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1.0 INTRODUCTION
A. Precautions
   * Read instruction manual completely before using
     the AF-IV.
   * Do not overload the AF-IV. The AF-IV has an overload
     capacity of 50% of the rated full scale. The Display
     on the AF-IV will read OVERLOAD when the AF-IV
     is overloaded. The rated full scale load is shown on
     the Capacity Label on the front of the AF-IV.
   * Turn off the AF-IV before connecting or
     disconnecting any cables to the AF-IV.
   * A warm up time of 2-5 minutes is
     recommended for the AF-IV.
   * Recharge the batteries per instructions
     section II.A before using the AF-IV
     for the first time.
   * Do not dis assemble the AF-IV.
     Disassembly voids the Warranty.
   * Load Cell attachments should be
     installed finger tight. Do not tighten
     with tools as a torque load on the Load Cell
     could damage the measuring system.
   * Be sure to use the most appropriate
     attachment for the given application.
   * Permanent damage may occur if any
     fixture attached to the load cell
     exceeds the maximum thread
     assembly depth shown below.
   * Whenever possible, the force should
     be applied to the free end of the load
     cell while the fixed end of the load cell
     is securely attached to a stationary test
     fixture (see drawing below).
   * The AF-IV is designed for axial
     loading. Applying load on an angle or eccentric
     loading may cause an erroneous
     reading.

B. Description
   1. General Description
      The AccuForce IV Digital Force Gauge
      is a precision instrument designed and
      constructed for long life. By following
      these instructions, optimum accuracy and
      performance can be attained.
   2. Features
      * 5000 updates per second allows peaks
        to be captured over 150 times faster
        than other force gauges.
      * 0.2% + 1 LSD (least significant digit)
        accuracy
      * Set-up parameters permit user
        configuration. All set-up parameters are
        stored in non-volatile memory.
      * Interfaces directly to any device
        capable of accepting RS-232, Mitutoyo,
        or analog input.
      * Functions can be controlled from
        the keyboard or remotely through the serial
        port.
11. OPERATION

A. Recharging

The AF-IV contains an internal rechargeable Nickel Cadmium (Ni-Cad) battery pack capable of powering the AF-IV for 8-10 hours on a full charge. **When batteries are low, the Display on the AF-IV will flash BATTERY every four seconds.**

Operation of the AF-IV when the batteries are low will produce unpredictable results. To recharge the batteries:

1. Turn the AF-IV off.
2. Insert the phone plug from the Charger/Converter into the Charger/Converter Jack on the AF-IV.
3. **Plug the Charger/Converter into a proper AC voltage outlet.** The input AC power and frequency requirements are listed on the Charger/Converter.
4. Allow batteries to charge for 16 to 18 hours.

The batteries supplied with the AF-IV should accept 1000 recharge cycles.

B. Set-up

To set up the AF-IV for use:

1. **Verify that the AF-IV is turned off (see II.C.1).**
2. If you will be powering the AF-IV from the line:
   a. Insert the phone plug from the Charger/Converter into the Charger/Converter Jack on the AF-IV.
3. If you will be powering the AF-IV from batteries:
   a. Charge the batteries per II.A if necessary.
   b. Attach all necessary cables to the I/O Ports.
   c. Proceed to II.C.1.

C. AF-IV Functions

1. **Turning On and Off**

   **Set-up parameters as well as calibration and configuration information for the AF-IV are loaded from nonvolatile storage when the AF-IV is turned on and saved to non-volatile storage when the AF-IV is turned off.**

2. To turn the AF-IV on, momentarily press the ON/OFF key on the Membrane Keypad. The AF-IV will respond by sounding a short tone, displaying ON for approximately two seconds and then begin displaying the present force readings, a warm-up time of 2-5 minutes is recommended.

3. To turn the AF-IV off, momentarily press the ON/OFF key on the Membrane Keypad. The AF-IV will respond by displaying OFF for approximately two seconds and then turn itself off.

2. **Changing Units of Measure**

   Force readings can be displayed in a variety of units of measure (see III.A for more information). The units of measure are shown on the two right-most characters of the Display.

