SC 900
Soil Compaction Meter

PRODUCT MANUAL
Item # 6110FS
CONTENTS

General Overview 3
Taking Compaction Measurements 4
Depth Sensor 5
Meter Operation 6
Connecting to a Computer 8
Identifying the COM Port 9
Connecting to a GPS Unit 10
Calibration/Battery Change 11
Main Toolbar 12
Meter Settings 14
Measurement Procedure 16
Warning Messages 18
Data Management 20
Meter Dimensions 21
Specifications 22
Appendix 1: Time Zone Corrections 23
Appendix 2: When to Replace the Cone 24
Warranty 26

This manual will familiarize you with the features and operation of your new Field Scout™ SC 900 Soil Compaction Meter. Please read this manual thoroughly before using your instrument. For customer support, or to place an order, call Spectrum Technologies, Inc.
(800)248-8873 or (815) 436-4440
between 7:30 am and 5:30 p.m. CST,
FAX (815)436-4460,
E-Mail: info@specmeters.com.
www.specmeters.com
Thank you for purchasing the Field Scout™ SC 900 Soil Compaction Meter. This manual describes the features and operation of the meter.

Soil compaction prevents moisture penetration, reduces fertilizer and chemical uptake and hinders plant root growth. In some cases, yield losses can run as high as 30% due to compaction. This new electronic soil compaction meter is the most versatile compaction meter on the market. Soil depth readings are determined by a sonic depth sensor. Cone index values are measured by a load cell sensor and can be displayed in PSI or kPa.

The Field Scout’s shaft-mounted probe allows the user to easily and rapidly take many measurements. The shaft can be disassembled into 2 pieces for easy storage and transport. The meter’s built-in datalogger can record data from several sites and eliminates the need to record data manually. Through the software, the user can download the data, change the logger settings and configure the meter.
TAKING COMPACTION MEASUREMENTS

The SC 900 is a state-of-the-art electronic cone penetrometer for use in soil density, trafficability and compaction studies. This soil compaction instrument measures cone index data, logs the data and allows the user to review the data to make soil management decisions.

It is recommended that compaction measurements be taken after a rain, or in the spring when the soils have good moisture content. Measuring soil compaction in dry soil conditions will not yield meaningful results.

The SC 900 compaction meter should be used before tillage to determine where the compacted areas of a field/plot are. Once the compacted areas, along with compaction depths, have been determined, a much more effective tillage system can be employed.

The unit works as an efficient diagnostic tool as well as a management unit after the tillage operation has been performed. One can determine how deep the soil has actually been worked and if the tillage operation has solved the compaction problems.
An ultrasonic sensor located at the base of the meter is used to measure the depth of penetration. The field of view extends about 30° from the shaft. The sensor measures distance by emitting a sound wave and measuring the travel time of the first reflected wave. Usually, this first reflection will come from the ground just adjacent to the shaft. However, if an object with a surface oriented toward the sensor is within the field of view, an erroneous depth measurement may be made. This can lead to depth error messages (see Warning Messages p. 18). If possible, try to remove the object and/or smooth the surface. Repositioning your feet and knees may also eliminate these errors. If the problem persists, use a flat target surface with a hole slightly large than the diameter of the cone to test the depth sensor and, if necessary, to take measurements. This target should be about 1 foot wide and can be made out of cardboard or something sturdier if more durability is required. To test the sensor, lay the target on the ground and place the shaft in the hole. Have another person slowly raise the target while you verify the meter is incrementing the depth.
**Meter Operation**

The ON switch turns the meter/datalogger on and off. When the meter is turned on, it will display the battery status for 3 seconds. For the next 3 seconds, it will display how much logger memory has been used and, if the logger was enabled in the software, whether the GPS signal was found. If a GPS signal is found, latitude and longitude data will be included in the data file.

![ON switch]

**Logger 75% Full**
**GPS=Yes**  **DGPS=No**

Sample meter power-up screens with datalogger enabled: left screen indicates GPS signal was found.

The meter will then be ready to take readings (see Measurement Procedure pg. 16).

