power switch on the front panel of the loading frame base to on. The switch will light and both units of the system will receive power, if interconnections were made in accordance with Chapter 4 of this manual.

When power is applied, an automatic Self Test Routine is performed as described in Section 7.3.

Allow a warm-up period of at least 15 minutes to assure load cell stability. This warm-up period is also necessary whenever a load cell is changed.

7.3 SELF TEST ROUTINE AT POWER UP

The following sequence of events occurs during the automatic self test of a 4200 series system when main power is applied. The user should monitor this routine closely, as it provides assurance of the reliability of the system before proceeding with test programs. (See Section 6.5 for details of this feature and user interaction.)

A. Turn instrument on. Scan all front panels and control panel during Self Test Routine and observe following action:

1. All lamps light, including the control switches and back-lit status indicators, and all displays show "-1.8888" for up to 10 seconds.

2. All lamps go out and all displays are blank for up to 5 seconds.

3. Self Test Result shows on Basic Panel Display for up to 5 seconds, then disappears (see NOTE). If Self Test Result remains on display, then system can not be operated and maintenance is required.

NOTE

The Self Test Routine can be repeated by pressing the Reject key (REJ) on the keypad during the time period when the Self Test Result shows on the Basic Panel Display. This allows the lamp test to be observed again. Also, if the Self Test Result remains on the display, which would indicate a failure, a second test might pass (CAUTION: This can indicate an intermittent condition or marginal failure).

B. After a successful Self Test, observe the following actions (depending upon options installed):

1. On Control Panel, the STOP switch is lit.

2. On Basic Panel:

a. The display is blank, except it will show "LOSS" if the operating units (Section 6.9.1) or the strain mode (Section 8.11.2) has been changed before turning power on.

b. The AT G.L. lamp is flashing.

c. An operating units status indicator is lit.

d. A TESTING AREA indicator is lit.

e. A STRAIN indicator is lit (if Strain option is installed).

3. If a Recorder Panel option is installed, an X-AXIS SELECT key lamp is lit.

4. If a Display Panel option is installed:

a. A display mode selection key lamp is lit.

b. If no prior values were stored, the displays show: LOAD, "----"; EXTENSION, ".000"; STRAIN, "----".

5. If a Limits Panel option is installed, a Limits Status lamp may be lit.

The particular lamps and indicators that are lit at the end of a Self Test Routine will vary depending upon the state of the system. That is, variables and functions may not be at the default state (see Table 6-5) due to a previous test which would be stored in the nonvolatile memory.

If the System Reset sequence is entered as described in Section 7.4, the default state will be restored.

7.4 SYSTEM RESET AT INITIAL POWER UP

When a 4200 series system is received and is initially powered up, it is recommended that a System Reset sequence be entered at the end of the Self Test Routine. This will ensure that system data storage is at the default state (Table 6-5).

To enter a System Reset: Press S1 on the Basic Panel, then press "0" and "ENTER" on the keypad; the Basic Panel Display will show "LOSS" after this sequence, which indicates to the user that any previously stored conditions or data is lost.

7.5 CALIBRATION

7.5.1 Overview

The calibration procedure precisely calibrates the load weighing system for the load cell in use. The system then is able to provide an accurate load signal which is automatically ranged during a test over 100% (X1), 50% (X2), 20% (X5) and 10% (X10) ranges of the load cell maximum capacity.

The calibration procedure will vary depending upon the type of load cell installed, which can be one of the following:

1. Self identifying and electrically calibrated (see Section 5.3.2).

2. Self identifying and mechanically calibrated.

3. Non-self identifying and electrically calibrated (see Section 5.3.4).

4. Non-self identifying and mechanically calibrated.

The procedures for calibrating all four types of load cells listed above are given in this section. These procedures, for the most part, involve entries of simple key sequences by the user.

Calibration also completes an operating reliability check of the Load Sensor Conditioner Board (see Self Test Routine, Section 6.5). The system responds to a bad calibration procedure by flashing the BAL or CAL lamps. If either of these lamps flash, the user must correct the error before proceeding. Section 7.7 includes a table of possible causes and solutions.

A test cannot be started while the LOAD CAL or LOAD BAL lamp is lit, and the calibration and balance functions are locked out while a test is running.

It is recommended that calibration be checked at least once a day during continuous operation.

7.5.2 Electrical Calibration of Self Identifying Load Cells

NOTE

When electrically calibrating a 4200 series dedicated load cell, the balance operation is performed automatically.

To calibrate the load weighing system with a self identifying electrically calibrated tension or compression load cell installed:

a. Press LOAD CAL key. The Basic Panel Display shows the maximum capacity of the cell and the LOAD CAL lamp lights.

b. Press ENTER on the keypad. After about 6 seconds, the LOAD CAL lamp goes out and the display goes blank indicating that calibration is completed. (Go to Section 7.6.)

7.5.3 Mechanical Calibration of Self Identifying Load Cells

To calibrate the load weighing system by mechanically calibrating with a self identifying load cell installed:

a. (1) If using a tension load cell, install a pin or other device in the load cell coupling for hanging a calibration weight.

(2) If using a compression load cell, set the cell on its cap on the base of the loading frame. Install an anvil on the load cell coupling.

b. Press LOAD BAL key. The LOAD BAL lamp lights.

c. Press ENTER on the keypad. After about 3 seconds, the LOAD BAL lamp goes out indi-

cating that the balance function is completed.

d. Hang calibration weight from tension cell coupling, or set weight on anvil of compression cell.

e. Press LOAD CAL key. The Basic Panel Display shows the maximum capacity of the cell and the LOAD CAL lamp lights.

f. On numeric keypad, key in value of calibration weight.

g. Press ENTER. After about 6 seconds, the LOAD CAL lamp goes out and the display goes blank indicating that calibration is completed.

i. Remove calibration weight and fixture from load cell. If calibrating a compression cell, install it in crosshead.

j. Press LOAD BAL key. The LOAD BAL lamp lights.

k. Press ENTER. After about 3 seconds, the LOAD BAL lamp goes out indicating that balance function is completed. (Go to Section 7.6.)