   To change the units of measure, momentarily press the UNITS key on the Membrane Keypad. The AF-IV will respond by displaying the next available units of measure and converting all readings (present, peak compression, peak tension, high set point, low set point, etc.) to the new units of measure. Continue this procedure until the units of measure you wish is shown.

3. **Zeroing**

   Zeroing (taring) permits accessories and attachments to be excluded from the force readings. Up to 20% of the rated full scale may be zeroed (tared out). The rated full scale is shown on the Capacity Label on the front of the AF-IV.

   To zero the AF-IV, momentarily press the ZERO key on the Membrane Keypad. The AF-IV will respond by displaying the present force reading followed by zeroing the peak compression and peak tension readings.

4. **Displaying Peak Readings**

   During operation the AF-IV is continuously tracking the highest peak compression and highest peak tension readings. The PEAK button permits displaying the peak compression or peak tension reading. Readings are displayed in a last-in first-out order. That is, the last value (peak compression or peak tension) displayed before exiting the Peak function is always the last displayed when the Peak function is entered. This technique minimizes the number of key presses necessary when tests are being performed in one direction only, while maintaining independence from the direction.

   To display the peak compression or peak tension, momentarily press the PEAK key on the Membrane Keypad. The AF-IV will respond by displaying the label for the last reading for approximately two seconds. The AF-IV will display the PEAK C or PEAK T for peak compression or PEAK T for peak tension) for one second and then display that peak reading. Every four seconds the label (PEAK C or PEAK T) will flash on the Display to remind you what value you are viewing. To cycle to the opposite peak value, momentarily press the SELECT key on the Membrane Keypad. The AF-IV will respond by displaying the label for the peak reading to be displayed (PEAK C for peak compression or PEAK T for peak tension) for one second and then display that peak reading. As mentioned previously, the label (PEAK C or PEAK T) will flash on the Display every four seconds to remind you what value you are viewing.

   To exit the Peak function and return to displaying the present force readings momentarily press the PEAK key on the Membrane Keypad. The AF-IV will respond by returning to displaying the present force readings.

If you wish to watch the peak increasing as the test is performed instead of recalling it after the test is complete simply follow the procedure above for displaying a peak reading before performing the test. Both techniques produce the same result so user preference dictates which one to use.

5. **Clearing Peak Readings**

   At the completion of a test, the peak readings are generally cleared (reset) for the next test.

   To clear both the peak compression and peak tension reading at the same time, momentarily press the CLEAR key on the Membrane Keypad while displaying the present force readings (that is while not displaying one of the peak readings). The AF-IV will respond by clearing both the peak compression and peak tension readings.

   To selectively clear the peak compression or the peak tension reading, momentarily press the CLEAR key on the Membrane Keypad while displaying the peak reading (peak compression or peak tension) you wish to clear (see II.C.4 for instructions on how to display a peak reading). The AF-IV will respond to clearing only the peak reading (peak compression or peak tension) being displayed.

6. **Setting High and Low Set Points**

   High and low set points provide visual indication, status indication, and audible indication (can be turned on or off) when the AF-IV has reached or exceeded the high or low set point limit or both. The actual values of the set points may be configured. The primary difference between a high set point and a low set point is that values mathematically above the high set point trigger the high set point condition and values mathematically below the low set point trigger the low set point condition. Since the AF-IV reports compression values as positive numbers and tension values as negative numbers the high set point will generally be used to indicate when a maximum compression value has been reached or exceeded, and the low set point will generally be used to indicate when a maximum tension value has been reached or exceeded. An explanation of how to configure the high set point follows. To configure a low set point, substitute the SET LOW key for the SET HIGH key in this explanation.

   To view the present value for the high set point, momentarily press the SET HIGH key
on the Membrane Keypad. The AF-IV will respond by displaying the present value of the high set point and you will notice cursor flashing on the right-most digit. To change the value for the high set point, two keys are used. Momentarily pressing the SELECT key increments the value the cursor is on by one if the cursor is over a numerical value or if the cursor is over the sign position (left-most character on the Display), toggles the sign between blank (for positive) and - (for negative). Momentarily pressing the DIGIT key moves the cursor one position to the left. Therefore, to change the value for the high set point, simply use the DIGIT key to move the cursor to the positions you wish to change and use the SELECT key at each of these positions to increment the value at the position until the value you wish is shown.

