User's Manual

SPC4™ Model 424A Electronic Load Indicating Fastener System

- Firmware Version 1.2 -

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WARNING

FASTENER INSTALLATION CAN BE VERY DANGEROUS OR EVEN DEADLY! ALWAYS WEAR PROTECTION EQUIPMENT AND FOLLOW INSTRUCTIONS CAREFULLY WHILE OPERATING YOUR TIGHTENING EQUIPMENT.

FOR SAFETY REASONS, NEVER PLACE ANY PART OF YOUR BODY, ESPECIALLY YOUR HEAD, DIRECTLY IN-LINE WITH THE FASTENER.

ELECTRICITY CAN CAUSE SEVERE INJURIES OR EVEN DEATH, SOMETIMES EVEN WITH RELATIVELY LOW VOLTAGES OR CURRENTS. THEREFORE, IT IS VITALLY IMPORTANT THAT ANY ELECTRONIC INSTRUMENTS, SUCH AS THIS SYSTEM, BE FULLY UNDERSTOOD BEFORE USE.

PLEASE DO NOT USE THIS SYSTEM, OR ANY OTHER PIECE OF ELECTRICAL OR ELECTRONIC TEST EQUIPMENT WITHOUT FIRST THOROUGHLY FAMILIARIZING YOURSELF WITH ITS CORRECT MODE OF OPERATION AND USE.

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1.0 Introduction

The SPC4™ Model 424A Electronic Load Indicating Fastener System (SPC4™ System) is designed to facilitate the fastener installation process by measuring in real time the clamp load seen in a bolted joint. The SPC4™ System can also control the operation of a tightening device, such as a torque wrench, to a preset joint clamp load. The SPC4™ System is used in conjunction with fasteners fitted with load indicating hardware.

The SPC4™ System incorporates precision electronic devices. As all attempts have been made to manufacture these components as rugged as possible, care must be taken in handling the monitoring unit, the power-switching unit, the displacement transducer and the connecting cabling. Flagrant or abusive handling of these components can render them inoperable and/or compromise the accuracy of the measured load readings. In addition, the precision datum disk reference surface machined into the head of each fastener must be kept unimpaired and clean for accurate measurement of load (see **Paragraph 5.0** for recommended cleaning procedures). To this end, all of the SPC4™ load indicating fasteners have been shipped with plastic caps installed to protect the datum disk surface. These protective caps should always remain on the datum disks and only be removed to install the electronic displacement transducer for measuring load. After measuring load, the protective caps should be replaced to keep the datum disk surface clean and to protect it from incidental contact damage.

With proper care and use, this system can provide years of reliable operation. To this end, it is very important to completely familiarize yourself with the operation of this system before use. Read this manual carefully and pay particular attention to all precautions and warnings.

1.1 Inspection

During unpacking of the SPC4™ System, carefully check each item for damage that may have occurred in shipment. If anything is damaged or missing, please contact:

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1.2 Included Items

1	SPC4™ System Electronic Load Monitor Model 424A (Hand-held Unit)	HHU
1	User's Manual (this manual)	UM
1	Calibration Gage (0% and 100%)	CG
1	Brass Bristle Brush	BBB
1	Carrying Case	CC
1	Power-switching Unit (220 VAC, 50/60 Hz input, 30A max.)	PSU
1	50ft. Extension Cord	EC

1.3 Description of the SPC4™ Model 424A Electronic Load Indicating Fastener System

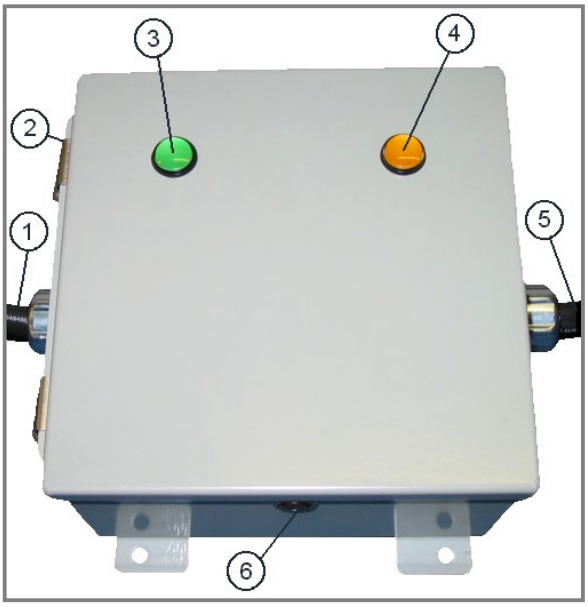


Figure 1.3.1 - Power-switching Unit - Top View

1 - "POWER IN" CABLE
2 - "POWER ON/OFF" BREAKER
3 - "POWER ON" INDICATOR
4 - "READY" INDICATOR
5 - "POWER OUT" CABLE
6 - "POWER" CONNECTOR

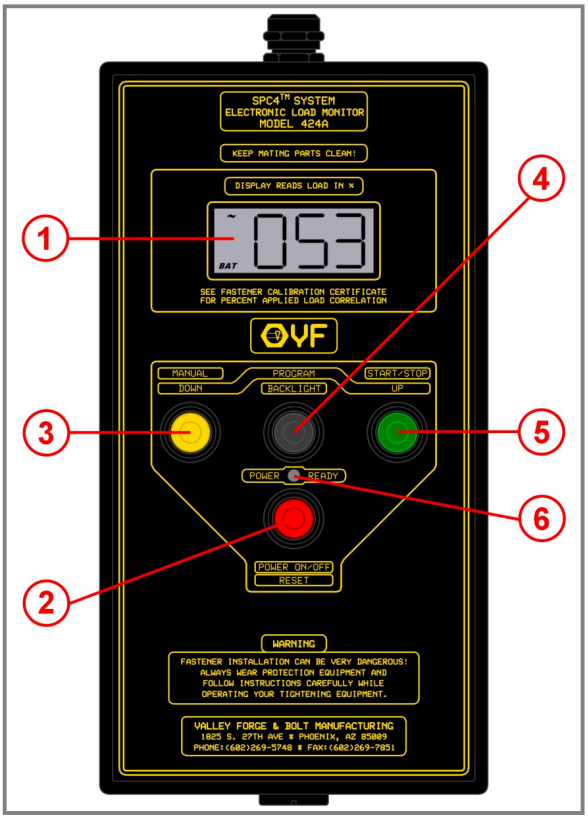


Figure 1.3.2 - Hand-held Unit - Top View

1 - "LCD" - LIQUID CRYSTAL DISPLAY
2 - "POWER ON/OFF | RESET" BUTTON
3 - "MANUAL | DOWN" BUTTON
4 - "PROGRAM | BACKLIGHT" BUTTON
5 - "START/STOP | UP" BUTTON
6 - "POWER | READY" INDICATOR