7.5.4 Electrical Calibration of Non-Self Identifying Load Cells

To calibrate the load weighing system with a non-self identifying electrically calibrated tension or compression load cell installed:

a. Press LOAD BAL key. The LOAD BAL lamp lights.

b. Press ENTER. After about 3 seconds, the LOAD BAL goes out indicating that balance function is completed.

c. Press LOAD CAL key. The LOAD CAL lamp lights, but the Basic Panel Display goes blank indicating that the load cell cannot be identified.

d. On numeric keypad, key in maximum capacity of load cell.

e. Press ENTER.

f. On numeric keypad, key in value of the calibration weight equivalent of the electrical calibration signal. For the Instron low capacity tension load cells (Section 5.3.4), this number would be as shown in Table 7-1 (for example, 200 for the 2512-101 cell).

Table 7-1. Low Capacity Load Cells Calibration Data

Tension Cell Catalog No.	Max. Cap.	Cal. Signal Weight Eqv.
2512-136	50 g	20 g
2512-101	500 g	200 g
2512-122	5 N	2 N

g. Press and hold calibration button on the load cell and press ENTER.

h. After about 6 seconds, the LOAD CAL lamp goes out and the display goes blank indicating that calibration is completed. Release calibration button.

i. Press LOAD BAL key. The LOAD BAL lamp lights.

j. Press ENTER. After about 3 seconds, the LOAD BAL lamp goes out indicating that balance function is completed. (Go to Section 7.6.)

7.5.5 Mechanical Calibration of Non-Self Identifying Load Cells

To calibrate the load weighing system by mechanically calibrating with a non-self identifying load

cell installed:

a. (1) If using a tension load cell, install pin or other device in coupling of cell for applying a calibration weight.

(2) If using a compression load cell, set the cell on its cap on the base of the loading frame. Install an anvil on the cell coupling.

b. Press LOAD BAL key. The LOAD BAL lamp lights.

c. Press ENTER. After about 3 seconds, the LOAD BAL lamp goes out indicating that balance function is completed.

d. Press LOAD CAL key. The LOAD CAL lamp lights, but the Basic Panel Display goes blank indicating that the load cell cannot be identified.

e. On numeric keypad, key in maximum capacity of load cell.

f. Press ENTER.

g. Hang calibration weight from tension cell coupling, or set weight on anvil of compression cell.

h. On numeric keypad, key in value of calibration weight.

i. Press ENTER. After about 6 seconds, the LOAD CAL lamp goes out indicating that calibration is completed.

j. Remove calibration weight and fixture from load cell. If calibrating a compression cell, install it in crosshead.

k. Press LOAD BAL key. The LOAD BAL lamp lights.

l. Press ENTER. After about 3 seconds, the LOAD BAL lamp goes out indicating that balance function is completed. (Go to Section 7.6.)

7.6 INSTALL GRIPS AND FIXTURES: BALANCE LOAD WEIGHING SYSTEM

The installation of grips and fixtures (Section 6.8) may be done before or after calibration, depending upon the type of load cell installed. Also, grips or fixtures may be changed between tests, in which case system calibration does not have to be repeated. However, it is necessary to balance out the tare weight of grips and fixtures whenever these are added or changed and the system has been calibrated.

NOTE

Always balance a calibrated load weighing system whenever grips and fixtures are added or changed.

To balance load weighing system:

a. Press LOAD BAL key (Figure 7-1). LOAD BAL lamp lights.

b. Press ENTER. After about 3 seconds, LOAD BAL lamp goes out and balance function is completed. (See Section 7.7 if LOAD BAL lamp flashes.)

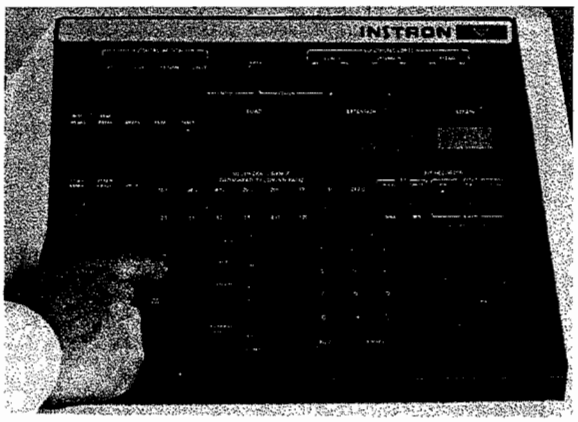

Figure 7-1. Balancing Load System

7.7 CALIBRATION AND BALANCE ERRORS

A 4200 series system signals the user when a problem exists in a transducer calibrating or balancing procedure. This warning is easily identified by the flashing of the LOAD CAL or LOAD BAL LAMPS for load cells, or the STRAIN CAL or STRAIN BAL lamps for extensometers. Also, if the 4200 system cannot properly read the identification of an identifiable transducer the Basic Panel Display will be blank.

Table 7-2 shows the probable causes and solutions for a flashing CAL or BAL lamp for either a load or strain transducer, and several other possible calibration problems.

Table 7-2. Transducer Calibration or Balance Errors

Calibration or Balance Error	Probable Cause	Solution
CAL lamp flashes after a self identifying transducer is calibrated automatically.	1. Transducer is not connected. 2. Transducer is defective. 3. Transducer interface board defective.	1. Check all cable connections. 2. Try another transducer. 3. Run self test.
CAL lamp flashes after a transducer is mechically calibrated using ing a weight or a calibration fixture.	1. Transducer is not connected. 2. Transducer is defective. 3. Calibration setting is over 102% or below 2% of transducer max. capacity. 4. Wrong full scale or calibration setting value entered on numeric keypad.	1. Check all cable connections. 2. Try another transducer. 3. Add proper weight or adjust fixture. 4. Check all figures and reenter.
BAL lamp flashes after a transducer is calibrated or balanced.	System was unable to remove tare weight of grips or fixtures.	Tare weight over 100% of transducer capacity. Remove weight by using lighter fixtures.
When LOAD CAL key is pressed: (1) The wrong value of transducer capacity appears on the Basic Panel Display; or (2) No value appears.	1. Operating units have not been changed to required types. 2. Transducer is non-self identifying.	1. Check units indicator for proper type. If wrong, turn off power, change units then turn power on and recalibrate. 2. Use mechanical calibration procedure.
CAL lamp remains on.	1. ENTER key was not pressed. 2. Wrong calibration sequence used.	1. Press ENTER. 2. Redo calibration procedure.

7.8 PRETEST SETUP PROCEDURES

7.8.1 Establish Gage Length

Gage length is the spacing between specimen contact faces of the upper and lower grips or fixtures at the start of a test, and establishes the initial length of the specimen. The choice of a suitable gage length depends upon the material under test (see Appendix A, Introduction to Testing). To ensure a uniformity in specimen length, this spacing must be the same for all similar tests. This requires that the moving crosshead return and stop at a preset limit, or gage length, at the conclusion of each test.