To exit the high set point function and return to displaying the present force readings, you must first select whether the audible indication will be on or off. To exit the high set point function and exit the audible indication selection function, momentarily press the SET HIGH key on the Membrane Keypad. The AF-IV will respond by displaying the present setting with the audible indication. To exit the audible indication selection function, momentarily press the CLEAR key on the Membrane Keypad. The AF-IV will respond by returning to displaying the present force readings.

8. Setting Serial Port Configuration
The AF-IV can communicate serially with devices capable of accepting an RS-232 or Mitsuioy input. The Serial Port Configuration allows you to configure the serial port for communicsting with RS-232 devices at 300, 600, 1200, 2400, 4800, 9600 or 19200 baud or for communicating with Mitsuioy devices. See I/O Port specifications in III.B.2 and III.B.3 for further information.

To view the present setting for the serial port, momentarily press the SERIAL MODE key on the Membrane Keypad. The AF-IV will respond by displaying the present setting for the serial port. To change the setting for the serial port, momentarily press the SELECT key on the Membrane Keypad. The AF-IV will respond by displaying the next available serial port configuration setting. Changing the setting for the serial port will change the settings for all other available serial port configuration settings.

9. Transmitting Readings
The Transmit feature allows readings to be transmitted one at a time to an RS-232 or Mitsuioy device connected at the I/O Port on the AF-IV. See I/O Port specifications in III.B.2 and III.B.3 for further information.

To transmit the readings, momentarily press the SEND key on the Membrane Keypad. The AF-IV will respond by displaying the present setting for the display on the Program. The AF-IV will respond by displaying the present setting for the display on the Program.

10. Displaying Serial Number
One of the items contained in the nonvolatile memory is the serial number for the AF-IV. In the event you have a problem with the AF-IV, you may be requested by support personnel to recall this serial number. Or, you may use this serial number for your own internal tracking and auditing. To view the serial number, momentarily press the Select key and finally momentarily press the Digit key one more time. The AF-IV will respond by displaying the eight character serial number. Press any key to return to displaying the present force readings.

11. Recalibrating Precautions:
- Do not attempt to recalibrate the AF-IV unless you fully understand the recalibration procedures below.
- The recalibration procedure requires that you press keys on the AF-IV Membrane Keypad these keys must be pressed lightly to avoid jarring the recalibration setup and thereby causing the recalibration to fail.
- The recalibration can be aborted at any step by pressing the Audible Indication (Aud. Mode) key. However, only the present step and all other remaining steps of the recalibration are then abandoned. Steps previously completed are not recoverable.
- Field recalibration can be performed from the front panel of the AF-IV. However, the following restrictions are imposed:

1. You must have a way to mount the Load Cell vertically to achieve both tension and compression recalibration.
2. The AF-IV will permit recalibration using deadweights within ±20% of the rated full scale. For example, if you will be recalibrating a 10 lb. AF-IV, your deadweights must be between 8 lb. and 12 lb. The deadweights must be cut to your local gravity or you must know your local gravity, the gravity where the weights were cut to and used one of the following equations to determine what force your deadweights will exhibit:

\[ \text{Force} = \text{mass} \times g \times \frac{\text{local gravity}}{980.665 \text{ cm/s}^2} \]

Equation 1

If your deadweights are cut to international standard gravity.

Equation 2

If your deadweights are cut to local gravity.

4. The deadweights must be accurate to 0.25%.
5. You must have a safe method of attaching the deadweights to the Load Cell in both tension and compression directions.
6. You must put the AF-IV in the units of measure you wish to recalibrate it in, before beginning the recalibration (see II.C.2).