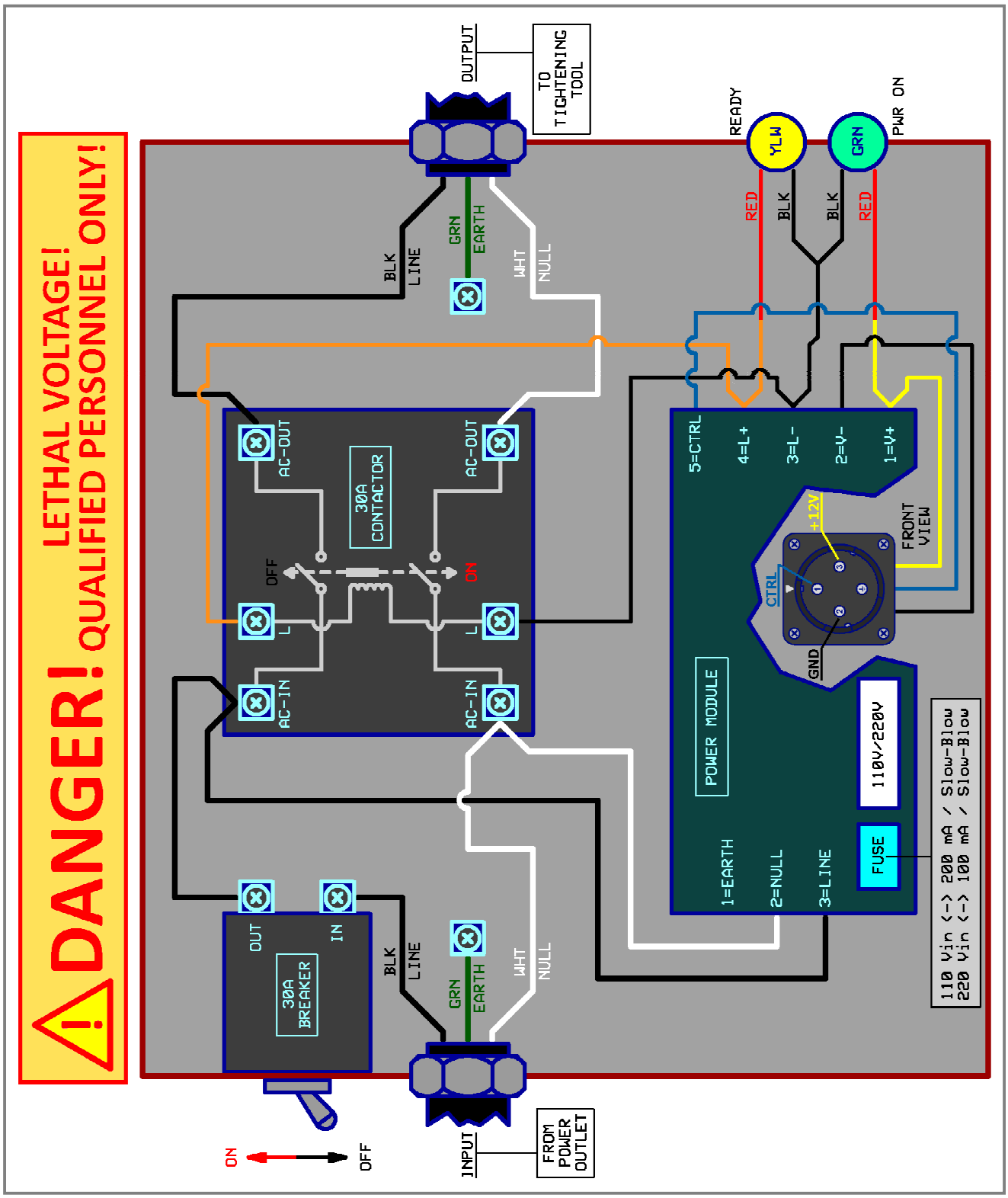


Figure 1.3.3 - Power-switching Unit - Internal Wiring

1.3.1 Power-switching Unit (PSU)

Please see "**Figure 1.3.1 - Power-switching Unit - Top View**" and "**Figure 1.3.3 - Power-switching Unit - Internal Wiring**".

1 - "POWER IN" CABLE

"Mains" input. Connect to a power outlet with a voltage rating of **220 VAC**, **50/60 Hz** and a minimum current rating of **30 A**. Requires wiring of a proper plug in concordance with "**Figure 1.3.3 - Power-switching Unit - Internal Wiring**".

2 - "POWER ON/OFF" BREAKER

Main ON/OFF switch. Also **30 A** magnetic breaker. Controls the power applied to hand-held unit and tightening tool. Protected by a splash-proof silicone rubber boot bonded to a built-in mounting nut.

3 - "POWER ON" INDICATOR

GREEN indicator. ON when the "Power ON/OFF" breaker is switched to ON position. At this point, the hand-held unit is powered and ready to start.

4 - "READY" INDICATOR

YELLOW indicator. ON when power is applied to the tightening tool. Controlled by the hand-held unit.

5 - "POWER OUT" CABLE

Switched power output. Connect to the tightening tool's power plug. Output rated **220 VAC**, **50/60 Hz**, **30 A** maximum. Controlled by the hand-held unit. Requires wiring of a proper socket in concordance with "**Figure 1.3.3 - Power-switching Unit - Internal Wiring**".

6 - "POWER" CONNECTOR

Connect to hand-held unit using the supplied extension cord. Do not forget to properly secure the connectors at both ends. To reduce the potential inrush current, it is recommended that this operation be executed with the power-switching unit switched OFF ("POWER ON/OFF" breaker in OFF position and "POWER ON Indicator" OFF).

IMPORTANT NOTE:

The "Figure 1.3.3 - Power-switching Unit - Internal Wiring" is not to be used as a "repair guide". It is shown in order to facilitate a better understanding of the operation of SPC4™ Model 424A System. It will also prove helpful when wiring the plug and the socket connectors at the ends of the power cables. Please do not try to open the enclosure or change its mode of operation!
In the unlikely situation that the lid must be open, this operation is to be executed only by qualified personnel!
Exercise extreme caution, observing the potentially lethal voltages present inside!
If the proper operation of the unit can not be restored by the basic troubleshooting techniques outlined in this manual, it is strongly recommended that the unit should be returned to manufacturer for repair.

1.3.2 Hand-held Unit (HHU)

Please see "**Figure 1.3.2 - Hand-held Unit - Top View**".

1 - "LCD" - LIQUID CRYSTAL DISPLAY

- Indicates the load value (most of the time) or the stop point value (when "**PROGRAM** | BACKLIGHT" button is pressed and held-in). Under certain conditions, it shows the results of the unit's self tests.

2 - "POWER ON/OFF | RESET" BUTTON

- **POWER ON/OFF**
  Turns ON the hand-held unit if the "**POWER** | READY" indicator **blinks - GREEN**. If the unit was previously ON, it turns it OFF. Its operation is disabled when the unit is OFF and the "**POWER** | READY" indicator is OFF or **blinks** - **RED**.
- **RESET**
  Must be pressed and held-in if the result of a tightening operation in "AUTO" mode is not what was expected (the pre-programmed stop point **± 3%**). This is to make sure that the operator is aware of this situation.