On a 4200 series system, gage length, the current spacing between grips or fixtures, is entered into memory whenever the G.L. RESET key is pressed. This feature provides a very accurate gage length setting.

Set gage length by driving the moving crosshead up or down, as required, using the JOG keys on the Crosshead Control Panel. Measure the spacing between contact faces of upper and lower grips, or anvil and compression plate, with a ruler. Then press the G.L. RESET key.

An alternate method to set gage length if the optional Display Panel is installed, is to carefully bring the grip faces (or anvil and compression plate) together using the JOG keys. Press the G.L. RESET key to reset the EXTENSION display to zero. Then drive the crosshead up until the required spacing is displayed (in inches or millimeters), and press the G.L. RESET key.

If the AT G.L. lamp had been flashing, indicating a power shutdown or system reset had occurred, it will become steady when the G.L. RESET is pressed. This lamp will go out whenever the crosshead is moved from gage length, but will relight when the crosshead is returned.

NOTE

Once gage length has been set, the crosshead will always return to this position upon a RETURN command.

7.8.2 Setting Crosshead Travel Limit Stops

The crosshead travel limit stops (Figure 7-2) are a safety feature which should be set after establishing gage length and before starting a test. If the user neglects to stop the crosshead properly or a system failure prevents the crosshead from stopping automatically at gage length (or at optional electronic limits), the stops will be contacted by the actuator on the crosshead, a limit switch will open, and the crosshead will stop.

CAUTION

Always set the crosshead travel limit stops before starting a test.

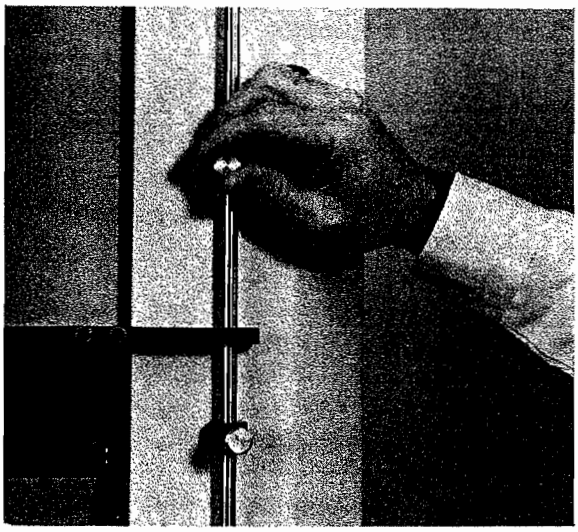

Figure 7-2. Setting Crosshead Travel Limit Stops

Set the upper limit stop to a point just beyond the expected maximum travel (extension) in the UP direction when tension testing, or just before gage length when compression testing. Tighten the stop securely on the limit switch rod.

Set the lower limit stop to a point just beyond the expected maximum travel (extension) in the DOWN direction when compression testing, or just before gage length when tension testing. Tighten the stop securely on the limit switch rod.

7.8.3 Set Crosshead Speed

The testing (crosshead) speed selected depends upon the type of material being tested. Some examples of typical speeds are given in Appendix A, Introduction to Testing. Usually, a testing rate is specified as (1) specimen strain rate in inches per inch per minute (or mm/mm/min); (2) percentage of specimen extension or compression per minute; or (3) as crosshead speed in inches (or mm) per minute.

When selecting a crosshead speed, the following should be considered:

1. Characteristics of the specimen material.

2. Total elongation or compression of specimen during the test.

3. Maximum speed of recorder response.

Speeds selectable and within specification for the Model 4201 range from 0.5 to 500 mm/min (0.02 to 20 in/min) for loads up to maximum capacity (5kN, 1125 lb, 500 kg).

Speeds selectable and within specification for the Model 4202 range from 0.5 to 500 mm/min (0.02 to 20 in/min) for loads to 5kN (1125 lb, 500 kg), and up to 250 mm/min (10 in/min) for loads between 5 kN to 10 kN (1125 lb to 2250 lb; 500 to 1000 kg).

CAUTION

If loading on the Model 4202 crosshead exceeds 5 kN (1125 lb, 500 kg) at speeds over 250 mm/min (10 in/min), the speed accuracy may not be within specification.

NOTE

If a crosshead speed is entered beyond the maximum range of the Model 4201 or 4202, it will not be accepted by the system. The maximum speed will automatically be set.

Set crosshead speed by entering the following key sequence:

a. Press SPEED key. A number will appear on the Basic Panel Display (either default value or a previously set speed).

b. Enter desired speed on numeric keypad (up to four digits and a decimal point). The displayed number will flash, indicating that it has not been entered into the system.

c. Press ENTER. The number will stop flashing.

NOTE

Crosshead speed may be changed at any time during a test by entering the above sequence.

7.8.4 Area Compensation

Area Compensation is a feature of the 4200 series systems which allows

the load signal to be calibrated in terms of stress (Load/Area). Thus, specimens of similar material but different cross-sectional area can be tested and a relationship established between the applied force and the specimen size. Appendix A, Introduction to Testing, contains a description of area compensation.

A 4200 series system will accept values of area compensation ranging from 9.999×10^{-50} minimum to 9.999×10^{50} maximum. The default value is 1.000×10^{0}, as expressed in scientific notation. However, the actual number is entered through the keypad using floating point format with values that can range between 9.999E-50 to 9.999E50. The default value is 1.000E00 in this format.

An area compensation value is entered by two key sequences. The initial sequence enters a base number, or mantissa, between 1.000 and 9.999. This number is the normalized value of the specimen cross-sectional area.

EXAMPLE

Specimen cross-sectional area $A = 0.156\ in^2 = 1.56 \times 10^{-1}$
Enter 1.56 (normalized value) as the mantissa.

After the first key sequence, the letter "E" and two digits appear on the display; this is the current exponent (power of 10) of the area value stored in nonvolatile memory. The second key sequence enters the exponent of the area value in the form of two digits ranging from -50 to 50, where the absence of the "+" sign denotes a positive number.

EXAMPLE

Specimen cross-sectional area $A = 0.156\ in^2 = 1.56 \times 10^{-1}$.
Enter -01 as the exponent of the area value.