The Recalibration function is divided into one set-up step and five calibration steps:

To enter the set-up step of the Recalibration function, momentarily press the Digit key, then momentarily press the Select key three times. The AF-IV will respond by displaying the rated capacity in the present units of measure and you will notice a cursor flashing on the right-most digit. At this time, you must change this value (if necessary) to the force exhibited by your deadweights. To change this value, two keys are used. Momentarily pressing the SELECT key increments the value the cursor is on by one if the cursor is over a numerical value or, if the cursor is over the sign position (left-most character on the Display), toggles the sign between blank (for positive) and - (for negative). You do not have to be concerned with the sign, Momentarily pressing the DIGIT key moves the cursor one position to the left. Therefore, to change this value to the force exhibited by your deadweights, simply use the DIGIT key to move the cursor to the positions you wish to change and use the SELECT key at each of these positions to increment the value at the position until the value you wish is shown. Press the Select key to proceed to Calibration Step 1. The AF-IV will respond by displaying STEP 1, Proceed to Calibration Step 1.

Calibration Step 1
At this time, you must mount the Load Cell vertically to calibrate the tension and compression directions and attach any weight carriers, hangars, hooks, etc. that are not part of the force you entered in the set-up step above. These tare weights must not exceed 20% of the rated full scale capacity. Press the Select key to proceed to Calibration Step 2. If Step
1 is successful, the AF-IV will respond by displaying STEP 2: proceed to Calibration Step 2. If Step 1 is not successful, the AF-IV will respond by displaying ERROR 1; proceed to Recalibration Errors.

Calibration Step 2
At this time you must apply the deadweights to the Load Cell in the tension direction. Press the Serial Mode key to proceed to Calibration Step 3. If Step 2 is successful, the AF-IV will respond by displaying STEP 3; proceed to Calibration Step 3. If Step 2 is not successful, the AF-IV will respond by displaying ERROR 2; proceed to Recalibration Errors.

Calibration Step 3
At this time, you must mount the Load Cell vertically to calibrate the compression direction and attach any weight carriers, hangars, hooks, etc. that are not part of the force you entered in the set-up step above. These bar weights must not exceed 20% of the rated full scale capacity. Press the Serial Mode key to proceed to Calibration Step 4. If Step 3 is successful, the AF-IV will respond by displaying STEP 4; proceed to Calibration Step 4. If Step 3 is not successful, the AF-IV will respond by displaying ERROR 3; proceed to Recalibration Errors.

Calibration Step 4
At this time, you must apply the deadweights to the Load Cell in the compression direction. Press the Serial Mode key to proceed to Calibration Step 5. If Step 4 is successful, the AF-IV will respond by displaying FINISHED; proceed to Calibration Step 5. If Step 4 is not successful, the AF-IV will respond by displaying ERROR 4; proceed to Recalibration Errors.

Calibration Step 5
At this time, the recalibration is finished. Press the Serial Mode key to exit the recalibration function and return to displaying the present force readings. The AF-IV will respond by returning to displaying the present force readings.

Recalibration Errors
In the event an error is encountered in the recalibration, the AF-IV will display an error message. The possible recalibration error messages displayed by the AF-IV and their meanings are:

<table>
<thead>
<tr>
<th>Error Message</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERROR 1</td>
<td>An attempt was made to place more than 20% of the rated full scale capacity on the Load Cell in Calibration Step 1.</td>
</tr>
<tr>
<td>ERROR 2</td>
<td>The deadweights applied in Calibration Step 2 failed to exhibit a tension force within ±20% of the value entered in the set-up step.</td>
</tr>
<tr>
<td>ERROR 3</td>
<td>An attempt was made to place more than 20% of the rated full scale capacity on the Load Cell in Calibration Step 3.</td>
</tr>
<tr>
<td>ERROR 4</td>
<td>The deadweights applied in Calibration Step 4 failed to exhibit a compression force within ±20% of the value entered in the set-up step.</td>
</tr>
</tbody>
</table>

There is no recovery from an error. To exit the Recalibration Function and return to displaying the present force readings, press any key. The AF-IV will respond by aborting the present step and all remaining steps of the recalibration and return to displaying the present force readings.