3 - "MANUAL | DOWN" BUTTON

- **MANUAL**
  When pressed and held-in, the hand-held unit switches to "MANUAL" mode and the tightening device is turned ON (it will stay ON as long as the "**MANUAL** | DOWN" button is held-in). In this mode, the pre-programmed value of the stop point is not important. This function provides flexibility in the operation of the unit as it can be used to fine-tune the tightness, or unload a previously tightened joint.
- **DOWN**
  Function available only when the "**PROGRAM** | BACKLIGHT" button is pressed and held-in. Decreases the value of the stop point. The minimum programmable value is **10%**.

4 - "PROGRAM | BACKLIGHT" BUTTON

- **PROGRAM**
  When pressed and held-in (with the hand-held unit already ON), the display will show "**P:xx**" (where **xx** represents the stop point value), and the stop point can be set using the "START/STOP | **UP**" and/or "MANUAL | **DOWN**" buttons. The available range is between **10%** and **99%**.
- **BACKLIGHT**
  Turns the display's backlight ON, if the "PROGRAM | **BACKLIGHT**" button is pressed and held-in **before** the hand-held unit is switched ON (by pressing the "**POWER ON/OFF** | RESET" button). To turn OFF the backlight, switch OFF the hand-held unit.

5 - "START/STOP | UP" BUTTON

- **START/STOP**
  If certain conditions are met, switches the hand-held unit to "AUTO" mode and, in correlation with the pre-programmed stop point, toggles the operation of the tightening device controlled by the power-switching unit. When an error condition occurs, this button is made inoperable.
- **UP**
  Function available only when the "**PROGRAM** | BACKLIGHT" button is pressed and held-in. Increases the value of the stop point. The maximum programmable value is **99%**.

6 - "POWER | READY" INDICATOR

- **POWER**
  When the hand-held unit is switched OFF, but still connected to the external power supply, this LED will **blink - GREEN** if the power supply is of the right polarity and voltage (approximately between 9 V and 18 V). It will **blink - RED** if the voltage is out of range. If this indicator is OFF, the power supply is not connected or the voltage is less than 5 V or of the wrong polarity.
- **READY**
  With the hand-held unit turned ON, this LED will be mostly OFF. It will turn ON (and stay ON - **GREEN**) whenever the tightening tool is switched ON. It will **blink - RED** if the result of a tightening operation in "AUTO" mode is not what was expected (the pre-programmed stop point **± 3%**). It will turn ON (and stay ON - **RED**) when "**PROGRAM** | BACKLIGHT" button is pressed.

1.3.3 Liquid Crystal Display (LCD)

Figure 1.3.4 - Liquid Crystal Display (LCD)

1 - "▲" (ARROW) ANNUNCIATOR

2 - "~" (TILDE) ANNUNCIATOR

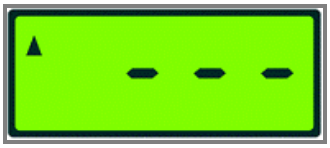
3 - "–" (MINUS) ANNUNCIATOR

4 - "BAT" (POWER SUPPLY) ANNUNCIATOR

5 - ":" (COLON) ANNUNCIATOR

6 - "NUMERICAL DISPLAY AREA"

1 - "▲" (ARROW) ANNUNCIATOR

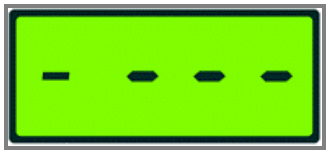


ON when the capacitive probe is not reading any meaningful capacitance (when it is not attached to the calibration gage or a bolt's datum disk).
The "NUMERICAL DISPLAY AREA" (**6**) will show "**---**".
In "PROGRAM" mode ("**PROGRAM** | BACKLIGHT" button pressed and held-in), the state of the probe is not checked, and this indicator will be OFF.

2 - "~" (TILDE) ANNUNCIATOR

ON when the tightening tool is powered and ready to operate.
In this state, the "POWER | **READY**" indicator from the hand-held unit will be ON - **GREEN** (**6** in **Figure 1.3.2 - Hand-held Unit - Top View**).
Also, the "READY" indicator from the power-switching unit (**4** in **Figure 1.3.1 - Power-switching Unit - Top View**) will be ON - **YELLOW**.

3 - **"–" (MINUS) ANNUNCIATOR**



Normally OFF, but it can become ON in special conditions: around 0% point (-5%...0%...5%) or, as shown at left, when the displayed value would have to be smaller than -30% (ex. -31%...-32%... etc.). This last case is probably a malfunction of some sort (dirty probe, bad contact between probe and datum disk etc.) and the "**---**" indication is there to make sure that the operator is made aware of the situation.

4 - **"BAT" (POWER SUPPLY) ANNUNCIATOR**

ON if the power supply of the hand-held unit fluctuates and drops under / goes over approximately 8.9 V / 18.1 V. At this point, the unit will continue to operate down-to / up-to approximately 7.75 V / 19.25 V. Outside of these absolute limits, the hand-held unit will automatically shutdown.
If this indicator comes ON and stays ON for times longer than 1...2 seconds, it is strongly recommended to stop operating the tightening tool and start investigating the causes. The guaranteed operating range of the hand-held unit is between 9 V and 18 V (over the whole operating temperature range).

5 - **":" (COLON) ANNUNCIATOR**

ON when the hand-held unit is in "PROGRAM" mode, or when the LCD is showing the firmware version (as part of the start-up sequence).
In "PROGRAM" mode, the indication will be "**P:xx**", where "**xx**" represents the stop point (programmable between **10%** and **99%**).
At start-up, the firmware version will be shown in the following manner: "**F:x.x**", where "**x.x**" represents the version number.

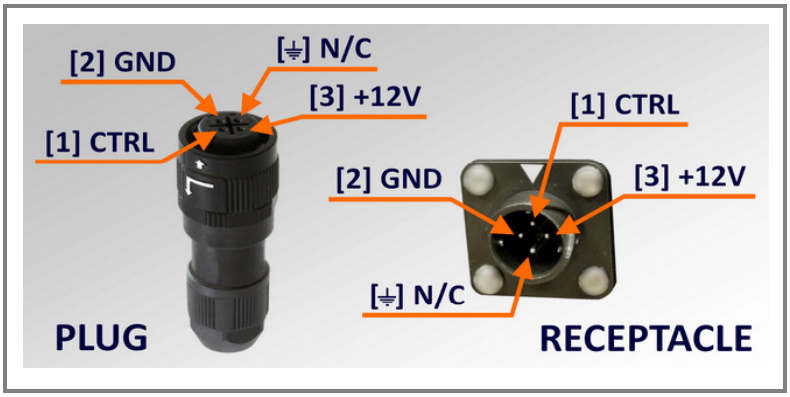
6 - **"NUMERICAL DISPLAY AREA"**

Most of the time displays the load in percent (between **-30%** and **125%**).
To accurately determine the clamp load, use this percentage in correlation with the fastener's calibration certificate.
Outside of range shown above, the LCD will show "**- ---**" or "**^ ---**".
In response to user's input, the same area can be used to display the stop point (in "PROGRAM" mode) or other information (as part of the start-up sequence).