The load signal output to the LOAD display and to a recorder is divided by the mantissa of the area value only. Therefore, stress (Load/Area) as indicated by these two devices is normalized in relation to actual stress. However, with the load sensitivity adjusted in proportion to specimen size, (area compensated) the recorder scale remains accurately calibrated in terms of stress (force per unit area).

CAUTION

To avoid overloads when area compensation is used, always determine the Maximum Allowable Stress for the load cell in use. (Important! See Appendix A, Section A.8.3.)

The parameters of stress (L/A) and energy are printed using the mantissa and exponent of the area value (see Section 8.8.5). Thus, actual stress based on the original cross-sectional area of the specimen can be read directly with an optional printer.

Set area compensation by entering the following key sequences:

a. Press AREA key. The SET lamp will light, and a number will appear on the Basic Panel Display (either the default value or the value of a previously set area compensation).

b. Enter mantissa (base number) of desired area compensation on keypad. This must be a number between 1.000 and 9.999 which is the normalized value of the specimen cross-sectional area. The displayed number will flash, indicating that it has not been entered into the system.

c. Press ENTER. If the number entered is not 1.000 and the exponent is not E00 (see Step d), then the ≠1 indicator will light. The entered number will disappear and the display will show "E" and two digits.

d. Enter exponent of area compensation number. (See IMPORTANT NOTE No. 1 below.) This must be a number between -50 and 50. The system will limit larger numbers to these values. If the required exponent is a positive number, press the ± key only if the currently displayed number is a negative quantity. The number will flash until it has been entered into the system.

e. Press ENTER. The exponent will disappear and the number set in Step b will reappear. Repeatedly pressing ENTER will cause the displayed value to alternate between the mantissa and the exponent.

IMPORTANT NOTES

1. Always record the load (stress) and energy data stored from a previous test before changing the exponent of the area compensation value. Otherwise, this data will be in error as it is immediately assigned the value of a newly entered exponent.

2. If the maximum and minimum load limits are used on the optional Limits Panel, these should be reset in accordance with the increased or decreased load channel sensitivity due to area compensation (the normalized value only, not the exponent) (see Section 8.7).

3. Area compensation is temporarily set to 1.000E00 (1.000×10^0) during a load cell calibration procedure. Any prior set value is restored when the procedure is completed.

7.8.5 Install Specimen for Basic Tension or Compression Test

Install specimen in the grips for tension testing, or on the compression plate or other fixture for compression testing.

The gage length has been set at this point, so do not move the crosshead. If the specimen does not fit, either trim it or change the gage length. Tighten the upper grip first (Figure 7-3). If this causes a preload, do not perform a balance procedure to compensate for it, as this is the initial loading on the specimen.

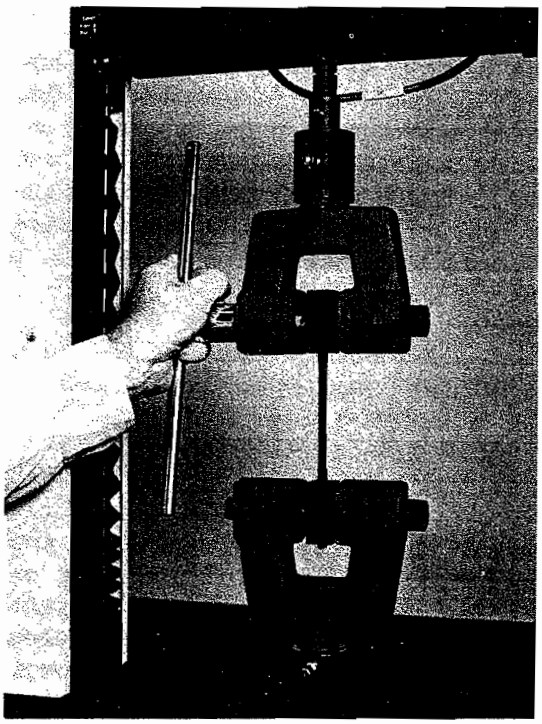

Figure 7-3. Installing Specimen for Tension Testing

7.8.6 Set Testing Area

The TESTING AREA function on the Basic Panel is not essential to the operation of the system unless pneumatic grips are being used with an optional Air Kit, or cycling is to be done using the optional Limits

Panel (Section 8.7). It is important, however, that this function be properly set so that the automatic overload detection circuit will stop a test if the load is overranged (see CAUTION below). The default condition (Table 6-5) for the TESTING AREA function is BELOW XHEAD.

The TESTING AREA function should be changed for one of the following two conditions only:

1. The sign of the output signal of the installed load cell is positive (+) for compression (applies to 2511-200 series compression cells only.) See NOTE below.

NOTE

When using a 2511-200 series compression cell and the TESTING AREA function is set to ABOVE XHEAD, it is necessary that any strain extensometer used also has a positive (+) output when compressed. If the sign of the extensometer is not the same as the sign of the load cell, the optional strain limits will not function properly. This can be corrected if the polarity of the extensometer output is reversed. Consult an Instron Regional Sales and Service Office if assistance is needed.

2. The load cell, other than a 2511-200 series compression type, is mounted for testing above the moving crosshead (requires special fixturing).

Note that for normal operation, the TESTING AREA function should be set to BELOW AHEAD. This applies to the 2512 series compression cells also.

To change TESTING AREA it must be enabled by initially pressing S1. The Basic Panel Display will show "SL". The TESTING AREA key can be pressed and the function changed to BELOW XHEAD or ABOVE XHEAD while this condition is active.

IMPORTANT NOTE

The TESTING AREA key stays enabled, with "SL" remaining on the display, until another key sequence is entered, such as: [S1] [0] through [S1] [6], [SPEED] or [AREA].

CAUTION

Before starting a test, always ensure that the TESTING AREA function is properly set. If it is not and a load overrange condition is detected, the LOAD status indicator will flash but the crosshead will not stop and damage to the load cell could occur.

7.8.7 Running Tests on a Basic System

The procedures in Sections 6.6 through 6.11, and in this chapter, have prepared a Model 4201 or 4202 basic system for a simple tension or compression test. A listing of these procedures is included in Section 7.8.8.

The output of a test with only a load cell installed is a load signal of 0 to ±10 vdc. This signal may be monitored if the system includes an optional Display Panel, and recorded if an optional Recorder Panel or Printer is installed. These and other optional accessories are described in Chapter 8.

Start a test by pressing the UP key on the Crosshead Control Panel for a standard tension test (Figure 7-4), or the DOWN key for a standard compression test.