111. SPECIFICATIONS
A. General Specifications
Update Rate: 5000 Hz (updates per second)
Accuracy: ±0.2% of rated full scale ±1 LSD Load
Ranges Available:
- 0.250 gm, (9 oz)
- 1 lb, (50 gm, 5N, 16 oz)
- 0.1 lb, (5 kg, 50N, 16 oz)
- 20 lb, (9 kg, 50N, 32 oz)
- 50 lb, (25 kg, 250N, 60 oz)
- 100 lb, (50 kg, 250N, 160 oz)
Resolution: 250 gm, -0.1 gm, 8 oz, -0.01 oz, 1 lb, -0.001 lb, 50 gm, -0.1 gm, 5 N, -0.001 N, 180 oz, -0.01 oz.
- 10 lb, -0.001 lb, 5 kg, -0.001 kg, 50 N, 0.01 N, 180 oz, -0.1 oz.
- 20 lb, -0.01 lb, 9 kg, -0.01 kg, 90 N, 0.1 N, 320 oz, -0.1 oz.
- 50 lb, -0.01 lb, 25 kg, -0.01 kg, 250 N, 0.1 N, 800 oz, -1 oz.
- 100 lb, -0.1 lb, 50 kg, -0.01 kg, 500 N, 0.1 N, 1600 oz, -1 oz.

Full Scale Deflection (approximate):
- 250 gm, -0.003 in.
- 1 lb, -0.006 in.
- 10 lb, -0.008 in.
- 20 lb, -0.008 in.
- 50 lb, -0.008 in.
- 100 lb, -0.008 in.

Overload Capacity: 50% of rated full scale.
Display reads OVERLOAD when in overload. Capacity Label on front of AF-IV indicates rated full scale.
Display: 6 character dot matrix LCD with 3/8 high characters. Force readings and units of measure are displayed.
Keypad: 12 key membrane with visible feedback (Display blanks) on key closure.
Power Requirement: Rechargeable battery pack (internal) for portable operation. Will operate on 11 5VAC (60 Hz) or 220 VAC (50 Hz) using appropriately supplied Charger/Converter.
Battery Life: 6-8 hours on a full charge.
Display flashes BATTERY during every 4 seconds when batteries are low.
Calibration: Factory calibration is computer controlled using suspended deadweights (NIST traceable). Field recalibration can be performed from the front panel (see 111.11). Operating Temperature Range: 50 to 100 degrees Fahrenheit.
Storage Temperature Range: -30 to 130 degrees Fahrenheit.
Gage Enclosure: Aluminum Alloy Number 360. Nominal wall thickness 0.060 in.
Gage Size: 9.28" x 3.60" x 2.05" (HWxWxD)
Carrying Case Size: 13.5" x 10 X 4.377" (LxWxH)
Gage Weight: 1.6 lb.
Shipping Weight (Gage, Carrying Case and Accessories): 5.8 lb.
Accessories: Charger/Converter, RS-232 Cable.

B. I/O Port Specifications
1. Connector description
The connector used for the AF IV I/O Port is a 25 pin female "D" connector as shown below. If you examine it closely you will notice that the pins on the connector are numbered.

The functions of the pins on the I/O Port are summarized in III.B.2, III.B.3, and III.B.4 below. Note that some of these pins are used for General functions such as the analog output whereas others are used for serial communications functions (RS-232 or Miltexy). Also note that some of the pins have two different functions depending on the serial port configuration setting (see II.C.8 for further information).

2. RS-232 Specifications
a. RS-232 I/O Port pin functions
<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Name</th>
<th>IOC Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RX</td>
<td>Receive</td>
<td>1. Data from AF-IV</td>
</tr>
<tr>
<td>2</td>
<td>TX</td>
<td>Transmit</td>
<td>1. Data to AF-IV</td>
</tr>
<tr>
<td>3</td>
<td>RTS</td>
<td>Request to send</td>
<td>1. Data from AF-IV</td>
</tr>
<tr>
<td>4</td>
<td>CTS</td>
<td>Clear to send</td>
<td>1. Data from AF-IV</td>
</tr>
<tr>
<td>5</td>
<td>DSR</td>
<td>Data terminal ready</td>
<td>1. Data from AF-IV</td>
</tr>
<tr>
<td>7</td>
<td>SG</td>
<td>Signal ground</td>
<td>1. Data from AF-IV</td>
</tr>
<tr>
<td>20</td>
<td>DTR</td>
<td>Data terminal ready</td>
<td>1. Data from AF-IV</td>
</tr>
</tbody>
</table>