1.3.4 Audio Annunciator (Buzzer)

In order to make it more "user-friendly", the hand-held unit is also equipped with an audio annunciator. The role of this annunciator is to provide audible feedback of the operation of the hand-held unit.
There will be a number of beeps at start-up / shutdown, corresponding to the stage the unit is in.
While operating the hand-held unit, the buzzer will emit a short beep every time a button is pressed, a series of 4 short beeps when an operation completed successfully or one long beep when the operation did not.

1.3.5 Extension Cord (EC)



+12 V - Positive Terminal

CTRL - CONTROL Terminal

LOW (0 V) - tightening tool OFF

HIGH (12 V) - tightening tool ON

GND - Ground Terminal (0 V)

Figure 1.3.5 - Extension Cord - Connectors (EC)

The extension cord has two bayonet lock type, 4-socket metal/plastic **plug** connectors on the ends of a 50-ft., three-wire cable. The arrangement of the terminals is the same for both ends.
The power-switching unit and the hand-held unit are both equipped with mating 4-pin metal **receptacle** connectors. The arrangement of the terminals is the same for both connectors.
The connectors have arrow markings. Match the position of the arrows on the plug and the receptacle and push to lock. Rotate the sleeve of the plug counter-clockwise to unlock.

2.0 Operation and Measurement

The following paragraphs describe the operation of the SPC4™ System**,** which consists of an electronic hand-held monitoring unit with a permanently attached displacement transducer (probe), a power-switching unit and the interconnecting cable (see **Figure 2.3.1 - Connection Diagram**).

The system is used in conjunction with fasteners fitted with load indicating hardware to effectively tighten bolted joints to a specific clamp load. Calibration certificates, supplied with each fastener, enable correlation of monitoring unit percentage readings to joint clamp load (bolt tension) in pounds.

2.1 Warning

**FASTENER INSTALLATION CAN BE VERY DANGEROUS OR EVEN DEADLY!
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FOR SAFETY REASONS, NEVER PLACE ANY PART OF YOUR BODY, ESPECIALLY YOUR HEAD, DIRECTLY IN-LINE WITH THE FASTENER.

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DO NOT USE THIS SYSTEM, OR ANY OTHER PIECE OF ELECTRICAL OR ELECTRONIC TEST EQUIPMENT, WITHOUT FIRST THOROUGHLY FAMILIARIZING YOURSELF WITH ITS CORRECT MODE OF OPERATION AND USE.

2.2 Precautions

[1] Always check the rating of the main power source before plugging in the power- switching unit. The working voltage and current are given in **Paragraph 3.1**.

[2] Be sure that the tightening device's power rating is within the rating of the power-switching unit (see **Paragraph 3.1**).

[3] If the "POWER ON/OFF" breaker is tripped, immediately disconnect the power- switching unit from the main power supply and investigate the reason(s) for the trip.

[4] The breaker and the contactor of the power-switching unit are rated for **30 A**. DO NOT try to override the breaker or to use the unit to supply current greater than **30 A**.

[5] When handling the probe, grip it with your hand in the area of the green arrows as shown in **Figure 2.2.1-A**. While the probe is pushed against the datum disk for engagement, slide the exterior sleeve of the transducer towards the fastener, until it locks the probe on the datum disk of the fastener. To disengage, grip the probe in a similar manner and simply slide the sleeve in the opposite direction.
It is essential to provide a path for the cable and the cable grip to move freely without crimping or bending. Do not pull or push the cable of the displacement transducer or the cable grip. Do not use the cable as a handle to carry the hand-held unit and/or the displacement transducer. Repeated deformation of the cable as shown in **Figure 2.2.1-B** will cause fracture of the wires in the region marked on the drawing (the red sign marked "**FRACTURE**") and render the probe inoperable.

[6] The shell of the displacement transducer is not insulated. Always be sure that the bolted joint to be tightened has no voltage on it.

[7] To obtain accurate measurements, periodically re-check the calibration as outlined in **Paragraph 2.5**.

[8] Handle the electronic instruments with care and keep protective caps on the fastener datum disks at all times.

[9] Do not attempt to clean the probe face or the datum disks by abrading them with emery cloth or sandpaper.

[10] Cleaning of the hand-held unit and/or the power-switching unit should be done with the power switches in "OFF" position and with all the interconnecting cables disconnected.

[11] Do not use abrasives, solvents or aromatic hydrocarbons to clean the instruments as damage may occur to the plastic cases. If cleaning is necessary, use only a mild solution of warm water and detergent.

[12] Do not attempt to repair the power-switching unit, the hand-held unit or the displacement transducer. These units contain no user-serviceable parts inside the enclosures.