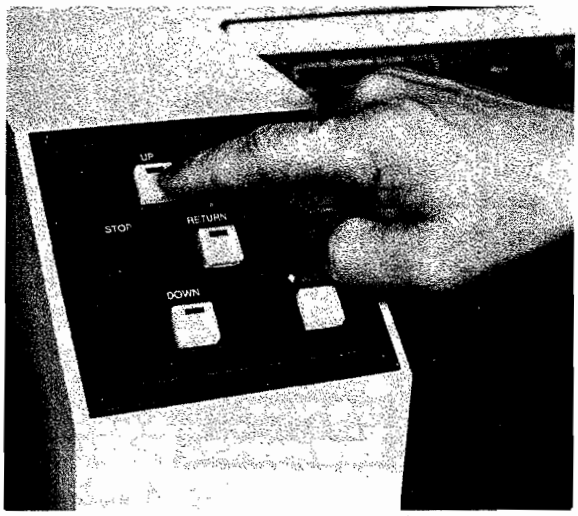

Figure 7-4. Starting a Tension Test

7.8.8 Listing of Pretest Procedures for a Basic System

The following list of procedures outline the steps necessary to set up a Model 4201 or 4202 basic system to perform a tension or compression test. Each procedure is referenced to the section which contains specific details. Chapter 8 provides descriptions and operating procedures for optional equipment.

1. Select a load cell (Section 6.6)
2. Install load cell (Section 6.7)
3. Install grips and fixtures (Section 6.8)
4. Select operating units (Section 6.9)
5. Connect accessories-options (Section 6.10)
6. Set preload levers (Section 6.11)
7. Turn instrument on (Section 7.2)
8. Monitor Self Test Routine (Section 7.3)
9. System reset (as required) (Section 7.4)
10. Calibrate system (Section 7.5)
11. Balance system (Section 7.6)
12. Set gage length (Section 7.8.1)
13. Set crosshead travel stops (Section 7.8.2)
14. Set crosshead speed (Section 7.8.3)
15. Set area compensation (Section 7.8.4)
16. Install test specimen (Section 7.8.5)
17. Set testing area (Section 7.8.6)
18. Start test (Section 7.8.7)

8.0 OPERATING AN EXPANDED SYSTEM

8.1 INTRODUCTION

This chapter describes the functioning of the optional operator interface panels and peripheral equipment (recorders, etc.) available for use with a 4200 series system, as listed in Table 8-1. The user should select the sections of this chapter that pertain to the particular options included with a system, and that will be required for current testing procedures.

The items listed in Table 8-1 may be included with a system initially or added later to expand its capabilities. Installation procedures are included with each option, if required. A separate operating instruction manual is included with each peripheral device.

Table 8-1. Optional Components and Peripheral Equipment

Optional Device	Instron Catalog No.	Reference Section
Recorder Panel and Interface Board	2310-817	8.2
Display Panel	2330-035	8.6
Limits Panel	2210-593	8.7
Strain Sensor Circuit Board - LVDT type extensometers	2210-826	--
Strain Sensor Circuit Board - Strain Gage Extensometers	2210-827	8.11 & 8.12
Strain Sensor Circuit Board -Instron XL Extensometer	2210-828	8.11 & 8.13
Microcon II Data Processor and Interface Board	4100-080 w/cassette 4100-081 w/o cassette	8.14
IEEE-488 Interface Board	2402-005	(Manual provided)
Programmable Computer	(Various)	(Manual provided)
Printer	2350-004	8.8
Strip Chart Recorder	2310-064	8.3
X-Y Recorder	2310-065	8.4
Incremental Extensometer	2610-001	8.16
Preset Points	- - -	8.9
Energy	- - -	8.10

8.2 RECORDER PANEL OPTION

The optional Recorder Panel permits the choice of using a strip chart recorder or X-Y recorder as a readout device for a load signal.

Selection keys on the panel allow the user to choose an operating range for a recorder from seven fixed gain factors. The keys can be enabled for setting either the load or strain channel range. The gain factors are a percentage of the maximum capacity of the load cell, or strain gage, in use that cause a full scale reading on the recorder.

A proportional mode provides a selection of six ratios between crosshead and chart speeds for a strip chart recorder. Parameter selection controls allow time, crosshead position or strain to drive the X-axis of an X-Y recorder, with settable full scale position span and time base.

The Recorder Panel option also includes a Recorder Board, as described in Section 3.5.2. Descriptions of Recorder Panel control functions are given in Table 6-4.

The operation of the Recorder Panel with an Instron Strip Chart Recorder and an Instron X-Y Recorder are described in Sections 8.3 and 8.4, respectively.

A description of the auxiliary output jacks (J2) on the control console connector panel is given in Section 8.5. These jacks are available for signal monitoring when the Recorder Panel is installed.

8.3 STRIP CHART RECORDER

8.3.1 Description

The Instron Strip Chart Recorder, has a single range which requires a 0 to 10 vdc input signal for full scale. The input from a 4200 series system is a load signal, which is automatically ranged to full scale. A gain factor is selected on the Recorder Panel by the user.

The recorder has a unidirectional chart with nine selectable speeds in the time drive mode. The range of speeds is 1.0 to 500 mm/min (0.05 to 20 in/min).

In the proportional drive mode, chart speed has a range of 0 to 600 mm/min (0 to 24 in/min). Speed is controlled by pulses from the 4200 series console which are proportional to the speed of the moving crosshead. The ratios are user-selectable on the Recorder Panel.

The 4200 series system provides an automatic chart stop signal at a crosshead "return" command. Pipping of the pen (event marker) is possible through the PIP jack on the loading frame connector panel (see Section 8.15).

The recorder is supplied with 280 mm wide, metric-scaled, Z-fold paper. Paper scaled in English units is available from Instron.

8.3.2 Installation

To use the recorder with the 4200 series system, plug the cable (A504-20) provided with the unit into connector, J9 (RECORDER), in the console (reference Section 6.10).

8.3.3 Operation

An Operating Instructions manual is supplied with the recorder. However, this section provides the differences in operation when used with a 4200 series system and the procedures for using the Recorder Panel.

8.3.3.1 Pen Scaling for Load Signal

a. Press LOAD RANGE key on the

Recorder Panel. This will enable the % RANGE keys in the load channel. The current load range will appear on the Basic Panel Display.

b. Press ZERO key on Recorder Panel. This will set the load signal to the pen at a zero reference. The Basic Panel Display will show "0000". Adjust POSITION control on recorder to set pen at a zero position.

c. Press a % key on Recorder Panel to select the gain factor for a full scale pen deflection. This will set the percentage of full scale of the installed load cell which will be calibrated to 10 volts. The Basic Panel Display will show value selected (see Example).