Note: If you are using GPS, but the meter doesn’t find the GPS signal when powering up, the meter will not search for the GPS signal when taking readings. Turn the meter off and on so it can look for the GPS signal. Once the signal is found, GPS information will be included in the data file until the signal is lost or the GPS unit is disconnected from the meter (see Connecting to a GPS Unit pg. 10).

0010 PSI 00 IN
Logger = OFF

If, when powered up, the screen indicates the data logger is not activated (see above screen), no data will be stored by the meter. The data logger can be activated through the SC 900 software (see Meter Settings, pg. 14).
Meter operation (cont.)

Immediately after the meter has successfully taken a full profile measurement, but before measuring another profile, the DELETE button will delete the profile before that has just been sent to the datalogger. The screen will then display the following message:

Reading Deleted

After measuring a profile, pressing the REVIEW button allows the user to see the cone index value at each depth. As the button is pressed, the display screen will scroll sequentially through the entire profile.

The START button readies the meter and datalogger to take a profile measurement. It must be pressed before every attempted profile measurement.
Connecting to a Computer

The data port on the underside of the SC 900 meter (shown above) can be accessed by removing the plastic screw. It is through this port that the meter is connected to either a PC or to a GPS unit.

Connecting to a PC

The SC900 software comes with a gray PC interface cable. This cable connects to the 9-pin serial port of your computer and to the meter’s computer port. The meter’s configuration can be modified by clicking on the Meter Settings button (see Meter Settings, p. 14). The Com Port, Meter Type, Download, Clear Memory and Meter Settings buttons are explained in the Main Toolbar section (p. 12).
The computer Communications Port to which the PC-3.5 serial cable is connected can be identified by using a paper clip.

1. Disconnect the serial cable from the meter.

2. To bring up the Port Selection screen, click on the Com Port Button, select the com port to be tested and click the Port Test button. Click the Test Port Now button. If the message “Connection OK” is displayed, another device (such as a modem) is probably connected to that port. If the message “No Connection” is displayed, this port may be the one connected to your serial cable and you can proceed to the next step.

3. Place a paperclip on the end of the serial pin so that it touches both the tip of the pin and the metal area between the two black rings. Again click on the Test Port Now button. If the message “Connection OK” now appears, this is the com port connected to your serial cable.

NOTE: The meter does not short-circuit the serial pin. Therefore, when the Test Port Now button is clicked while the meter is connected, the “No Connection” message will be displayed.
Connecting to a GPS Unit

Cable Connections
A GPS/DGPS cable (item # 2950C) is required to connect the SC900 meter to a GPS unit. This cable has a 9-pin male connection and a stereo pin that connects to the meter’s data port. You will also need a cable that allows the GPS unit to connect to a 9-pin male serial port. If this cable doesn’t come standard with your GPS unit, it should be available from the manufacturer. This cable is generally used to upload information from a computer to the GPS unit. These components should be connected as shown in the figure below.

GPS Setting
Your GPS unit must be set for NMEA 0183 input/output messages. If the meter has trouble receiving the GPS signal, check that it has the following settings:

- Data bits: 8
- Stop bits: 1
- Baud rate: 4800 bps
- Parity: None
- Timing: 1 second
- GGA data string

Connecting the SC900 meter to a GPS unit
Calibration/Battery Change

Calibration

The reading of the meter’s load cell can be recalibrated with the following procedure.

Note: During the calibration procedure, care must be taken to ensure that the only force on the load cell is the weight of the meter itself.

1. Balance the meter in an upright position on a hard surface.
2. Press and hold the START button.
3. With the START button depressed, press and release the ON button. The LCD will count down from 5 to 1.
4. The meter should now read between 5 and 10 P.S.I. (35 - 70 Kpa). This reflects the weight of the meter itself.

Changing the Batteries

To change the batteries, remove the 4 philips-head screws from the face plate of the meter. Remove the face plate to access the battery compartment. The meter requires 4 AAA batteries.
Com Port
The gray software cable connects the meter to the computer data port. Select the Com Port that is assigned to the computer data port. See Identifying the Correct Com Port (p. 9) for instructions on how to determine which port to select.