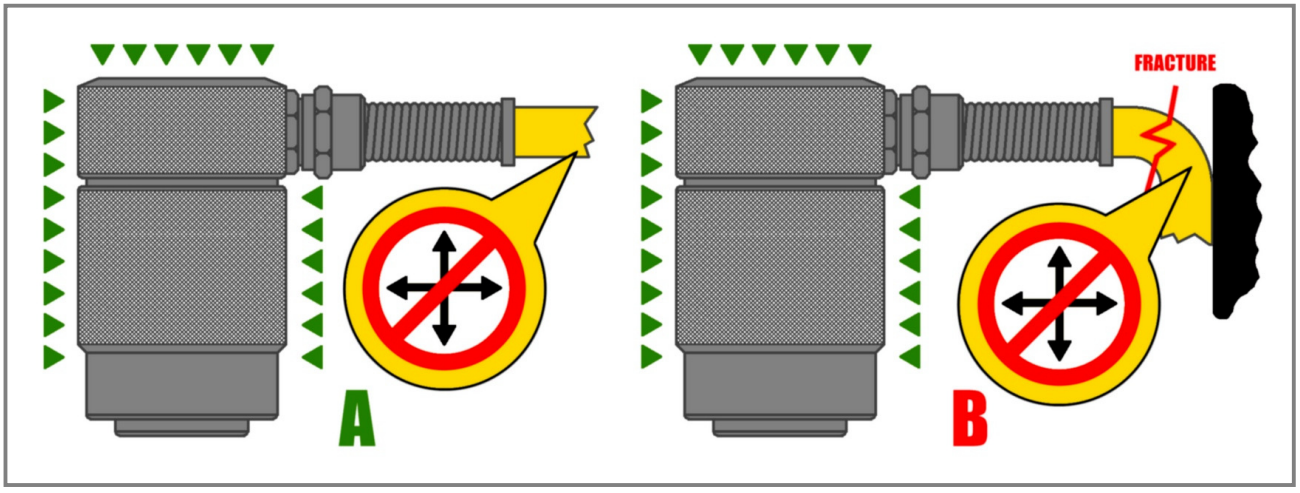


Figure 2.2.1 - Handling the Probe

2.3 Connection Diagram

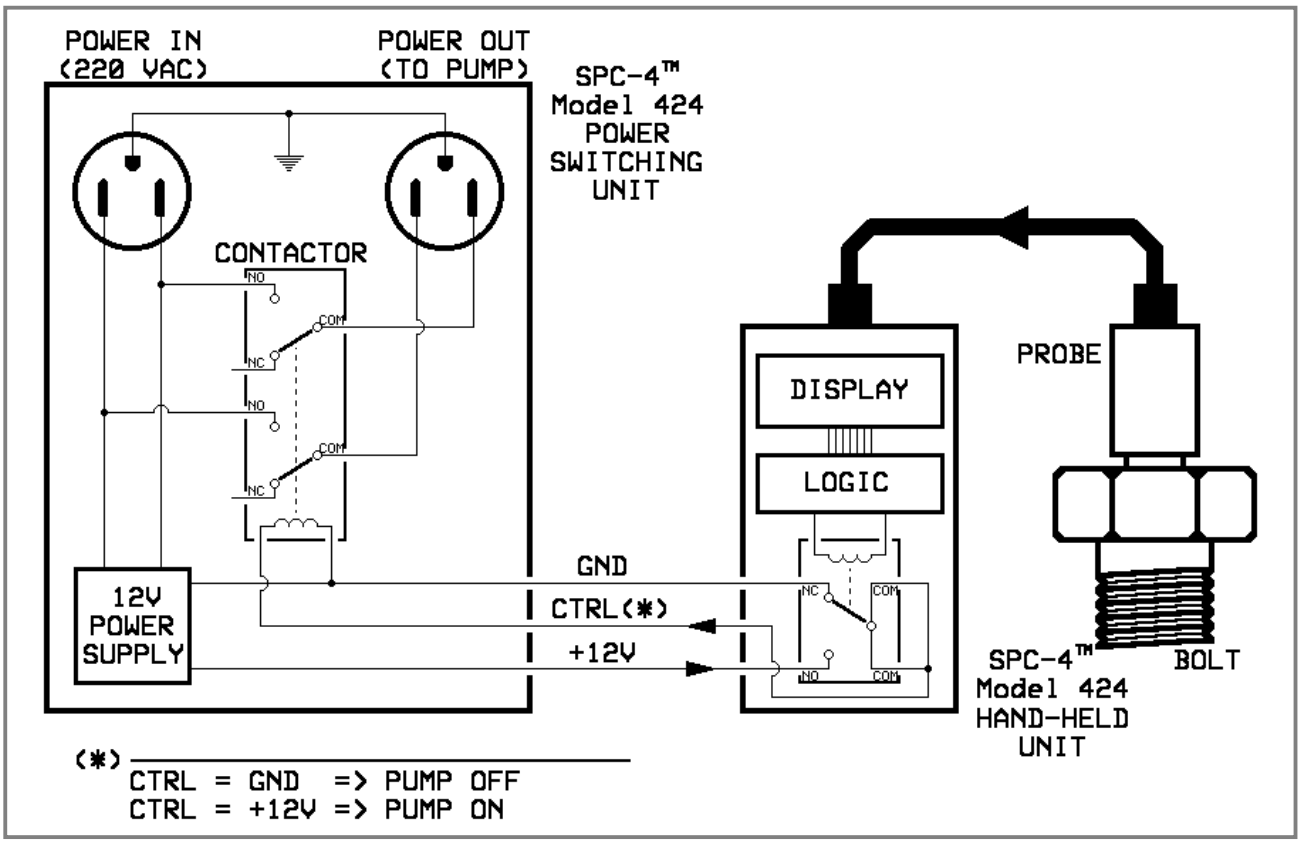


Figure 2.3.1 - Connection Diagram

ALWAYS use only the original power supplies, cables and accessories!
BEFORE making any electrical connections, make sure that all ON/OFF switches are in the OFF position!
DO NOT use non-standard or damaged cables and connectors!

2.4 Power-up

The following power-up procedure should be followed in the order shown to eliminate chances of damaging the system or to adversely affect its operation (refer to **Figure 1.3.1 - Power-switching Unit - Top View**, **Figure 1.3.2 - Hand-held Unit - Top View, Figure 1.3.3 - Power-switching Unit - Internal Wiring** and **Figure 1.3.5 - Extension Cord - Connectors**).

[1] With the power-switching unit unplugged from the main power supply (wall outlet), connect the tightening tool's power supply to the "POWER OUT" cable of the power-switching unit.

[2] Using the extension cord, plug and secure one of its connectors into the "POWER" connector located on the power-switching unit. At this point, DO NOT CONNECT THE HAND-HELD UNIT YET.

[3] With the "POWER ON/OFF" breaker in the OFF position, connect the "POWER IN" cable of the power-switching unit to the main power supply (wall outlet). Switch the "POWER ON/OFF" breaker in the ON position. The "POWER ON" light should go on. If not, check the wiring and the power supply. The "READY" light should be OFF.

[4] Switch the "POWER ON/OFF" breaker in the OFF position.

[5] Plug the remaining connector (at the free end of the extension cord) into the hand-held unit's socket (situated on the bottom of the unit).

[6] Switch the "POWER ON/OFF" breaker in the ON position.

[7] Watch the state of the "**POWER** | READY" LED from the hand-held unit.

- If it **blinks** - **GREEN**, the right polarity and level supply voltage is present at the input of the system. Secure the connector into the socket of the hand-held unit. Now the "POWER ON/OFF RESET" button of the hand-held unit can be pressed and the system will be ready for use.
- If the "**POWER** | READY" LED does not **blink** - **GREEN** (**blinks** - **RED** or stays OFF), DO NOT attempt to switch ON the hand-held unit. Unplug the "POWER" connector immediately and investigate the reason as follows:

  First, using a voltmeter (not supplied), determine if the supply voltage (12 V nominal) is reaching the plug (male) of the "POWER" connector and if it is of the right polarity (see **Figure 1.3.5 - Extension Cord**). If everything checks OK, most likely the hand-held unit is defective. If the supply voltage is not present at this end of the extension cord, or is of the wrong level or polarity, disconnect the other end of the extension cord and measure the voltage in the socket (female) at the output of the power-switching unit (see **Figure 1.3.5 - Extension Cord - Connectors**). If all tests are OK at this location, the extension cord could be defective. If the level of the supply voltage is outside of 9 V to 18 V range and/or of the wrong polarity, the power-switching unit could be defective.

[8] With the "**POWER** | READY" LED **blinking - GREEN**, press and release the "**POWER ON/OFF** | RESET" button. To turn ON the backlight, before pressing the "**POWER ON/OFF** | RESET" button, press and hold-in the "PROGRAM | **BACKLIGHT**" button (this button can be released after the start-up / self-test phase has ended).

[9] The unit will run a LCD test (all segments ON) and the start-up self tests. The display will show the start-up screens as shown below. The buzzer will emit one long beep after every stage of the start-up sequence. If everything checks OK, the display will show the value measured by the capacitive transducer, "**^ ---**" if the probe is not attached to anything (calibration gage or bolt), or "**- ---**" if the displayed value would have to be smaller than -30% (ex. -31%...-32%... etc.) - most likely the effect of a malfunction of some sort.