Example: Assume a 5 kN load cell is installed.

Key Legend	Display Shows	Full Scale on Recorder
100%	5.000	5.00 kN
50%	2.500	2.50 kN
40%	2.000	2.00 kN
25%	1.250	1.25 kN
20%	1.000	1.00 kN
10%	.5000	.50 kN
5%	.2500	.25 kN

8.3.3.2 Checking Pen Calibration (Optional)

Instron recorders are calibrated at the factory and should not require adjustment. However, pen deflection can be checked for accuracy by producing a known load signal from the balanced and calibrated load cell. The method used depends upon the type of cell in use, as follows:

a. If a non-self identified load cell is installed, simply hang a precision weight from the cell and measure the pen deflection. The amount of pen deflection depends upon the RANGE % selected (Section 8.3.3.1, Step c.) which sets the chart full scale value.

b. If a self identified load cell is installed, the procedure of Step a. above may be used or, by closing the load cell calibration relay (Step 1 below) a precision load signal will be applied to the recorder (see NOTE and Example).

NOTE

The voltage, generated when the load cell calibration relay is closed, is the same as would be produced by an applied load equal to 50% of the maximum capacity of the cell. This signal is always the SI equivalent value (newtons) for whatever system of units is in use, as shown in Table 8-2.

Table 8-2. Calibration Signal 4200 Series Load Cells

Load Cell Maximum Capacity - Newtons	*Calibration Signal Value - SI Equivalent		
	Newtons	Pounds	KGrams
50	25	5.62	2.55
500	250	56.2	25.49
5000	2500	562	254.9
10,000	5000	1124	509.8

*To convert newtons:
1. Multiply by 0.2248089 to obtain pounds.
2. Multiply by 0.1019716 to obtain kilograms.

Example: Assume a 5 kN (1000 lb, 500 kg) load cell is installed and English units are in use. A % RANGE of 100 is selected

for a recorder full scale value of 1000 lb. The pen will deflect an equivalent 562 lb (56.2% of full scale on a 10-inch chart) when the calibration relay is closed. (This signal appears on the LOAD display of the optional Display Panel, if TRACK is enabled.)

1. To close load cell calibration relay, press LOAD CAL key and then press 0 and ENTER on keypad. The LOAD CAL and LOAD BAL lamps will both be lit when this relay is closed.

2. **IMPORTANT** - After checking pen deflection, open the calibration relay by repeating the sequence used to close the relay: Press LOAD CAL, then press 0 and ENTER on keypad. The LOAD CAL and LOAD BAL lamps will go out. A test can not be started when the calibration relay is closed.

8.3.3.3 Chart Time Drive Mode

To operate in the Time Drive mode: (Also see Section 8.3.4)

a. Set PROP/TIME switch on recorder to TIME.

b. Select chart speed using CHART DRIVE keys on recorder.

c. Press SELECT X AXIS POS key on Recorder Panel (the related lamp will light). This avoids interaction with X-Y channel.

d. Chart motion will start when a test is started and the crosshead moves up or down.

8.3.3.4 Chart Proportional Drive Mode

To operate in the Proportional Drive mode: (Also see Section 8.3.4)

a. Set PROP/TIME switch on recorder to PROP.

b. Press PROP key on Recorder Panel to enable the RATIO selection keys. The PROP lamp will light and the LOAD RANGE lamp will go out.

c. Press a RATIO key on Recorder Panel to set a ratio between crosshead speed and chart speed. The Basic Panel Display will show the value selected (see Example).

Example: Assume a crosshead speed of 10 mm/min is selected.

Key Legend	Display Shows	Recorder Chart Speed
2:1	2 1	5 mm/min
1:1	1 1	10 mm/min
1:2	1 2	20 mm/min
1:5	1 5	50 mm/min
1:10	1 10	100 mm/min
1:20	1 20	200 mm/min

NOTE

The chart speed of the Instron Strip Chart Recorder is limited to 500 mm/min (20 in/min). If a higher speed is attempted, the PROP lamp on the Recorder Panel will flash.

d. Press SELECT X AXIS POS key on Recorder Panel (the related lamp will light). This avoids interaction with X-Y channel.

e. Chart motion will start when a test is started and the crosshead moves up or down.

8.3.4 Operating Notes - Strip Chart Recorder

1. It is not necessary to depress the START/STOP switch on the recorder, as the chart will start automatically when a test is started. The chart will stop if the crosshead is commanded to "return", but

will keep running if a "stop" command is entered while the crosshead is moving up or down. (If the recorder START/STOP switch is set to START, the chart will run continuously after a test is started.)

2. Always verify the RANGE % in use before starting a test. This can be changed during a test, but LOAD RANGE must be enabled (lamp lit). The Basic Panel Display will show the full scale value (load equivalent) selected.

3. Always verify the RATIO in use for proportional mode operation before starting a test. This can be changed during a test, but PROP must be enabled (lamp lit). The Basic Panel Display will show the ratio selected.

8.4 X-Y RECORDER

The Instron X-Y Recorder is an optional readout device supplied for use with a 4200 Series system. This recorder (Instron Catalog No. 2310-065) is manufactured by Allen Datagraph, Inc., Salem, NH 03079. An instruction manual, Allen Part No. 90060047, is supplied with the recorder and should be referred to for unpacking, specifications, paper and pen loading, theory of operation, routine maintenance and trouble-shooting procedures. A replacement copy of the manual is available from Allen Datagraph.

The recorder is similar to the Model 910 unit described in the manufacturer's manual, except for the following additional features:

- o Power input connector adaptable for 100, 120, 220 or 240 VAC
- o Signal input cable supplied with recorder
- o ZERO check pushbutton provided on control panel
- o Calibration adjustments accessible from control panel

8.4.1 Description

The Instron X-Y Recorder has single range X and Y axes which require 0 to 10 vdc input signals for full scale. The X-axis has a 38 cm (15 in.) span, and the Y-axis has a 25 cm (10 in.) span.

The input on the Y-axis from a 4200 series system is a load signal which is automatically ranged to full scale. A gain factor is selected on the Recorder Panel by the user. The X-axis can be set to track the position of the crosshead, a time base, or strain.