Meter Type
Select the SC900 option from the list of available Field Scout meters.
Download
To download data from the internal data logger, turn the meter off and connect the gray serial cable to the RS-232 port on the underside of the meter. Click the Download button on the main software screen. In the Save Data As screen, give the file a descriptive name and select the location where it will be saved. When the file has been saved, the software will give you the option of immediately viewing the file. The data file is stored as a comma-delimited text file and may be viewed in text editor or spreadsheet software.

Clear Memory
Data is not automatically removed from the logger memory after a download. The Clear Memory button clears all data from the logger memory.

Meter Settings
Click this button to configure the meter and data logger. Refer to Meter Settings (p. 14) for more details.
The Meter Settings screen in the Field Scout Soil Compaction Meter software is used to configure the meter and datalogger for your specific application. This screen can be accessed by clicking on the Meter Settings button on the main toolbar screen (see pg. 14). The fields are described below.

**Meter Name:** The name given the meter will be the title on the first line of the downloaded text file.

**Logger Settings:** The datalogger is enabled and disabled by checking the first box. If the datalogger is enabled, it will search for a GPS signal when the meter is turned on. If a signal is found, position data will be stored along with the soil compaction data. If no GPS signal is available when the logger is turned on, the logger will no longer look for one when measuring and recording soil moisture data. If the second box is
checked, the logger will store the GPS value only if it has been differentially corrected. If the differential correction is not found, only the soil compaction value will be stored in the data file. A time-zone correction should be entered in the third box. Appendix 1 (pg. 23) lists time zone corrections for several cities.

**Measurement Units:** The meter can be configured to display and record data in English units (Cone Index in PSI and depth in inches) or SI units (Cone Index in kPa and depth in centimeters).
MEASUREMENT
PROCEDURE

Recording the best quality data requires some practice. Your objective is to uniformly push the probe into the ground using an even motion. The programmed rate, specified in the ASAE standards, is approximately 2 seconds per 2 inches. If this rate is exceeded, the meter will show an Error display (see Warning Messages pg. 18).

To take a profile measurement:

1. Push and release Start button.
2. Wait for LCD to display the profile information screen. The top line shows the current cone index and the depth. At the surface the depth will be zero. The second line indicates how many profiles have been taken (If the logger is disabled, the second line will say the logger is off). This resets to 1 every time the meter is turned on.

```
0010 PSI 00 IN
N=1
```

Profile Information Screen

3. Stand with your feet at least 4 to 6 inches from the probe tip. This ensures the sonic depth sensor will measure accurately. Tall, nearby objects or walls will also inhibit the ability of the depth sensor to “see” the ground surface. If you are working in turf or an especially uneven soil surface, you may need to use a target to ensure reliable performance (see Depth Sensor p. 5). It is advisable to smooth the soil surface as much as possible before inserting the probe. As the probe is inserted into the soil, the
Measurement Procedure (Cont.)

Depth measurement on the display will increase in 1-inch increments. The cone index will change in response to soil compaction differences.

4. Push probe into ground slowly and evenly so that there is not any side stress on the shaft. If an error message is generated (see Warning Messages pg. 18), start over by removing probe and pushing the Start button.

5. Remove probe gently. If the profile was successfully measured, the following message will be displayed.

6. You can review compaction measurements increments by pushing the Review button. You can also delete the profile by pushing the Delete button. See Meter Operation (pg. 6) for details.

7. Press Start to ready the probe for the next measurement.

Geo-Referencing Compaction Measurements:

To geo-reference, you will need to connect a GPS/DGPS unit to the SC 900 and proceed as described above. The GPS format should be NMEA 0183. See Connecting to a GPS Unit (pg. 10) for further details.
**Warning Messages**

If the meter is unable to successfully measure a soil compaction profile, it will display one of the following warning messages and no data will be sent to the data-logger. In these instances, it is necessary to withdraw the probe from the soil (if necessary) and hit the START button to continue using the meter (see Measurement Procedure pg 16).