Fig. 2.4.1 - Start-up Screens

At all times (with the hand-held unit ON), if the power supply voltage drops below (approximately) 8.9 V or goes over 18.1 V, the "**BAT**" annunciator will come ON. The operation of the unit is not affected at this point, but it is strongly recommended to stop operating the system and start investigating the causes, if the "**BAT**" annunciator stays ON for more than 1...2 seconds. If the supply voltage is less than (approximately) 7.75 V or greater than 19.25 V, the unit will automatically shutdown. The tightening tool will be then automatically turned OFF.

2.5 System Calibration Check

Using **Figure 2.3.1 - Connection Diagram** and **Paragraph 2.4**, hook-up the system. To perform the following procedure, the system (power-switching unit and hand-held unit) must be ON and the tightening tool must be OFF. In this case, the stop point is inconsequential.

[1] Install the probe on the supplied calibration gage (on the end marked "*0%*") by pushing it against the datum disk and sliding the exterior sleeve of the probe until it locks in place. The display should read "**000**" (or between "**- 005**" and "**005**") as shown below at left in **Figure 2.5.1 - System Calibration Check**.

[2] Install the probe on the supplied calibration gage (on the end marked "*100%*") by pushing it against the datum disk and sliding the exterior sleeve of the probe until it locks in place. The display should read "**100**" (or between "**095**" and "**105**") as shown below at right in **Figure 2.5.1 - System Calibration Check**.

If the display does not read 0% or 100% (within ±5%), see **Paragraph 5.3.**

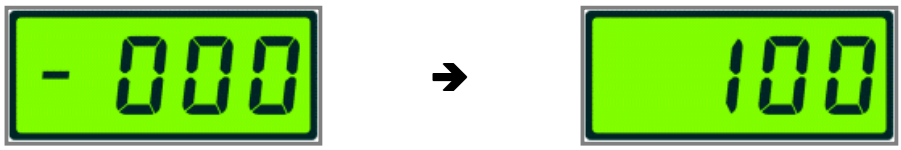


Figure 2.5.1 - System Calibration Check

2.6 Checking the Tightness of a Joint

Using **Figure 2.3.1 - Connection Diagram** and **Paragraph 2.4**, hook-up the system. To perform the following procedure, the system (power-switching unit and hand-held unit) must be ON and the tightening tool must be OFF. In this case, the stop point is inconsequential.

[1] Check the calibration of the unit (see **Paragraph 2.5.**).

[2] Install the probe on the fastener to be checked for tightness by pushing it against the datum disk and sliding the exterior sleeve of the probe until it locks in place.

[3] Read the percentage on the display.

[4] Remove the probe from the datum disk and repeat the step **[2]** and **[3]**, two additional times. In checking the tightness of a previously tightened joint, it is recommended that three readings be taken to assure uniformity of the load readings.

[5] If the three percentage readings are not within ±5% of each other, see **Paragraph 5.3.**

[6] Using the calibration curve for the bolt being checked, determine the load corresponding to the average percentage reading obtained in step **[4]**.

2.7 "MANUAL" Mode

Using **Figure 2.3.1 - Connection Diagram** and **Paragraph 2.4**, hook-up the system. To perform the following procedure, the system (power-switching unit and hand-held unit) must be ON and the tightening tool must be OFF. In this mode, the stop point is inconsequential.

2.7.1 Joint Tightening

[1] Assemble joint.

[2] Install the probe on the fastener to be tightened by pushing it against the datum disk and sliding the exterior sleeve of the probe until it locks in place. The display should read "**000**", within ±5%. If the display does not read 0% (within ±5%), see **Paragraph 5.3.**

[3] Select the percentage reading corresponding to the desired load value from the calibration curve for the bolt being tightened.

[4] Attach the tightening tool.

[5] Press and hold-in the "**MANUAL** | DOWN" button. At this point, the "**~**" (tilde) annunciator will be ON (left screen in **Figure 2.7.1 - "MANUAL" Mode**), the "POWER | **READY**" LED will be ON - **GREEN** and the power will be available at the tightening tool and control joint tightening.

[6] Operate the tightening tool until the desired percentage reading is indicated on the display.

[7] To stop the tightening process, release the "**MANUAL** | DOWN" button to discontinue power to the hydraulic pump and control. At this point the "**~**" (tilde) annunciator and "POWER | **READY**" LED will go OFF (right screen in **Figure 2.7.1 - "MANUAL" Mode**).

2.7.2 Increasing/Decreasing the Tightness of a Joint

[1] Determine the tightness of the joint as detailed in **Paragraph 2.6.**

[2] Select the percentage reading corresponding to the new load value from the calibration curve for the bolt to be re-tightened.

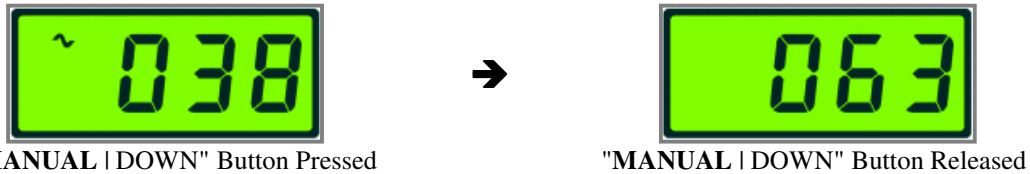
[3] Install the probe on the fastener to be re-tightened by pushing it against the datum disk and sliding the exterior sleeve of the probe until it locks in place.

[4] Attach the tightening tool.

[5] Press and hold-in the "**MANUAL** | DOWN" button. At this point, the "**~**" (tilde) annunciator will be ON (left screen in **Figure 2.7.1 - "MANUAL" Mode**), the "POWER | **READY**" LED will be ON - **GREEN** and the power will be available at the tightening tool and control joint tightening.

[6] Operate the tightening tool until the desired percentage reading is indicated on the display.

[7] To stop the tightening process, release the "**MANUAL** | DOWN" button to discontinue power to the hydraulic pump and control. At this point the "**~**" (tilde) annunciator and "POWER | **READY**" LED will go OFF (right screen in **Figure 2.7.1 - "MANUAL" Mode**).



"**MANUAL** | DOWN" Button Pressed → "**MANUAL** | DOWN" Button Released

Figure 2.7.1 - "MANUAL" Mode

2.8 "AUTO" Mode

In this mode the tightening tool can be set to deliver the maximum torque energy available, resulting in a relatively short tightening cycle.

The user can start the tightening procedure by pressing and releasing the "**START/STOP** | UP" button and, if the necessary conditions are met, the tightening tool can be cycled using its own control until the pre-programmed stop point is reached. To stop the tool in the middle of a tightening cycle, press the "**START/STOP** | UP" button again. In case of emergency, press the "**POWER ON/OFF** | RESET" button to shutdown the whole system.

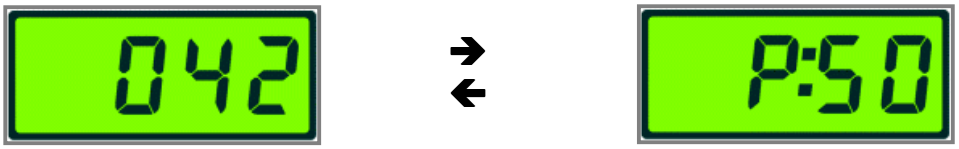
Using **Figure 2.3.1 - Connection Diagram** and **Paragraph 2.4**, hook-up the system. To perform the following procedure, the system (power-switching unit and hand-held unit) must be ON and the tightening tool must be OFF. In this mode, the user has to set the desired stop point value. This setting will have to be in the **10%** to **99%** range.