The 4200 series system provides an automatic pen lift signal at crosshead "return" and "jog" commands. Also, the pen will lift automatically if system main power is shut down. Pipping of the pen (event marker) is possible through the PIP jack on the loading frame connector panel (see Section 8.15).

The recorder is factory calibrated for operation in English or metric units, as specified by the user. If not specified, calibration is in English units. A supply of 11 x 17 in. graph paper, compatible with the calibrated units, is provided with the recorder. The following additional supplies are available from Instron:

Paper (English Units)	88-6-18
Paper (Metric Units)	88-6-19
Pens, Black (6)	3740-137
Pens, Red (6)	3740-138

8.4.2 Installation

8.4.2.1 Power Requirements

The Instron X-Y recorder is set

at the factory to accept a main power input of 120 ±10 VAC, single phase. A 3-wire power cable for that voltage is included. If the power source to be used is this standard voltage, proceed to Section 8.4.2.3, Signal Input Connection. If not, follow the instructions in Section 8.4.2.2.

8.4.2.2 Nonstandard Main Power

If the power source to be used is not 120 ± 10 VAC, the power input connector on the underside of the recorder can be altered to accept other voltages in the range of 90 to 250 VAC (see Table below).

X-Y Recorder Line Voltage Selection

If line voltage is:	Set AC input connector to:
120 ±10 VAC	120 VAC (Std.)
240 ±10 VAC	240 VAC
100 ±10 VAC	100 VAC
220 ±10 VAC	220 VAC

To adapt the X-Y Recorder for a different line voltage, extract the small printed circuit card from the power input connector (use long nose pliers) and reinsert it with the desired voltage visible. Ensure that the fuse is properly seated.

If the X-Y Recorder is to be adapted for 200-250 VAC operation, the power cable must be altered by adding a male plug that is specified for that power source outlet. Observe the following CEE wire color code for the cable:

Brown - high (live)
Light Blue - low (neutral)
Green & Yellow - earth/ground

NOTE

The fuse requirement for all AC power input voltages is a $^1/_2$-amp slo-blo, type 3AG.

8.4.2.3 Signal Input Connection

To use the X-Y Recorder with the 4200 series system, plug the cable (A504-128) provided with the unit into the connector on the underside of the recorder and into connector, J9 (RECORDER), in the console (see Section 6.10).

NOTE

The recorder must be grounded to operate properly.

8.4.3 Operation

An Operating Instructions manual is supplied with the recorder. However, this section provides the differences in operation when used with a 4200 series system and the procedures required to use the Recorder Panel for setting inputs to the X and Y axes.

8.4.3.1 Pen Scaling for Load Signal

a. Press LOAD RANGE key on Recorder Panel. This will enable the % RANGE keys in the load channel. The current load range will appear on the Basic Panel Display.

b. Press ZERO key on Recorder Panel. This will set the load signal to the pen at zero. The Basic Panel Display will show "0000". Adjust the Y POSITION control to set pen at a zero position. (The pen should not shift if the ZERO pushbutton is pressed.)

c. Press a % key on Recorder Panel to select the gain factor for a full scale pen deflection. This will set the percentage of full scale of the installed load cell which will be calibrated to 10 volts. The Basic Panel Display will show value selected (see Example).

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Example: Assume a 5 kN load cell is installed.

Key Legend	Display Shows	Full Scale on Recorder
100%	5.000	5.00 kN
50%	2.500	2.50 kN
40%	2.000	2.00 kN
25%	1.250	1.25 kN
20%	1.000	1.00 kN
10%	.5000	.50 kN
5%	.2500	.25 kN

8.4.3.2 Checking Y-Axis Calibration (Optional)

(Refer to Section 8.3.3.2)

8.4.3.3 X-Axis Position Drive Mode

To drive the X-axis as a function of moving crosshead position:

a. Press the SET POS. F.S. (Position Full Scale) SPAN key on the Recorder Panel. The related lamp will light.

b. Enter the tracking scale factor on the numeric keypad. This value is the displacement (extension) of the crosshead from gage length that is to appear as full scale on the recorder. Example: Enter 2.000 for 2 mm of extension to drive the X-axis 38 cm (or 2 in. of extension to drive the X-axis 15 in.). The displayed number will flash until it has been entered into the system.

c. Press ENTER on keypad. The number will stop flashing.

d. Press the SELECT POS (Position) key on recorder panel to enable this function to control the recorder X-axis. The related lamp will light.

e. Set the X-axis at a zero reference position by adjusting the recorder X POSITION control while holding the ZERO pushbutton depressed.

8.4.3.4 X-Axis Time Drive Mode

To drive the X-axis as a function of time:

a. Press the SET TIME F.S. (Time Full Scale) MIN key on the Recorder Panel. The related lamp will light.

b. Enter the recorder time base on the numeric keypad. This value is the number of minutes required for the recorder to reach full scale (10 volts). The time base is reset to 0 volts and the pen is returned to the origin on a crosshead return command. Example: To obtain a 5 minute time base on the X-axis, enter 5.000. The displayed number will flash until it has been entered into the system.

c. Press ENTER on keypad. The number will stop flashing.

d. Press SELECT TIME key on the recorder panel to enable this function to control the recorder X-axis. The related lamp will light.

e. Set the X-axis at a zero reference position by adjusting the recorder X POSITION control while holding the ZERO pushbutton depressed.

8.4.3.5 X-Axis Strain Drive Mode

To drive the X-axis as a function of strain:

NOTE

The use of a strain channel for recording purposes requires the installation of an optional Strain Sensor Board (see Table 8-1).

a. Select the active strain channel to be used by pressing the STRAIN 1 or 2 key on the Basic Panel. The related lamp will light.

b. Press the SELECT STRAIN - X-AXIS key on Recorder Panel. The related lamp will light.

c. Press STRAIN RANGE key on Recorder Panel. This will enable the % RANGE in the strain channel. The current strain range will appear on the Basic Panel Display.

d. Press ZERO key on Recorder Panel. This will set the strain signal to the X-axis at a zero reference. The Basic Panel Display will show "0000". Adjust X POSITION control on the recorder to set a zero position. (There should be no shift in the X-axis position if the ZERO pushbutton is pressed.)

e. On the Recorder Panel, press a % key to select the gain factor for full scale deflection on the X-axis. This will set the percentage of full scale, of the maximum strain of the installed extensometer, which will be calibrated to 10 volts. The Basic Panel Display will show value selected (see Example).

Example: Assume a strain gage extensometer with a 25mm gage length and a 10% maximum strain capability is used.