b. RS-232 General Specifications
Communications systems: Full duplex serial
Definition: DCE (Modem)
Baud Rate: Selectable 300, 600, 1200, 2400, 4800, 9600 or 19200
Start bits: 1
Data bits: 8
Parity: None
Stop bits: 1
Coding: ASCII
Transmission sequence (each character): LSR first
End of transmission delimiter: CR LF

c. RS-232 Output data format
In the RS-232 mode, transmissions from the AF IV take two forms: responses and data.
Responses are basically a reproduction of what is shown on the Display. In some cases where these responses could be confused with actual data (such as high and low set points), prefix identifiers have been added. Responses are transmitted in response to one of the Set-up RS-232 Commands (see III. B.2.d) or in response to a critical condition. The length (number of characters) of responses varies, however, as indicated in III.B.2.b, all responses are delimited by a CR character followed by a LF character. The possible responses include:

<table>
<thead>
<tr>
<th>Response Type Meaning</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVERLOAD Critical</td>
<td>AF-V is overloaded.</td>
</tr>
<tr>
<td>BATTERY Critical</td>
<td>AF-V batteries are low.</td>
</tr>
<tr>
<td>OFF Critical</td>
<td>AF-V has been turned off.</td>
</tr>
<tr>
<td>OFF Critical</td>
<td>AF-V has been turned off.</td>
</tr>
<tr>
<td>AUD OR Response</td>
<td>Audible indication.</td>
</tr>
<tr>
<td>OFF Critical</td>
<td>AF-V has been turned off.</td>
</tr>
</tbody>
</table>

Data will be transmitted in response to one of the Data RS-232 Commands (see III.B.2.d) or in response to the SEND button on the Membrane Keypad being momentarily pressed. The length (number of characters) of data is constant at 11 characters (including the CR and LF end of transmission delimiters). Data will take the form:

- **Character 1 - P:** V, or Space
- **Character 2 - ():** Sign or Space
- **Character 3 - V:** Sign specifies the data is peak compression data
- **Character 4 - Space:** Specifies the data is present data
- **Character 5 - Space:** Specifies the data is negative space
- **Character 6 - Sign:** Sign specifies the data is positive

3. Mitutoyo Specifications

a. Mitutoyo IO Port pin Functions

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Clock</td>
</tr>
<tr>
<td>5</td>
<td>Ready</td>
</tr>
<tr>
<td>7</td>
<td>Signal</td>
</tr>
<tr>
<td>16</td>
<td>Data</td>
</tr>
<tr>
<td>20</td>
<td>Request</td>
</tr>
</tbody>
</table>

b. Mitutoyo General Specifications

- **Input command Type Function**
  - **Set-up**: Same function as SETUP key on Membrane Keypad (see II.C.2).
  - **Set-up**: Same function as ZERO key on Membrane Keypad (see II.C.3).
  - **Set-up**: Same function as FE key on Membrane Keypad (see II.C.4).
  - **Set-up**: Same function as CLEAR key on Membrane Keypad (see II.C.5).
  - **Set-up**: Same function as SET HIGH key on Membrane Keypad (see II.C.6).
  - **Set-up**: Same function as SET LOW key on Membrane Keypad (see II.C.7).
  - **Set-up**: Same function as DMP key on Membrane Keypad (see II.C.8).
  - **Set-up**: Same function as SERIAL MODE key on Membrane Keypad (see II.C.9).
  - **Set-up**: Same function as DMP key on Membrane Keypad (see II.C.10).

4. General Function Specifications

a. General Function IO Port pin Functions

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Signal</td>
</tr>
<tr>
<td>9</td>
<td>Highpass</td>
</tr>
<tr>
<td>10</td>
<td>Lowpass</td>
</tr>
<tr>
<td>11</td>
<td>Analogout</td>
</tr>
</tbody>
</table>