NOTES:

(1) The stop point must be set at least 5% above the clamp load value shown on display (unless starting from 0%, when this value has to be at least 10%). Setting a stop point value less than 5% over the clamp load value shown on the display is possible, but starting the tightening tool (in the "AUTO" mode) is not. If the user attempts to start the tightening tool under these conditions, an error condition will be experienced (see Note **(3)**) and the tightening tool will not start.
As an example, if an existing clamp load of 40% is present in the joint, a selection of 44% as the stop point value will return an error condition after pressing (and releasing) the "**START/STOP** | UP" button (see Note **(3)**).
By design, the "AUTO" mode is only to be used to increase the tightness of a bolted joint. For fine tuning the tightness of a bolted joint, either higher or lower, use the "MANUAL" mode (see **Paragraph 2.7**). Only the "MANUAL" mode is available for loosening a joint.

(2) At the end of the tightening cycle (after a manual or automatic shutdown), the power to the tightening tool will be cut-off, the "**~**" (tilde) annunciator and the "POWER | **READY**" LED will go OFF. The buzzer will emit 4 short beeps if the operation completed successfully (if the attained clamp load is within ±3% of the pre-programmed stop point) and the display will show the final clamp load value. If the operation did not complete successfully (if the attained clamp load is not within ±3% of the pre-programmed stop point), an error condition will be experienced (see Note **(3)**).

(3) An error condition will trigger the following events: the tightening tool will be turned OFF and the hand-held unit will "lock" in a cycle where the buzzer emits one long beep. The display will alternately show the current clamp load (seen by the capacitive probe) and the pre-programmed stop point. Also, the "POWER | **READY**" LED will **blink** - **RED**. This is to make sure that the operator is made aware of the result of the tightening operation. To exit this "locked" state, press and hold-in the "POWER ON/OFF | **RESET**" button for 1 second or so... After releasing the "POWER ON/OFF | **RESET**" button), the buzzer will emit 4 short beeps and the normal mode of operation will be restored.



Clamp Load Display — Stop Point Display

Figure 2.8.1 - "AUTO" Mode - Error Condition

2.8.1 Joint Tightening

[1] Assemble joint.

[2] Install the probe on the fastener to be tightened by pushing it against the datum disk and sliding the exterior sleeve of the probe until it locks in place. The display should read "**000**", within ±5%. If the display does not read 0% (within ±5%), see **Paragraph 5.3.**

[3] Select the percentage reading corresponding to the desired load value (stop point) from the calibration curve for the bolt being tightened.

[4] Press and hold-in the "**PROGRAM** | BACKLIGHT" button. The "POWER | **READY**" LED will come ON - **RED** and the display will switch to "PROGRAM" mode (showing "**P:xx**"), to confirm the programming phase.

[5] Using the "START/STOP | **UP**" and/or "MANUAL | **DOWN**" buttons set the desired stop point value.

[6] Release the "**PROGRAM** | BACKLIGHT" button. The "POWER | **READY**" LED will go OFF and the display will switch back to the load indication.

[7] Attach the tightening tool.

[8] Press and release the "**START/STOP** | UP" button to power the tightening tool. At this point, the "**~**" (tilde) annunciator will be ON, the "POWER | **READY**" LED will be ON - **GREEN** and the tightening tool can be cycled using its own control until the stop point is reached (shutting down automatically) or until the "**START/STOP** | UP" button is pressed again.

[9] Determine if the tightening operation completed successfully or not.

2.8.2 Increasing the Tightness of a Joint

[1] Determine the tightness of the joint as detailed in **Paragraph 2.6.**

[2] Select the percentage reading corresponding to the new load value (stop point) from the calibration curve for the bolt to be re-tightened.

[3] Install the probe on the fastener to be re-tightened by pushing it against the datum disk and sliding the exterior sleeve of the probe until it locks in place.

[4] Press and hold-in the "**PROGRAM** | BACKLIGHT" button. The "POWER | **READY**" LED will come ON - **RED** and the display will switch to "PROGRAM" mode (showing "**P:xx**"), to confirm the programming phase.

[5] Using the "START/STOP | **UP**" and/or "MANUAL | **DOWN**" buttons set the desired stop point value.

[6] Release the "**PROGRAM** | BACKLIGHT" button. The "POWER | **READY**" LED will go OFF and the display will switch back to the load indication.

[7] Attach the tightening tool.

[8] Press and release the "**START/STOP** | UP" button to power the tightening tool. At this point, the "**~**" (tilde) annunciator will be ON, the "POWER | **READY**" LED will be ON - **GREEN** and the tightening tool can be cycled using its own control until the stop point is reached (shutting down automatically) or until the "**START/STOP** | UP" button is pressed again.

[9] Determine if the tightening operation completed successfully or not.

3.0 SPC-4™ Model 424 Electronic Load Indicating Fastener System Specifications

3.1 Power-switching Unit

Input Voltage:	220 VAC (±10%), 50/60 Hz
Output Voltages:	
To Tightening Device:	220 VAC (±10%), 50/60 Hz, 30 A max.
To Hand-held Unit:	12 VDC (±10%), 500 mA max.

3.2 Hand-held Unit

Input Voltage:	12 VDC
Nominal Range:	9 VDC to 18 VDC (±5%)
Battery Indicator:	under 8.9 VDC / over 18.1 VDC (±5%)
Power Consumption:	3.3 mA (40 mW) - standby 65 mA (780 mW) - typical (relay and backlight OFF) 90 mA (1080 mW) - relay ON 100 mA (1200 mW) - backlight ON 120 mA (1440 mW) - maximum (relay and backlight ON)
Display Type:	LCD Gray Transflective 3-1/2 Digits
Viewing Area (W x H):	45.7 x 17.8 mm / 1.800 x 0.700 inch
Measuring Method:	16 Bit Analog to Digital Conversion
Precision:	Equal to, or better than, ± 5% (± 2% typical)
Optimum Viewing Direction:	6 o'clock
Backlight:	Green LED

3.3 Environmental

Operating Conditions:	
Temperature:	-10 to 60 °C / 14 to 140 °F
Humidity:	80% max.
Storage Conditions:	
Temperature:	-20 to 70 °C / -4 to 158 °F
Humidity:	95% max.
Ingress Protection Class:	IP-40 (dust proof).

4.0 Physical Characteristics

4.1 Power-switching Unit

Dimensions (W x L x H):	250 x 250 x 120 mm / 9.84 x 9.84 x 4.72 inch
Weight:	4.9 kg / 10.8 lbs.

4.2 Hand-held Unit

Dimensions (W x L x H):	110 x 270 x 50 mm / 4.33 x 10.63 x 1.97 inch
Weight:	830 g / 1.8 lbs.