Key Legend	Display Shows	Full Scale on Recorder
100%	25.00	2.50 mm
50%	12.50	1.25 mm
40%	10.00	1.00 mm
25%	6.25	.68 mm
20%	5.00	.50 mm
10%	2.50	.25 mm
5%	1.25	.13 mm

8.4.3.6 Checking X-Axis Calibration (Optional)

Instron recorders are calibrated at the factory and should not require adjustment. However, the X-axis on the X-Y recorder can be checked for accuracy by applying a known signal to the input and measuring the resulting deflection. The method used depends upon the mode of operation, as follows:

a. If operating in the Position Drive mode, allow the moving crosshead to drive (up or down). Check that the recorder X-axis deflection, as modified by the scale factor in use (Section 8.4.3.3), tracks the displacement shown on the EXTENSION readout of the optional Display Panel.

b. If operating in the Time Drive mode (Section 8.4.3.4), the X-axis deflection versus time can be checked with an accurate timing device.

c. If operating in the Strain Drive mode (Section 8.4.3.5), the X-axis deflection can be checked by:

1. If a non-self identified extensometer is in use, displace the extensometer using a precision device such as a micrometer calibrator. Measure the X-axis deflection. This depends upon the RANGE % selected (Section 8.4.3.5, Step e.) which sets a full scale value.

2. If a self identified extensometer is in use, the procedure of Step a. above may be used or, by closing the extensometer calibration relay, as in Step (a) below, a precision strain signal will be applied to the recorder (see the following NOTE and Example).

(a) To close extensometer calibration relay, press the STRAIN CAL key and then press 0 and ENTER on keypad. The STRAIN CAL and STRAIN BAL lamps will be lit when relay is closed.

NOTE

The voltage, generated when the extensometer calibration relay is closed, is the same as would be produced by an applied strain equal to 100% of the maximum capacity of the extensometer. This strain signal is always an equivalent value for the system of units in use and the strain operating mode (see Section 8.11.2).

Example: Assume a self identified strain gage extensometer with a 1-inch gage length and a 10% maximum strain capability is in use. The system is set for English units, the strain operating mode is Percent (%) and a % RANGE of 100 is selected for a full scale strain value. The X-axis will deflect the full span (15 in.), which is equivalent to 10% strain, when the strain calibration relay is closed. (This signal appears on the STRAIN display of the optional Display Panel.)

(b) **IMPORTANT** - After checking X-axis deflection, open the calibration relay by repeating the sequence used to close the relay: Press STRAIN CAL, then press 0 and ENTER on keypad. The STRAIN CAL and STRAIN BAL lamps will go out. A test can not be started when the calibration relay is closed.

8.4.4 Operating Notes - X-Y Recorder

1. To operate the X-Y recorder with a 4200 system, set the LOAD/RUN switch to RUN. This will activate both axes.

2. It is not necessary to set the PEN UP/DOWN switch to DOWN, as the pen will drop automatically when a test is started and the crosshead moves up or down. The pen will "lift" if the crosshead is commanded to "return"or "jog", but will remain down on a crosshead "stop" command. (The pen will stay down if the PEN switch is set to DOWN.)

3. Always verify the RANGE % in use for the load channel (or strain channel) before starting a test. This can be changed during a test, but LOAD RANGE (or STRAIN RANGE) must be enabled (lamp lit). The Basic Panel Display will show the full scale value selected in load (or strain) equivalent units.

8.5 AUXILIARY OUTPUT JACKS

The jacks (J2) on the connector panel at the rear of the console are parallel outputs of the signals used to drive an X-Y recorder (Section 8-4). These are provided for signal monitoring purposes at the convenience of the user.

The jacks provide the following output signals:

LOAD - 0 to 10 vdc full scale

STRAIN 1 - 0 to 10 vdc full scale

STRAIN 2 - 0 to 10 vdc full scale

SWITCHED - Position, Time or Strain outputs as set by SELECT X-AXIS keys on Recorder Panel (see Sections 8.4.3.3, 8.4.3.4 and 8.4.3.5).

TIME/POSITION - Time or Position outputs as set by SELECT X-AXIS

keys on Recorder Panel (see Sections 8.4.3.3, and 8.4.3.4).

The Proportional mode for strip chart control (see Section 8.3.3.4) is not available at the J2 jacks.

The relationship between the SWITCHED and TIME/POSITION outputs depend upon the X-Axis function selected on the Recorder Panel, as shown in Table 8-3.

Table 8-3. Console Connector Panel J2 Jacks X-Axis Outputs

X-Axis Function	SWITCHED Output	TIME/POSITION Output
POSITION	Position	Position
TIME	Time	Time
*STRAIN	Strain 1 or Strain 2	Time

*Strain limits will be as selected on the Limits Panel (Section 8.7).

The J2 jacks accept standard "banana plugs". The red jack is signal "high"; the black jack is signal ground. When connecting a recorder or meter to the jacks, use a differential or floating input to avoid ground loop effects.

8.6 DISPLAY PANEL

8.6.1 Description

The optional Display Panel has three 4-digit LCD displays which allow the current value of load, extension and strain to be tracked for observing during a test. The tracking value on each display at the end of a test is not stored.

Additional functions enable the values of load, extension and strain at peak load and at specimen break to be saved for viewing on the displays at the end of a test. The peak and break values are stored in system memory (nonvolatile) until overwritten by the next test, or the system is reset.

When Area Compensation is in use, the gain of the load signal applied to the LOAD display is divided by the normalized mantissa (base number) of the area value (see Section 7.8.4). Hence, when Area Compensation is not equal to 1.000, the LOAD display indicates the normalized value of stress. (See Appendix A.)

EXAMPLE

Specimen loading = 20 lb
Area compensation (normalized) = 1.56
LOAD display shows 12.82 (psi)

Descriptions of the Display Panel control and indicator functions are contained in Table 6-2.

NOTE

The STRAIN display will be blank if a strain option is not installed.

8.6.2 Operation

a. **Press the TRACK key to track load, extension and strain on the displays at any time during a test.** The TRACK lamp will light and the three displays will show the constantly changing values while the test is in progress. The storage of peak and break values is not interrupted when the TRACK key is pressed. These functions are always recorded.

b. **Press the PEAK key to set the displays to show load, extension and strain values that occur at the peak load during a test.** This can be done at any time, either before, during, or at the end of a test when the values are stored. The PEAK lamp is lit when this function is active.