**Warning Messages**

- **Start Over**
  - **Depth > zero!**
  
  The meter cannot begin taking readings until the probe senses the tip is at the soil surface. The meter can sense a false non-zero depth if the user’s feet are too close to the shaft, if an object such as a tree or large plant is near the measurement area or if debris such as roots, soil or leaf matter is clinging to the shaft.

- **Low Battery**

  Indicates the batteries need to be changed. The battery compartment is located beneath the face of the meter.
Warning Messages (Cont.)

!Error-Too Fast! Hit RVW to Save

0010 PSI 00 IN !Error-Too Fast!

If the meter is inserted faster than the speed allowed by the ASAE standard (2 inches per 2 seconds), the meter cannot compute the cone index. You may see this message more often when taking readings in areas with non-compacted zones beneath strongly compacted zones. You have the option of saving this profile anyway by pressing the Review button. In this case, you’ll see a Profile Information Screen with an error message on the lower line.

Start Over Excessive Force

The maximum load the load cell can withstand is 250 lbs (113 kg). Exceeding this limit can cause permanent damage to the meter. The “Excessive Force” warning message appears when 210 lbs (95 kg) or more is applied to the load cell.

Start Over !! Depth Error !!

This error message indicates that the meter missed a depth reading. This can be caused by a momentary, but rapid, insertion of the probe into the soil or by an object such as a foot or a knee suddenly coming into the field of view of the sonic depth sensor.
Data Management

Sample data showing results of data collected with and without GPS activated. Note: GPS signal not found when recording first four sample numbers.

The data is stored in comma-delimited text files. These files can be opened with text-editing software (e.g. Microsoft Word) or spreadsheet software (e.g. Excel).

The first two lines of the data file give the logger’s name and serial number. The third line indicates that latitude and longitude are referenced to the 1984 World Geodetic Survey datum. The fourth line shows the cone index unit system. The fifth line shows the column headings for the rest of the data file. Each row of data represents a measurement profile.

Logging sessions are started and completed by turning the meter on and off. The start of a logging session is indicated by the data line “Logger Started”. If a GPS signal was found at the start of a logger session a time stamp is included on the “Logger Started” line.
**Meter dimensions**

The following are the dimensions of the SC 900 Soil Compaction Meter.

- **Meter**: 7.25” x 19.75” x 8.5” x 12”
- **Shaft**: 19.75”
- **Connection**: 8.5”
- **Cone Tip**: 7.25”
## Specifications

<table>
<thead>
<tr>
<th>Measurement Units</th>
<th>Cone Index (PSI or kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>1” (2.5 cm), 5 PSI (35 kPa)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.5” (±1.25 cm), ±15 PSI (±103 kPa)</td>
</tr>
<tr>
<td>Range</td>
<td>0 - 18” (0 - 45 cm), 0 - 1000PSI (0 - 7000 kPa)</td>
</tr>
<tr>
<td>Maximum Insertion Speed *</td>
<td>72 in/min (182 cm/min)</td>
</tr>
<tr>
<td>Maximum Applied Load *</td>
<td>210 lbs</td>
</tr>
<tr>
<td>Power</td>
<td>4 AAA alkaline batteries, Approximately 12 month life</td>
</tr>
<tr>
<td>Logger Capacity</td>
<td>772 profiles without GPS, 579 profiles with GPS/DGPS</td>
</tr>
<tr>
<td>Display</td>
<td>16 character, 2 line LCD</td>
</tr>
<tr>
<td>Weight</td>
<td>2.75 lbs. (1.25 kg)</td>
</tr>
</tbody>
</table>
## Appendix 1

### Time Zone Corrections

<table>
<thead>
<tr>
<th>Time Zone Correction</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Dublin, Lisbon, London</td>
</tr>
<tr>
<td>3</td>
<td>Rio de Janeiro, Montevideo</td>
</tr>
<tr>
<td>4</td>
<td>Asuncion</td>
</tr>
<tr>
<td>5</td>
<td>Atlanta, Indianapolis, New York, Ottawa, Bogota, Montreal, Toronto</td>
</tr>
<tr>
<td>6</td>
<td>Guatemala City, Houston, New Orleans, Chicago, Mexico City, Winnipeg</td>
</tr>
<tr>
<td>7</td>
<td>Phoenix, Denver, Edmonton</td>
</tr>
<tr>
<td>8</td>
<td>San Francisco, Los Angeles, Vancouver</td>
</tr>
<tr>
<td>9</td>
<td>Anchorage</td>
</tr>
<tr>
<td>10</td>
<td>Honolulu</td>
</tr>
<tr>
<td>11</td>
<td>Wellington</td>
</tr>
<tr>
<td>13</td>
<td>Adelaide, Melbourne, Sydney</td>
</tr>
<tr>
<td>14</td>
<td>Vladivostok, Brisbane</td>
</tr>
<tr>
<td>15</td>
<td>Seoul, Tokyo</td>
</tr>
<tr>
<td>16</td>
<td>Beijing, Hong Kong, Manila, Singapore, Taipei</td>
</tr>
<tr>
<td>17</td>
<td>Hanoi, Jakarta, Vientiane</td>
</tr>
<tr>
<td>18</td>
<td>Calcutta, New Delhi</td>
</tr>
<tr>
<td>19</td>
<td>Kabul, Islamabad</td>
</tr>
<tr>
<td>20</td>
<td>Tehran, Abu Dhabi, Dubai</td>
</tr>
<tr>
<td>21</td>
<td>Moscow, Nairobi, Kampala, Riyadh</td>
</tr>
<tr>
<td>22</td>
<td>Ankara, Athens, Helsinki, Istanbul, Cairo, Johannesburg, Harare</td>
</tr>
</tbody>
</table>
Appendix 2
Determining When to Replace Cone

Repeated soil sampling will wear down the metal cone. Periodically measure the diameter of the cone using a dial caliper or micrometer that allows you 0.001-inch measurements.

Place the caliper/micrometer on the shoulder of the cone. Figure 1 shows the proper placement and Figure 2 the layout of the shoulder.

The determination as to when to replace the cone will depend on how the user is applying the meter.

If you are using the meter to get absolute compaction readings, replace the cone when there is a “wear factor” of 3%. Three percent wear affects the cone index measurements by 5%. A new cone has a diameter of 0.505”, see Figure 3. When the cone diameter reaches 0.490” (3% wear), replace the cone.
When you are doing **comparative** analysis of the readings in a field or a plot, the measurements will be consecutive. The amount of wear of the cone will not be a factor. In this case, it is recommended that the cone be replaced when the shoulder is not easily recognizable as a shoulder anymore.

![Figure 3](image.png)

Replace the cone as follows:
1. Lay meter on its side
2. Unscrew worn cone by hand or with a pair of pliers
3. Attach new cone into meter shaft
4. Tighten to a snug fit with hands or pliers. Be careful not to imprint the cone with pliers.

Replacement cones can be ordered from Spectrum Technologies or an authorized Spectrum Dealer.
WARRANTY

This product is warranted to be free from defects in material or workmanship for one year from the date of purchase. During the warranty period Spectrum will, at its option, either repair or replace products that prove to be defective. This warranty does not cover damage due to improper installation or use, lightning, negligence, accident, or unauthorized modifications, or to incidental or consequential damages beyond the Spectrum product. Before returning a failed unit, you must obtain a Returned Materials Authorization (RMA) from Spectrum. Spectrum is not responsible for any package that is returned without a valid RMA number or for the loss of the package by any shipping company.
DECLARATION OF CONFORMITY

Spectrum Technologies, Inc.
12360 S. Industrial Dr. East
Plainfield, IL 60585 USA

Model Numbers: 6110FS
Description: Soil compaction meter
Type: Electrical Equipment for Measurement, Control, and Laboratory Use

The undersigned hereby declares, on behalf of Spectrum Technologies, Inc. of Plainfield, Illinois, USA, that the above referenced product, to which this declaration relates, is in conformity with the provisions of:

Standards:
- EN 61326-1:2006
- EN 61000-4-3:2002
- EN 55011:2007

Douglas L. Kieffer,
Soil/Water Products Manager
February 27, 2009