5.0 User Maintenance – Recommended Cleaning Procedures

5.1 Cleaning the Probe and the Datum Disks

IT IS IMPERATIVE THAT BOTH THE PROBE FACE AND FASTENER DATUM DISK SURFACE BE KEPT CLEAN AND DRY FOR ACCURATE MEASUREMENT OF LOAD. UNDER NO CIRCUMSTANCES SHOULD THE PROBE FACE OR THE DATUM DISK SURFACE BE CLEANED BY ABRADING WITH EMERY CLOTH OR SANDPAPER.

Cleaning of the probe face should only consist of wiping with a lint-free, dry cotton cloth followed by forced, moisture-free, air cleaning. An example of a clean and dirty probe face is shown in **Figure 5.2.1**.

The following cleaning recommendations are made in the event that incidental soiling of the datum disk surface does occur.

(1) In most cases, light soiling of the datum disk surface such as moisture, dust, dirt, oil, metal chips, etc., can be cleaned by wiping with a lint-free, dry cotton cloth followed by forced moisture free, air cleaning. The forced air stream can be compressed air delivered through an air nozzle, or a can of compressed air commonly used in cleaning electronic components and computer equipment.

(2) For cleaning oil or grease from the datum disk, soaking the cloth with a solvent such as alcohol or acetone may be required for thorough cleaning. The use of automotive brake fluid in an aerosol can has proven successful in cleaning these contaminants. However, it must be a fast-drying formula and one that leaves no residue.

(3) In the event that light rusting of the datum disk surface occurs, light brushing with the supplied brass bristle brush should precede the cleaning procedure described above.

NOTE:

To maintain the integrity of SPC4™ load indicating fasteners and minimize error in measuring joint clamp load, it is imperative that the protective caps remain on the datum disk surface of each fastener at all times. The cleaning recommendations listed above, in most cases, will assure accurate load measurement. However, the **ONLY WAY** to truly assess the effectiveness of a cleaning operation is to check the 0% (unloaded) reading of the fastener. This can easily be done on fasteners not yet installed in an assembly. However, loaded bolts in an assembly that require cleaning must be unloaded to assure the effectiveness of the cleaning process.

It is understood that unloading bolts in a bolted joint assembly to assess the effectiveness of a cleaning process may present a problem in many applications. For this reason, the imperativeness of leaving the protective caps on the datum disk is reiterated. It is felt that any light soiling of the datum disk surface that may occur with protective caps installed can be easily cleaned using the procedures detailed above and eliminate the need to unload the fastener.

HANDLE THE ELECTRONIC INSTRUMENTS WITH CARE AND KEEP PROTECTIVE CAPS ON THE FASTENER DATUM DISKS AT ALL TIMES!

Valley Forge and Bolt Manufacturing Company assumes no responsibility for inaccurate loading or failure of SPC4™ load indicating fasteners as a result of damage to the measuring instruments caused by improper handling or as a result of improperly maintained datum surfaces.

5.2 Cleaning the Enclosures

CAUTION: Any attempts of cleaning the hand-held unit and/or the power-switching unit should be made with the power switches in the "OFF" position and the interconnecting cables should be disconnected!

For exterior cleaning, wipe the cases with a mild solution of warm water and detergent. Do not use any type of abrasives or solvents! The connectors can be cleaned using moisture-free forced air cleaning. For very dirty or oxidized connectors, use a combination of forced air cleaning and an electrical contact cleaner available in aerosol cans. Allow at least 10 minutes to dry before use.

5.3 In Case of Difficulties

THE PROBE AND DATUM DISK FACES SHOULD BE THOROUGHLY INSPECTED BEFORE EACH USE. MOST OF THE ERRONEOUS LOAD MEASUREMENTS ARE THE RESULT OF A DIRTY PROBE AND/OR A DIRTY DATUM DISK. CHECK THE SURFACES OF BOTH OF THEM PERIODICALLY FOR METAL CHIPS, LIQUIDS, DIRT, AND ACCUMULATED RUST ON THE CONTACT SURFACES. FOREIGN MATTER ACCUMULATING BETWEEN THESE SURFACES WILL RADICALLY AFFECT THE LOAD MEASUREMENTS.

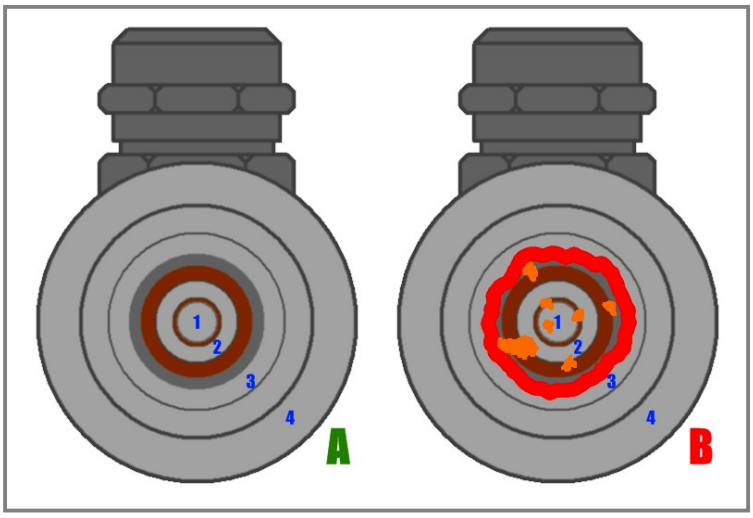


Figure 5.2.1 - Probe - Front View

A clean probe face is shown in **Figure 5.2.1-A**, where [1] is the sensor, [2] the guard, [3] the interior body, [4] the exterior body, and the brown material is an electrical insulator.

For discussion purposes, **Figure 5.2.1-B** depicts an example of an extremely contaminated probe surface (most likely severe enough to render it inoperable) that can be experienced if proper cleaning procedures are not followed.

The red deposits shown as a ring at the edge of part [3] represent dirt that can accumulate after repeated use. These deposits usually result in erratic and inconsistent load readings. The orange deposits depict small metallic chips that can often become lodged into the insulator surfaces. In most of the cases, they will render the probe inoperable. And in other cases, may result in erroneous “consistent” readings with a zero offset. For example, when using the 0% datum disk gage, a reading of 20% will be displayed instead of 0%, and 120% instead of 100% when using the 100% datum disk gage.

The SPC4™ System is designed to be accurate, reliable, and easy to use. However, it is possible that you will have trouble during operation. If a problem occurs during operation follow the steps listed below in an attempt to determine the source of the problem.

(1) Re-read the operating instructions.

(2) Check the power supply. If possible, replace with a new unit.

(3) Visually inspect the connectors and the interconnecting cables. Check them for continuity (see **Figure 1.3.5 - Extension Cord - Connectors**).

(4) Re-read the recommended cleaning procedures detailed in **Paragraph 5.0** and thoroughly clean the probe, and the supplied calibration gage.

(5) Re-check the calibration of the system as outlined in **Paragraph 2.5**.
If problems persist, contact Valley Forge & Bolt Manufacturing at the address shown in **Paragraph 1.1.**

NOTES: