

LUCAS® 3

CHEST COMPRESSION SYSTEM

SERVICE MANUAL

US



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Preface

This Manual describes how to maintain, test, troubleshoot, and repair the LUCAS® 3.

Another publication, the **LUCAS® 3 Chest Compression System - Instruction for Use** (IFU) is for physicians, clinicians, and emergency care providers. The IFU provides step-by-step instructions for use, as well as operator-level testing and maintenance.

Disclaimer

Physio-Control does not accept liability for injury to personnel or damage to equipment that may result from misuse of LUCAS. Under no circumstances shall Physio-Control be liable for incidental or consequential damage arising from the use of LUCAS.

All discovered failures that directly or indirectly have, or may have, affected patient or user safety shall, with no delay, be reported directly to the Quality Department at Physio-Control, Inc.

All the screenshots or pictures in this document are for the example only; they are subject to change without matching the latest versions of software.

Trademarks

LUCAS® 3 is a trademark of Jolife AB. LUCAS 3 Report Generator is a trademark of Physio-Control, Inc. Microsoft and Windows are registered trademarks of Microsoft Corporation in the US and/or other countries. Specifications are subject to change without notice.

Definitions, Acronyms, and Abbreviations

IFU	Instructions for Use, LUCAS 3, PN/CAT #: 3326785-0## / 26500-00#### Instructions for Use, LUCAS 3 Version 3.1, PN/CAT #: 3326785-1## / 26500-00####
LRG	LUCAS® 3 Report Generator, a data download Software
DT Express	Data Transfer Express
FSR	Field Service Representative (services products in the Field)
LUCAS	LUCAS® 3 Chest Compression System
LIFENET	LIFENET System including website
Nm	Unit for torque value in Newton Meter
PCO file	Physio Case Object file, a data format for a combination of device data and user-entered data. Data in this format can be imported and exported by Physio-Control data management applications.
PIP	Performance Inspection Procedure
SmartDesk	LIFENET connectivity support

Contacting Physic-Control

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Toll Free (USA only): 800.442.1142
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Service Personnel Qualification

Service personnel must be properly qualified and trained, and thoroughly familiar with the operation of the LUCAS® 3. They must meet at least one of the following requirements (or the equivalent):

- Physio-Control Service Depot technicians
- Physio-Control Field Service Representatives
- 3rd Party Service Providers that have service agreements with Physio-Control

Service Information

Before attempting to clean or repair any assembly in the device, the Service personnel should be familiar with the information provided in Preventive Maintenance.

A qualified Technical Support should inspect any device that has been dropped, damaged, or abused to verify that the device is operating within performance standards listed in the Performance Inspection Procedures (PIP).

Replacement procedures for the device are limited to those items accessible at the final assembly level. Replacements and adjustments must be made by qualified service personnel. Replacements at the final assembly level simplify repair and servicing procedures and help ensure correct device operation and calibration.

To obtain service and maintenance for your device, contact your local Physio-Control service or sales representative. In the USA, call Physio-Control Technical Support at 1.800.442.1142. Outside the USA, contact your local Physio-Control representative.

When you call Physio-Control to request service, provide the following information:

- Model number and part number
- Serial number
- Observation of the problem that led to the call

Configuration Information

This service manual covers the LUCAS® 3 also known as LUCAS in this manual.

Unless otherwise noted, functions and features are consistent as specified throughout this manual. Differences are noted as appropriate.

Item Number	Catalog Number	Description
3326785-0##	99576-0000##	LUCAS 3, *
3326785-0##	99576-0000##	LUCAS 3 version 3.1, *

Note:

in the dash number of Item Number and Catalog Number is different for each language specification.

* Description contains country specification.

Device Tracking

All performed service where modules are replaced, the serial no./batch no. of each module shall be stated in the service report. This information is then sent to Physio-Control, Inc., on a monthly basis.

The modules that have traceability are:

- Compression Module
- Electronic PCBs
- Electric Motor
- Battery
- Main Body
- Support Leg
- Hood
- Back plate

Recycling Information

Important!

The Battery used in LUCAS shall be returned to the local recycling station or dealer/distributor for correct recycling.

LUCAS contains of several materials as listed below:

- Polyphthalamide (PPA) with 50% glass fiber
- Polyamide reinforced with 30% glass fiber
- Polycarbonate/Polybutylene Terephthalate
- Polycarbonate
- Polyurethane
- PVC
- POM
- Silicone
- Chloroprene
- Aluminum
- Stainless steel
- Brass

For further recycling information please contact Jolife AB, Sweden.

Warnings and Precautions

Except the warnings stated below, there are also warnings and precautions mentioned in the following documents that are of relevance during service and maintenance of LUCAS.

LUCAS®3 Chest Compression System - Instruction for Use (PNs/CAT #: 3326785-0## / 26500-00####)

LUCAS®3 Version 3.1 Chest Compression System - Instruction for Use (PNs/CAT #: 3326785-1## / 26500-00####)

- **Electrical Hazard**

Use caution when examining or operating the device without its covers.

- **Chemical Hazard**

The Battery contains chemicals, in case of leakage use extreme caution to avoid injuries. Never try to open the casing of the Battery.

- **ESD Protection**

Always use ESD protection when handling electronic boards and connections.

Warranty

To obtain a detailed warranty statement, contact your local Physio-Control representative or go to www.physio-control.com

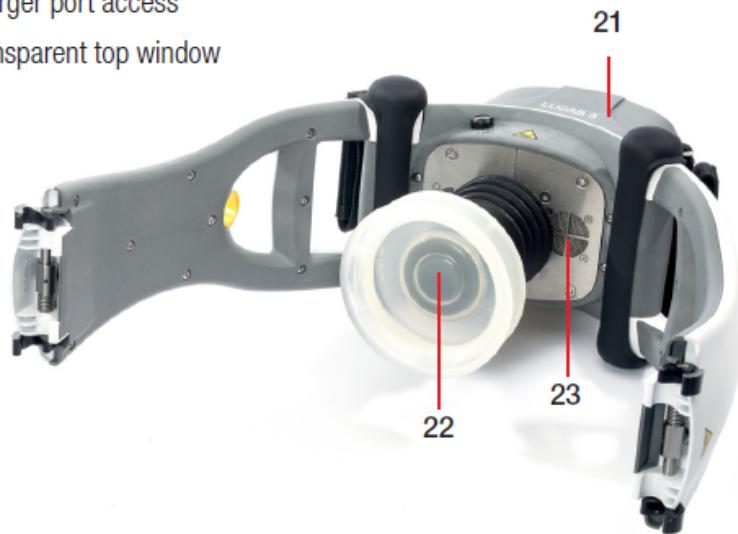
Device Information

LUCAS® 3 Components



1. Hood
2. User Control Panel
3. Battery
4. DC input
5. Bellows
6. Suction Cup*
7. Patient wrist strap*
8. Release ring
9. Support leg
10. Support leg strap
(part of the Stabilization Strap)
11. Neck strap*
(part of the Stabilization Strap)
12. Back Plate*
13. Claw locks
14. Car Power Cable
15. Power Supply cord
16. Power Supply
17. External Battery Charger
18. Carrying Case
19. Charger port access
20. Transparent top window

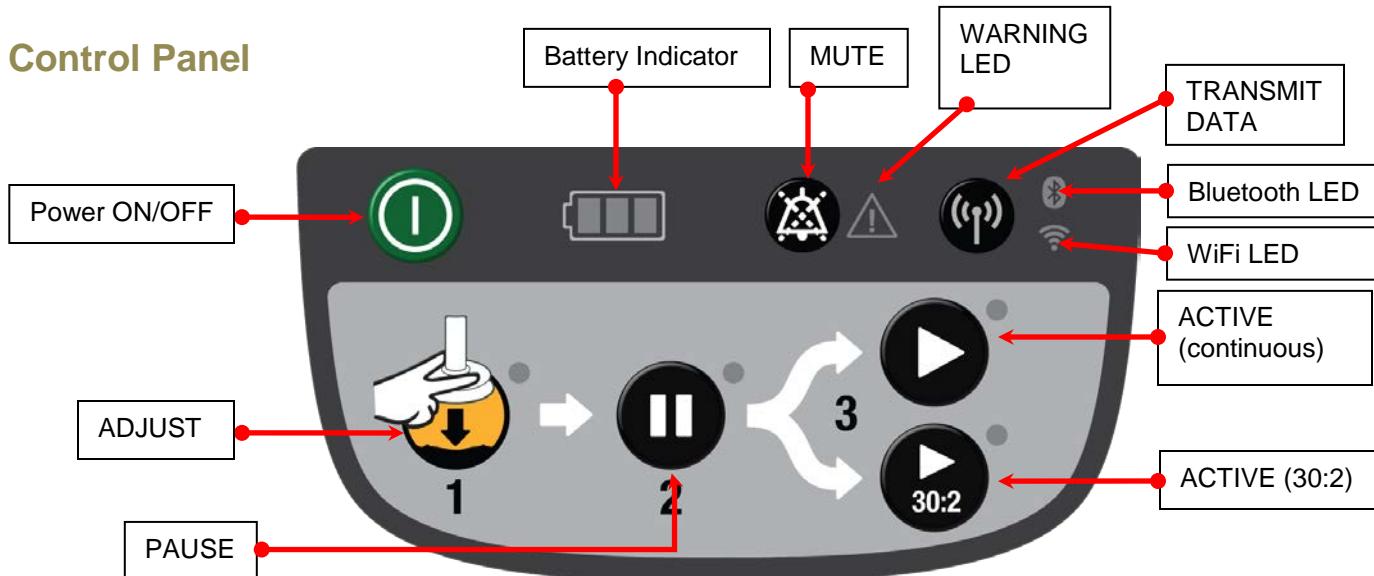
21. Upper Part
 22. Pressure pad*
 23. Vent holes
- * Applied part
(according to IEC 60601-1)



LUCAS has two Support Legs that lock to the Back Plate with Claw Locks. The Support Legs are foldable for convenient transportation.

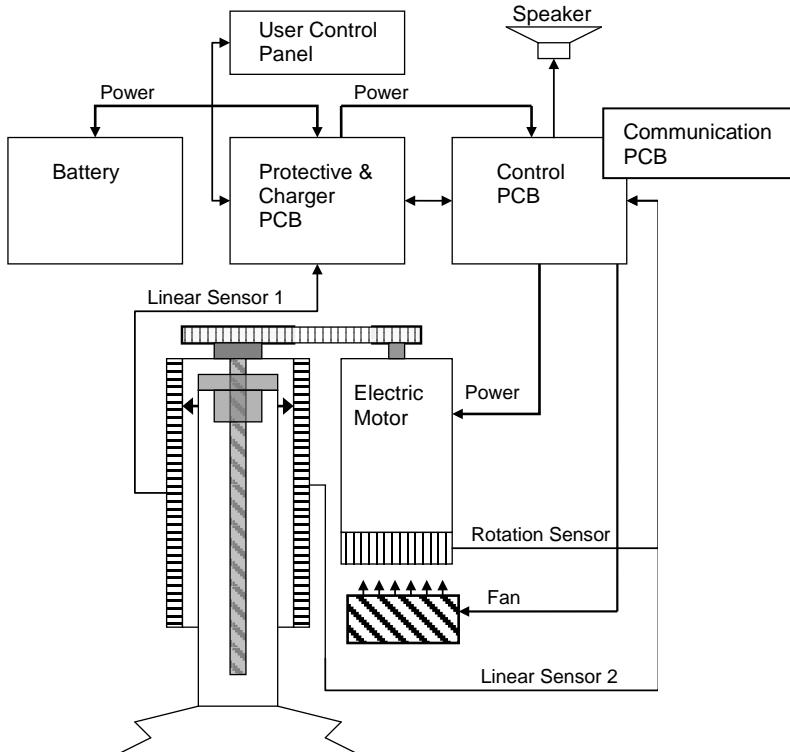
The Claw Locks automatically lock to the Back Plate when LUCAS is pressed on to it. To unlock the Claw Locks, pull the Release Rings

Control Panel



The User Control Panel is the user interface with which the device can be controlled and monitored through seven button switches and a number of LED's. The User Control Panel is situated on the hood and is connected to the protective/charger system that sends the signals to the control system. For further details on the User Control Panel please read chapter 2.7 in the Instructions for Use which also explains the different states on the Battery indicator.

Electronics Block Diagram



LUCAS is driven by a rechargeable Lithium Ion Polymer (LiPo) Battery. The Battery can be charged during operation by an external Power Supply, connected to a wall outlet, or with a Car Power Cable. You can also remove the Battery from LUCAS and recharge it in a separately sold Battery Charger of desktop model.

NOTE: The Battery must be connected even when the device is supplied by the power supply.

The Battery is mechanically keyed in LUCAS and in the Battery Charger to make sure you get the correct installation. The top of the Battery has connections for power and communication to the Battery Charger and to LUCAS.

The Battery has built in intelligence to monitor the number of usage cycles and battery age to tell the user when to replace the Battery. It also monitors the internal temperature of the Battery.

The Battery supplies the electronics and the electrical Motor. The Motor is connected to the linear unit via a drive belt.

The electronics is divided in four parts but situated on three separate PCB's:

1. The **Control System** that controls the motor with information from the user interface and from the rotation and linear sensors.
2. The **Communication System** that sends data wirelessly via Bluetooth and WiFi to/from computer.
3. The **Protective System** that controls inputs and outputs and shut off in case of a problem. The internal Battery Charger that controls the charging sequence of the Battery.

There are two separate linear measuring sensors that monitor the movement of the Suction Cup:

1. **Linear sensor 1** is for the Control System,
2. **Linear sensor 2** works as a reference to the Protective System.

An electrical fan is situated at the bottom of the device for cooling the electrical motor and other electronics, the fan starts when the internal temperature reaches 40°C and stops when the temperature is below 30°C

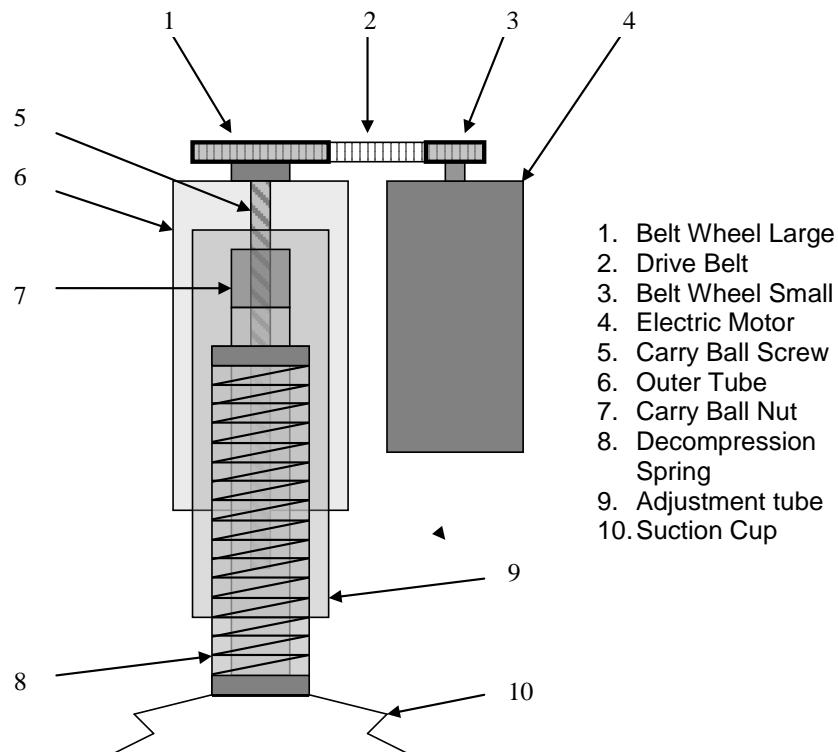
Compression Mechanism

The **Drive Belt**, driven by the electrical Motor, drives the **Carry Ball Screw** forcing the **Carry Ball Nut** up and down.

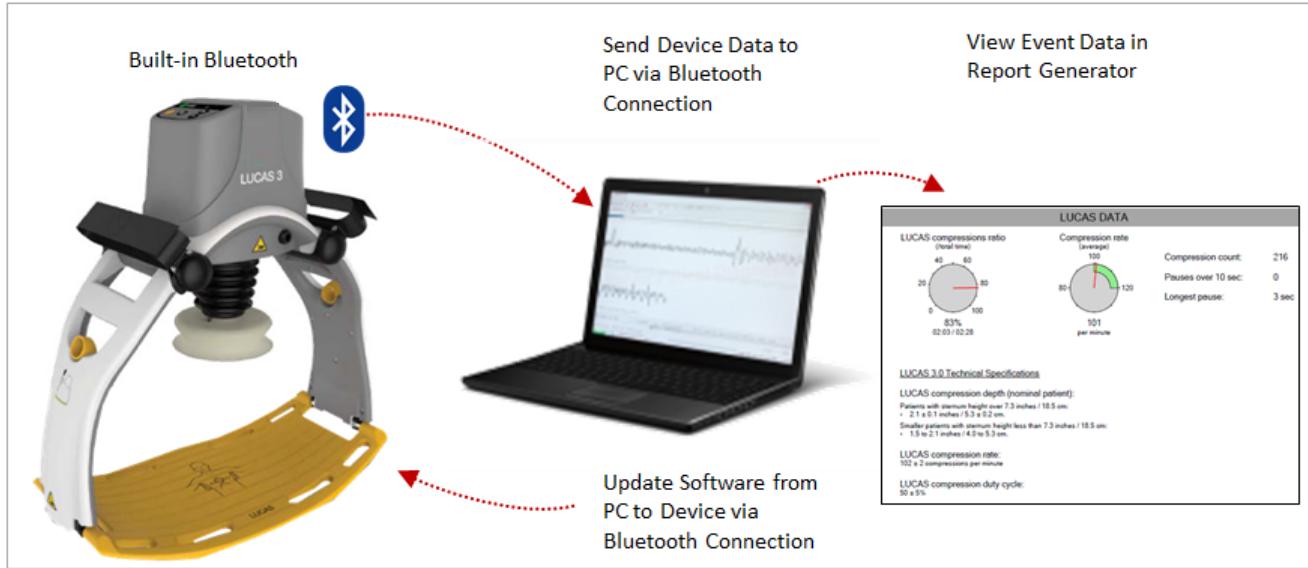
The **Carry Ball Nut** is fitted to a piston that moves the suction cup piston up and down.

The **Decompression Spring** reduces the upstroke force.

The **Suction Cup** is adjusted to the patients' chest with a servo aid system. The suction cup can easily be replaced with respect to hygiene.



Device Communication



LUCAS® 3 has a built-in communication board with Bluetooth or WiFi connection, it allows:

1. Post-event data being download to the PC without opening the hood, and view Event Data in the Report Generator after data download.
2. WiFi with LIFENET connectivity.
3. Setup Options configurable via LIFENET through WiFi or with the LUCAS® 3 Program Loader.
4. Using LUCAS® 3 Program Loader with Bluetooth connection to update Software from PC to Device, view device log, and perform sensor calibration.

LUCAS® 3 Program Loader

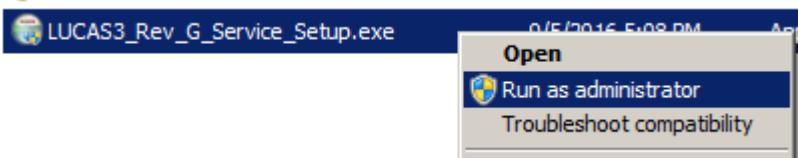
LUCAS® 3 program loader is software for updating the program and change the Setup options in LUCAS. It can also be used to read errors and warnings from the device, and perform the sensor calibration. This section explains how the software works.

- LUCAS 3 Program Loader should only be used by trained personnel
- Antivirus protection and fire walls should be installed on the computer that have the LUCAS 3 Program Loader installed.
- All suspected cyber security threats shall be reported to Physio-Control.

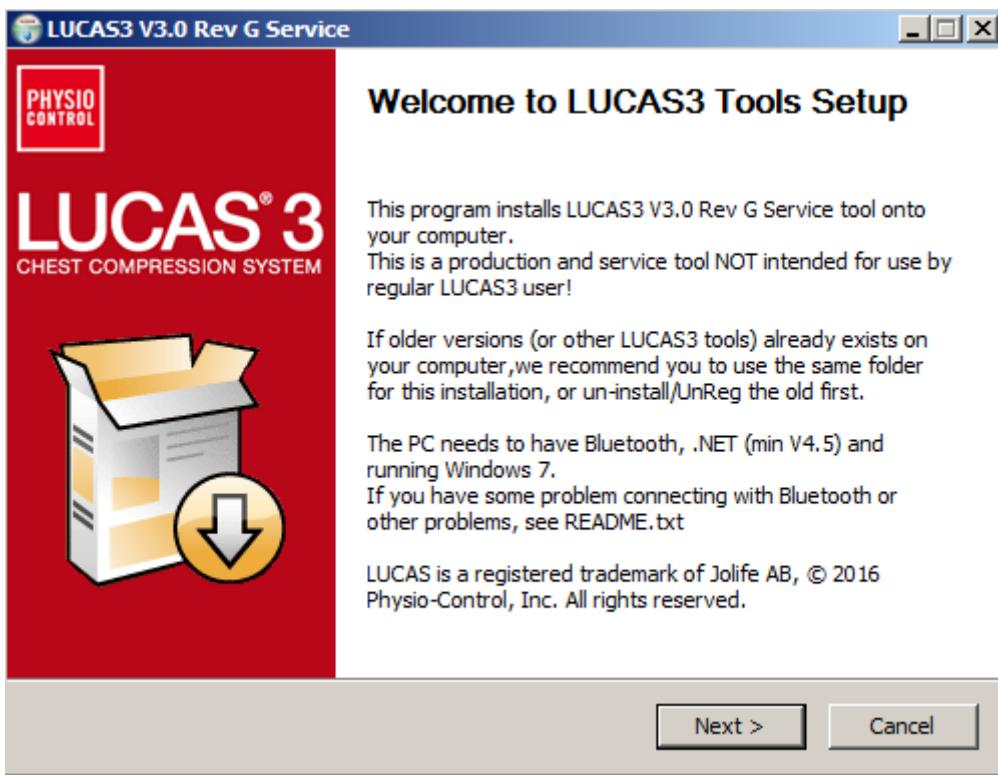
Software installation

To install LUCAS 3 Program Loader version 3.x:

1. Right Click on LUCAS3_V3X_RevX_Service_Setup.exe, and Run as administrator

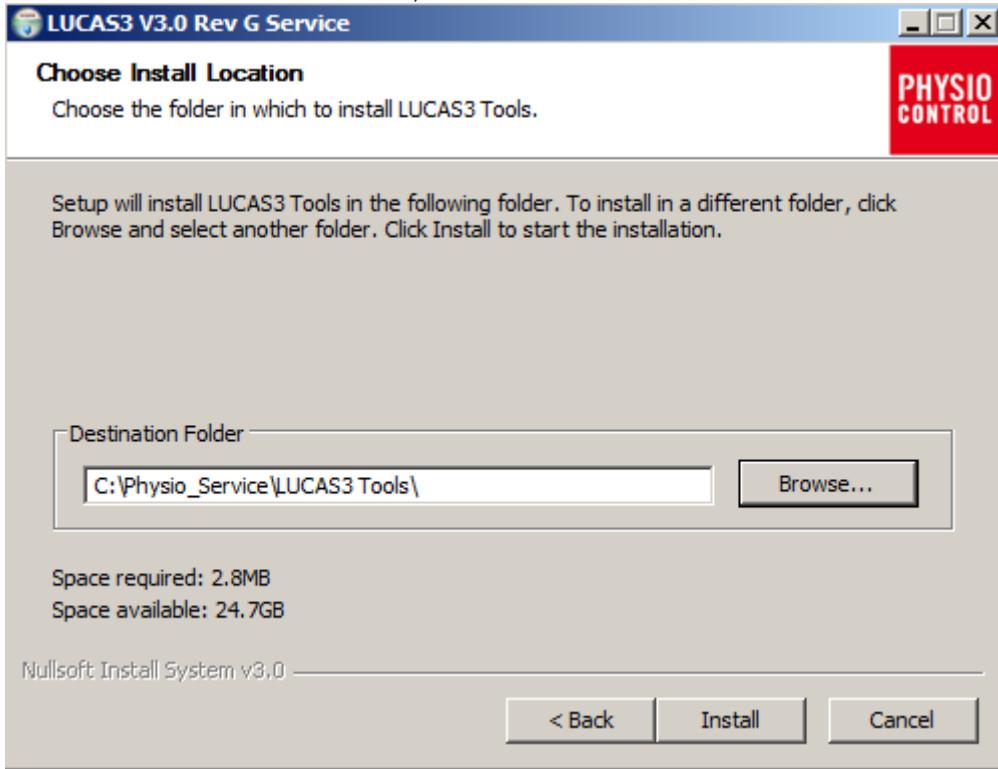


2. Installation starts
3. Click on **Next** from this screen:

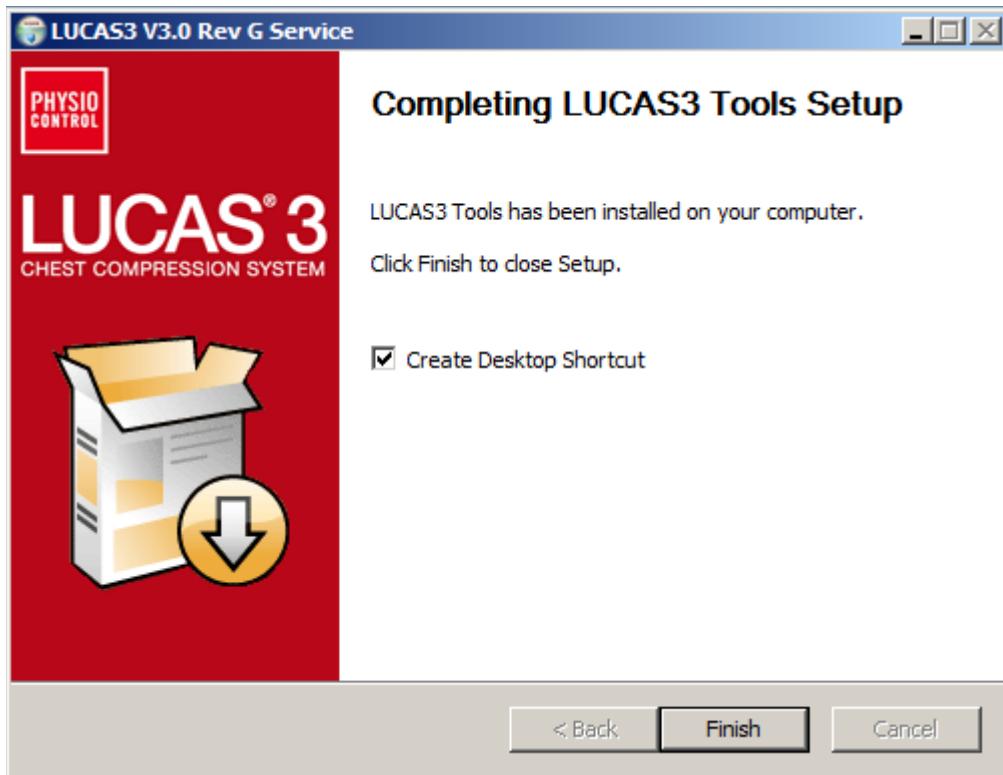


(Visual differences in screen interface may occur for different software versions.)

4. Choose installation location on PC, and Click **Install**



5. Click **Finish** to add the shortcut on the Desktop



6. Test LUCAS 3 Program Loader by double click on desktop icon
(Note. Different software versions can occur)



LUCAS3 V3.0
Rev G Service

Connect the device via Bluetooth

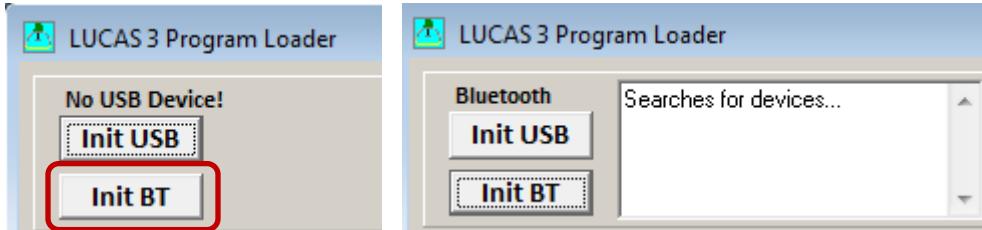
When updating the program in LUCAS using the Bluetooth connection, there is no need to open the hood.

1. Ensure the LUCAS Device is powered OFF and no LEDs are on.
2. Press and hold **TRANSMIT DATA** button for one second to turn on Bluetooth mode, ensuring the Bluetooth symbol lights up and flashing.

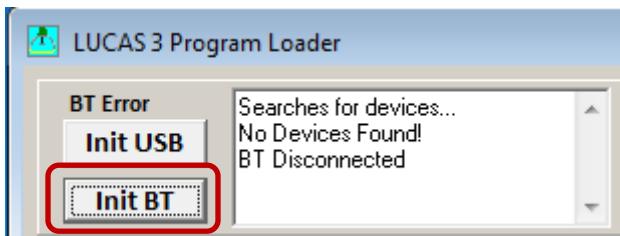




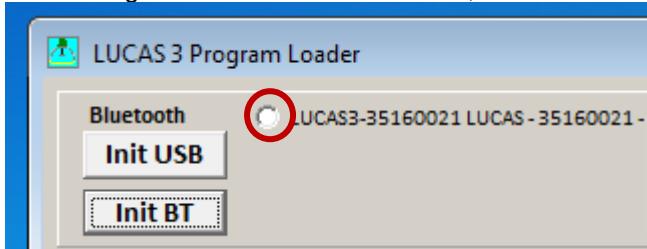
3. Start the LUCAS 3 Program Loader software by executing LUCAS3_V3_X_REV_X_Service.exe file, (Note. Different software versions can occur)
4. Click **Init BT** to connect PC to LUCAS 3 device via Bluetooth, and Wait for Program Loader to search for LUCAS 3 device...



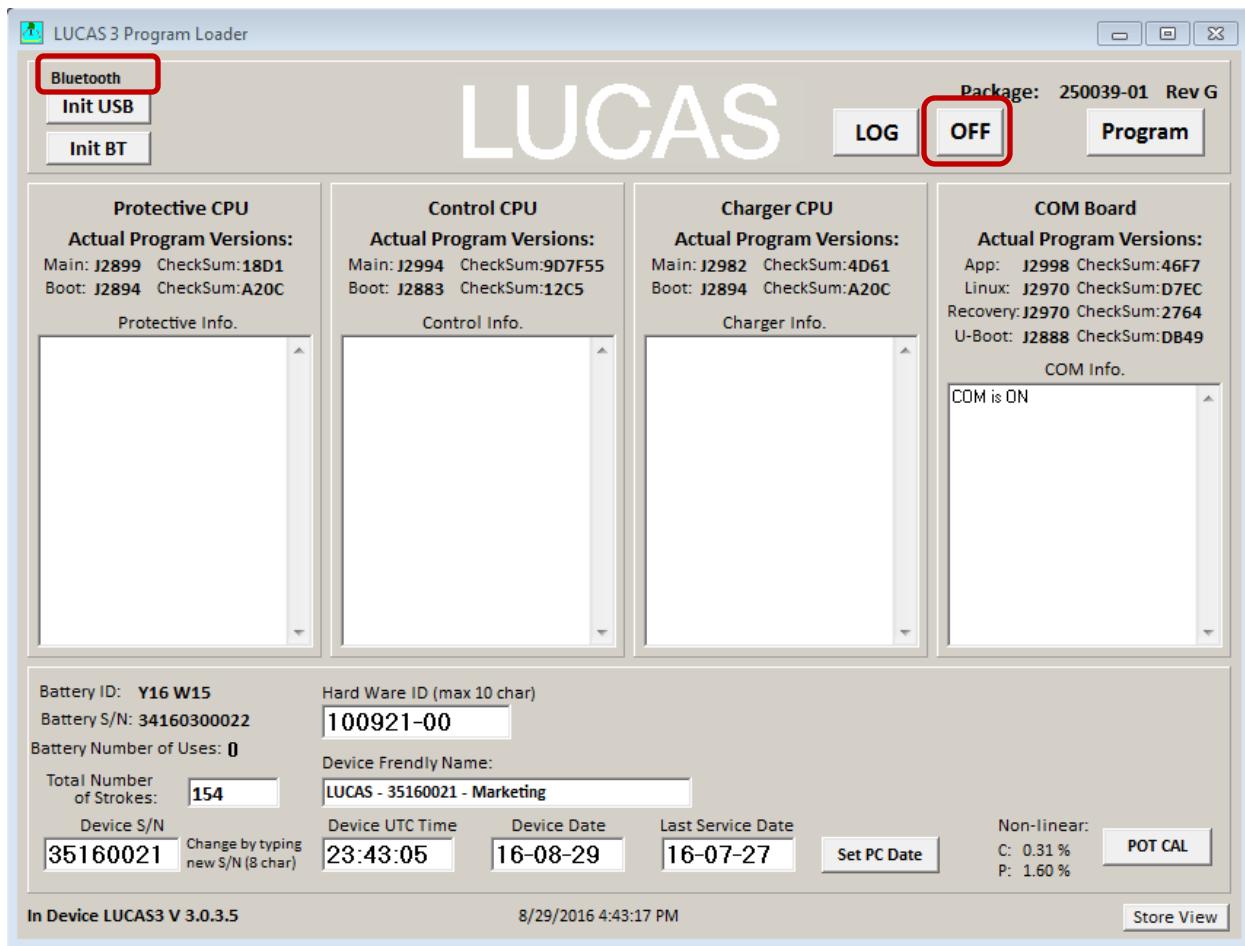
5. If **No Devices Found** message displayed, click **Init BT** and try again. **Note:** It may take up to 30 seconds for the LUCAS 3 communication app to boot up. You may have to click **Init BT** 2 ~ 3 times before LUCAS device shows up on the screen. If “**BT Error**” occurred repeatedly, refer to [Bluetooth Connection Error](#) in troubleshooting chapter.



6. When Program Loader found LUCAS 3, select the LUCAS that shall be connected.



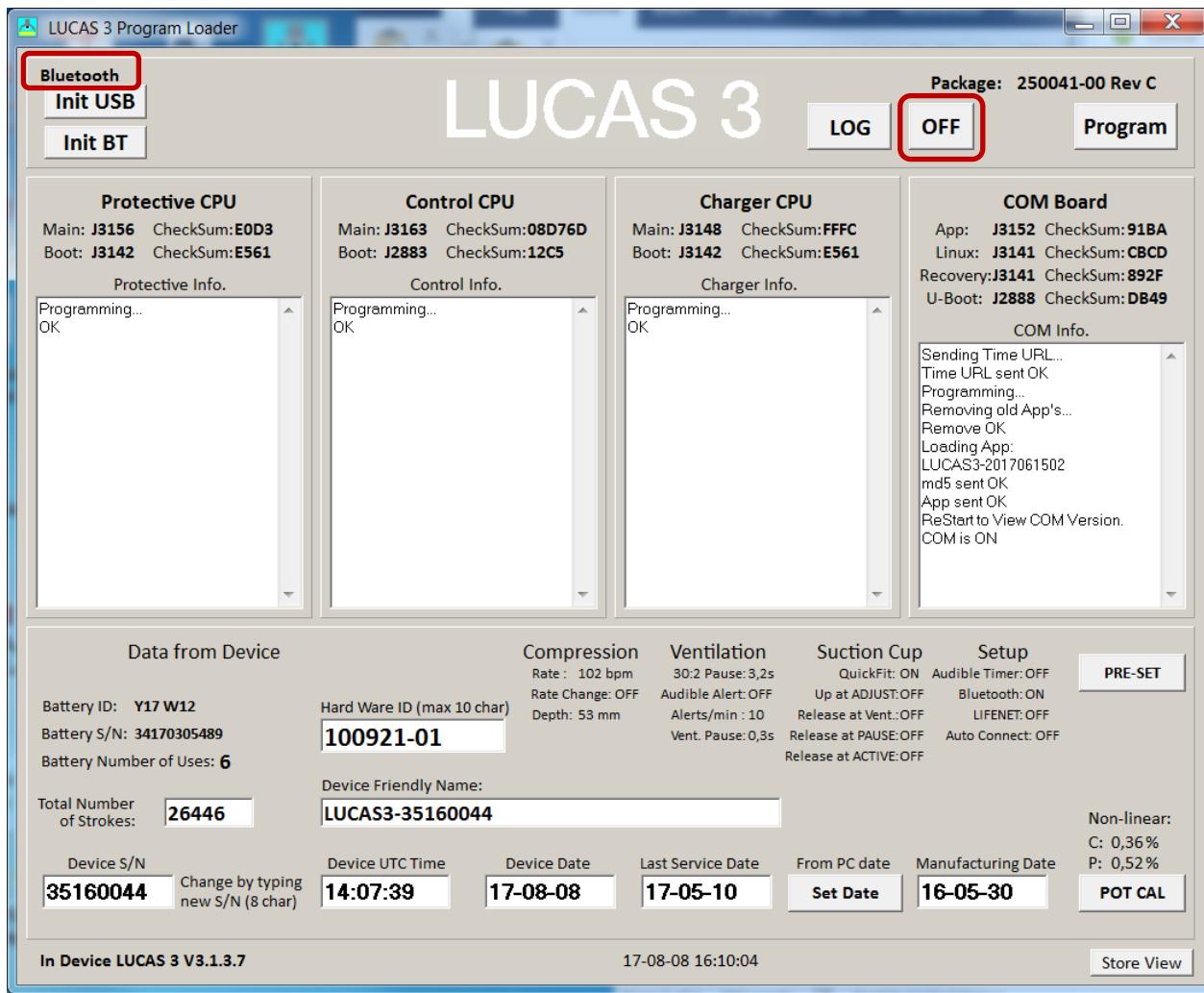
7. When Bluetooth connection is established, the Program Loader screen will show CPUs information shown as following pictures.



- Picture shows connection via Bluetooth for LUCAS 3 Version 3.0 (Part No: 250039-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –

- Check that the serial number (S/N) in the Device S/N window is equal as the S/N number on the device type label



- Picture shows connection via Bluetooth for LUCAS 3 Version 3.1 (Part No: 250041-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –

- Check that the serial number (S/N) in the Device S/N window is equal as the S/N number on the device type label
8. To disconnect Bluetooth connection, click on **OFF** button. The Bluetooth symbol light will go off.

Connect the device via USB cable

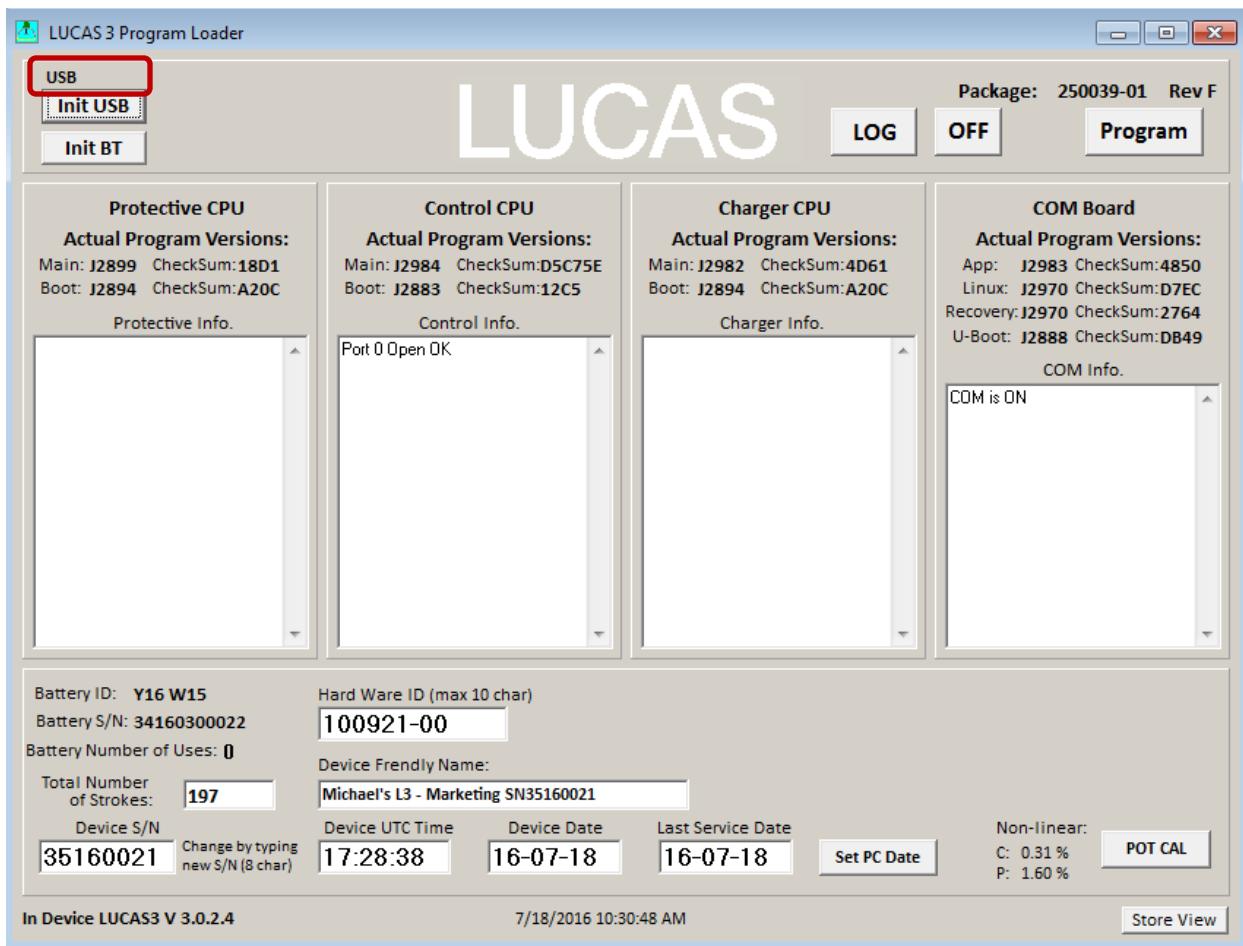
1. Remove the hood according to **Disassembling** instruction in [How to Replace the Hood](#), and use the Hood Holder bracket to hold the hood on the side and the battery should be installed.
2. Connect an USB cable between the computer and the device, the connector is situated at the lower left side of the Control PCB.



3. Start the device
4. Start the software by executing LUCAS3_V3_0.exe file, (Note. Different software versions might occur)
5. Normally the software detects the device at start. If not, then Click **Init USB**.

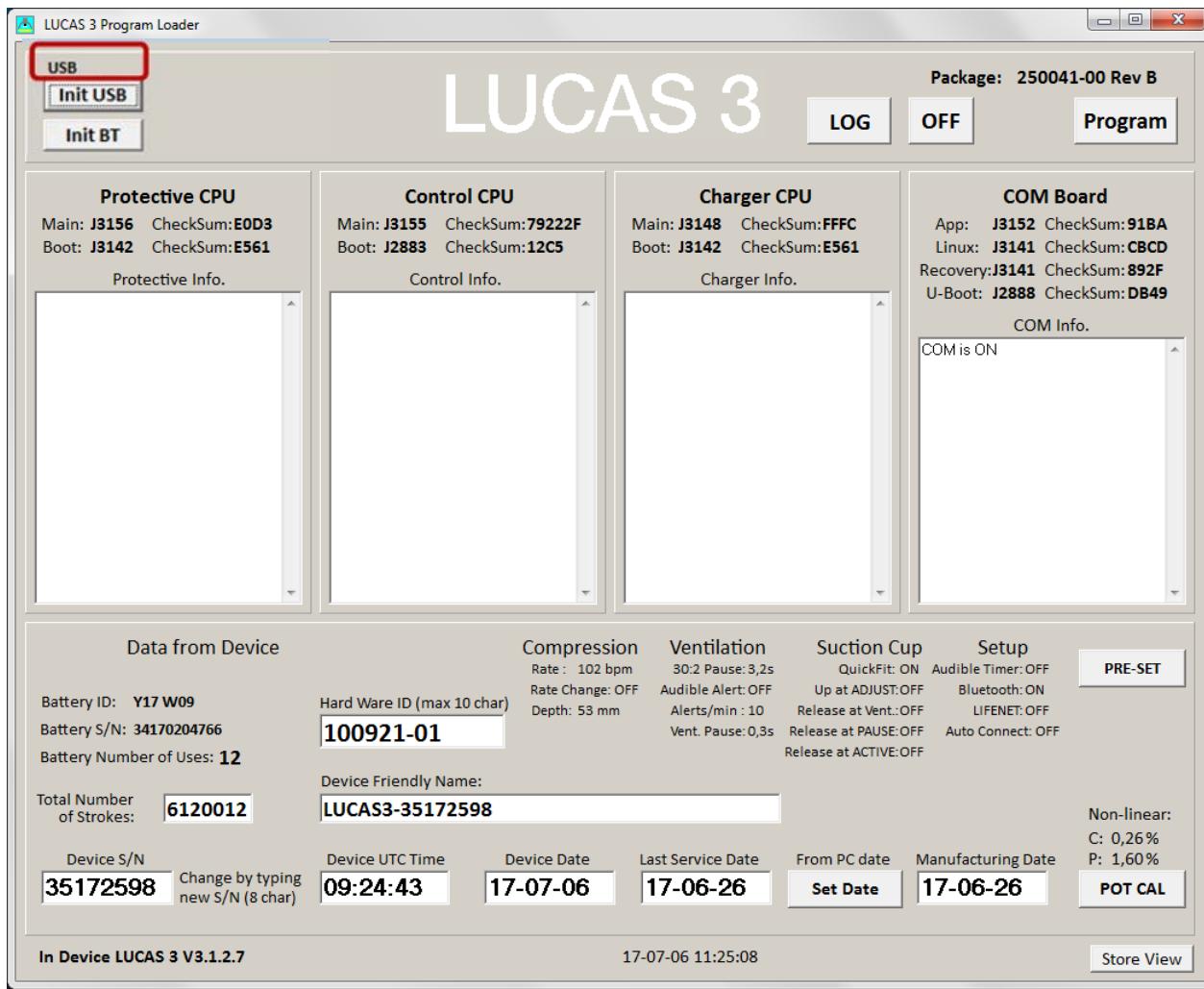


6. When USB connection is established, the Program Loader screen will show CPUs information



- Picture shows connection via USB cable for LUCAS 3 Version 3.0 (Part No: 250039-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –



- Picture shows connection via USB cable for LUCAS 3 Version 3.1 (Part No: 250041-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –

View Error Code

Once the connection is made from Bluetooth or USB cable, the information about the device should appear in the designated CPU windows.

The device Errors and Warnings will appear in each CPU's box window.



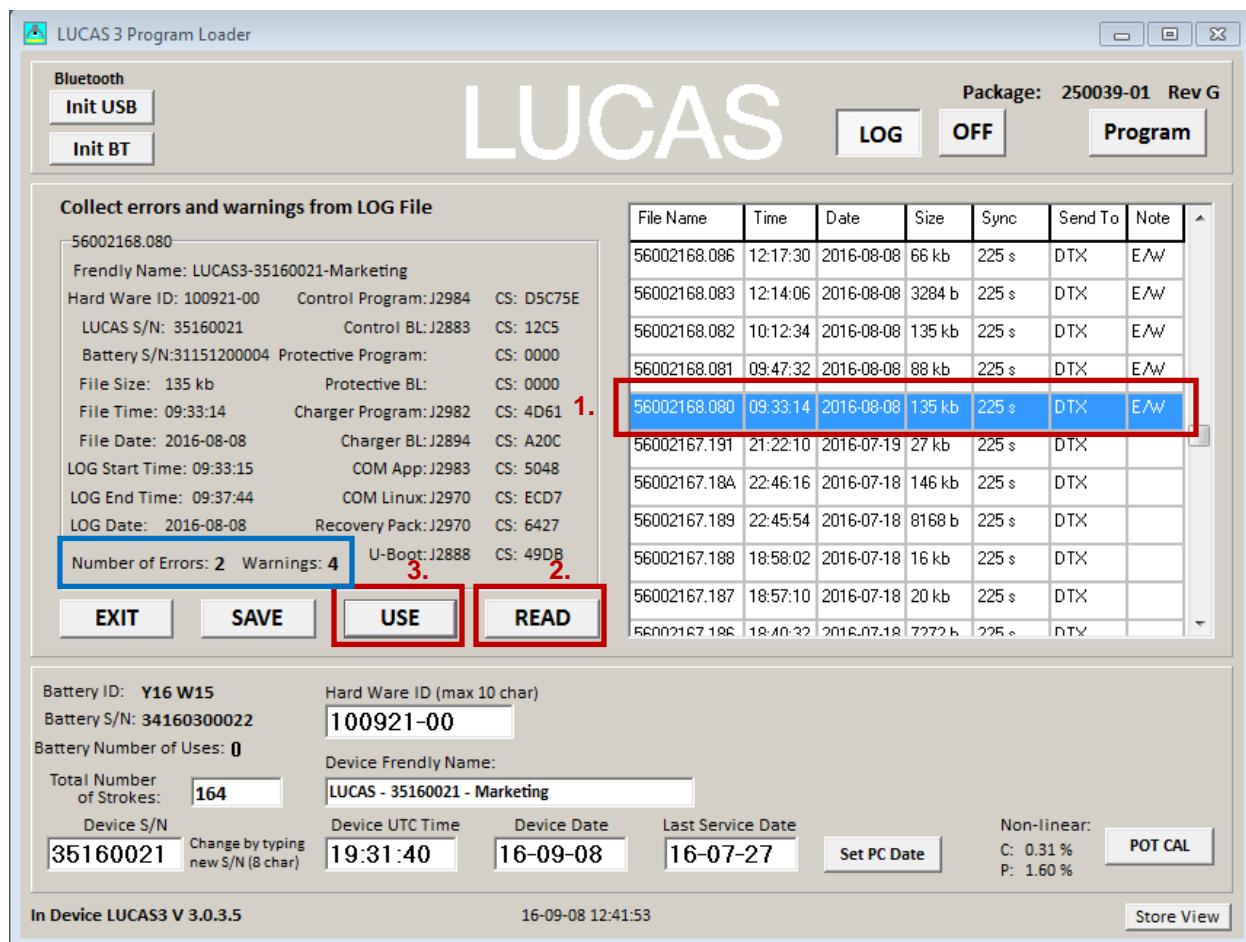
To view existing log information on the device, click **LOG** button, , Log view shows log data on screen.

Highlight a row

- Press **READ** to view log data
- Press **USE** to see the Error and Warnings code in different CPU windows
- Press **SAVE** to save the raw log file data to PC (only for developers to use)
- Press **EXIT** to exit LOG view

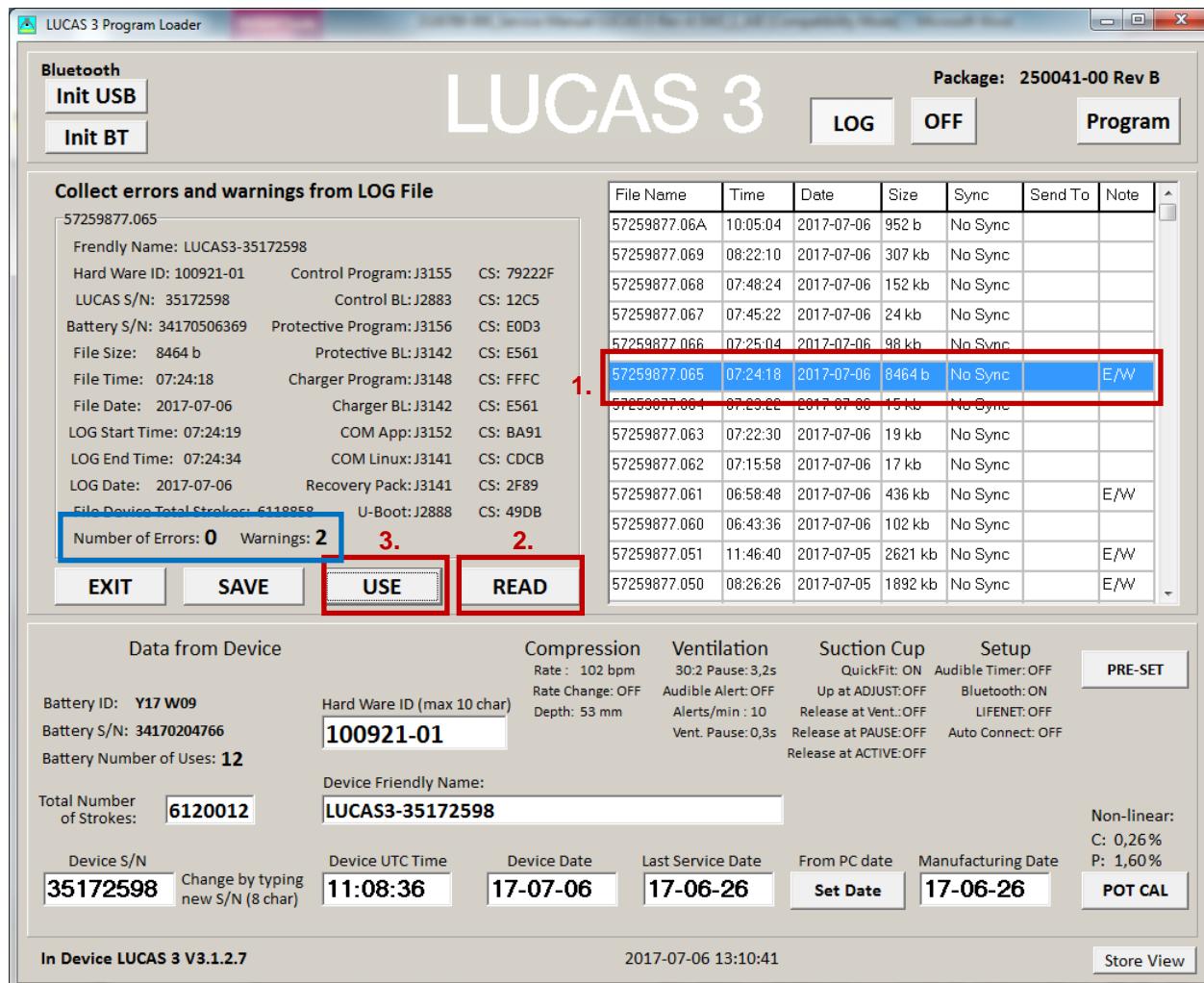
Example:

1. Highlight a row according to **Date** and **Time** the error occurred from LOG view;
2. Click **READ** and wait to see the “Collect errors and warnings from LOG File” to show up on the left side of window;
3. If the **Number of Errors** or **Warnings** are not 0, Click **USE** to see the highlighted LOG Error code in the CPU windows (**USE** will exit LOG view also).



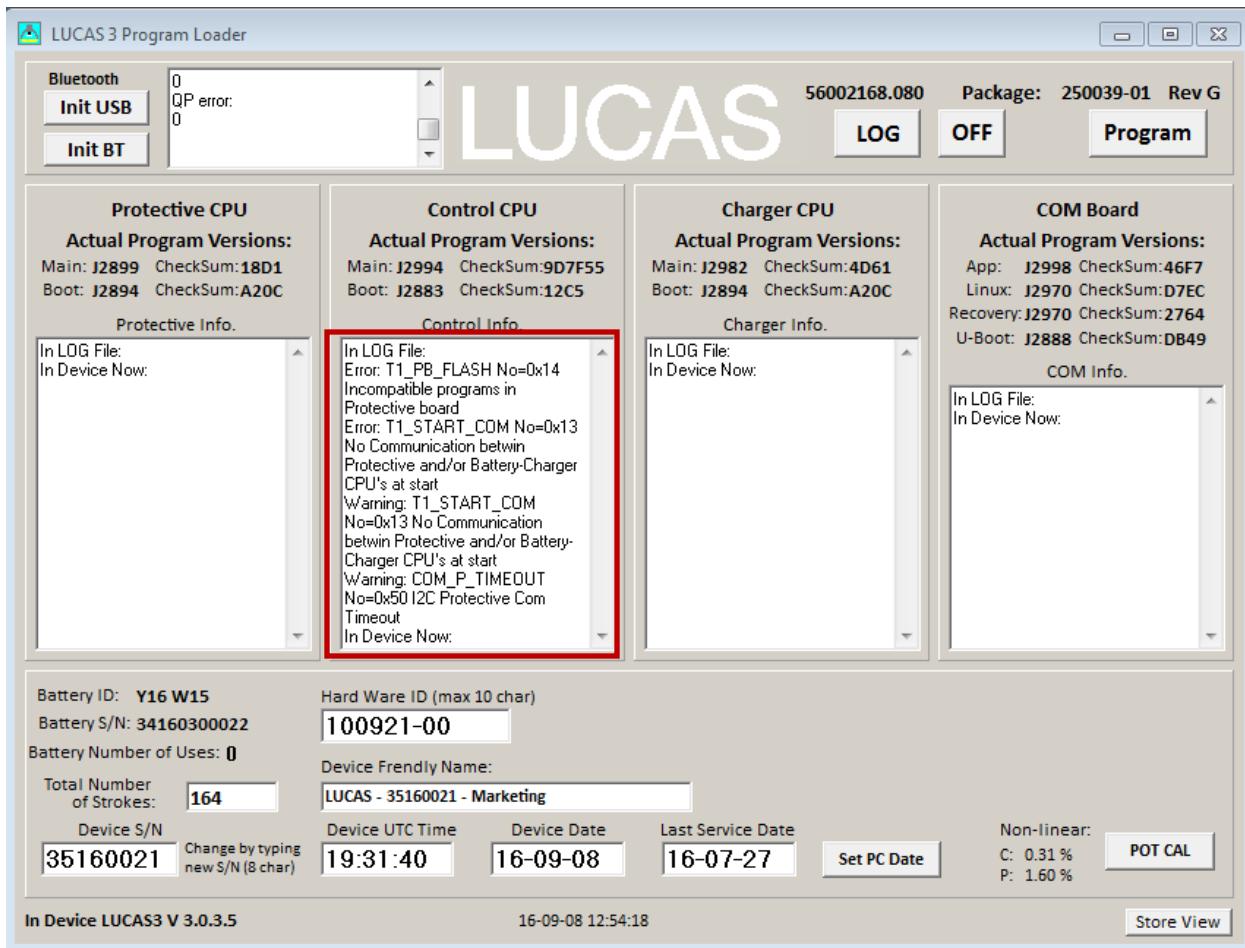
- Picture shows LOG File content on the left for LUCAS 3 Version 3.0 (Part No: 250039-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –



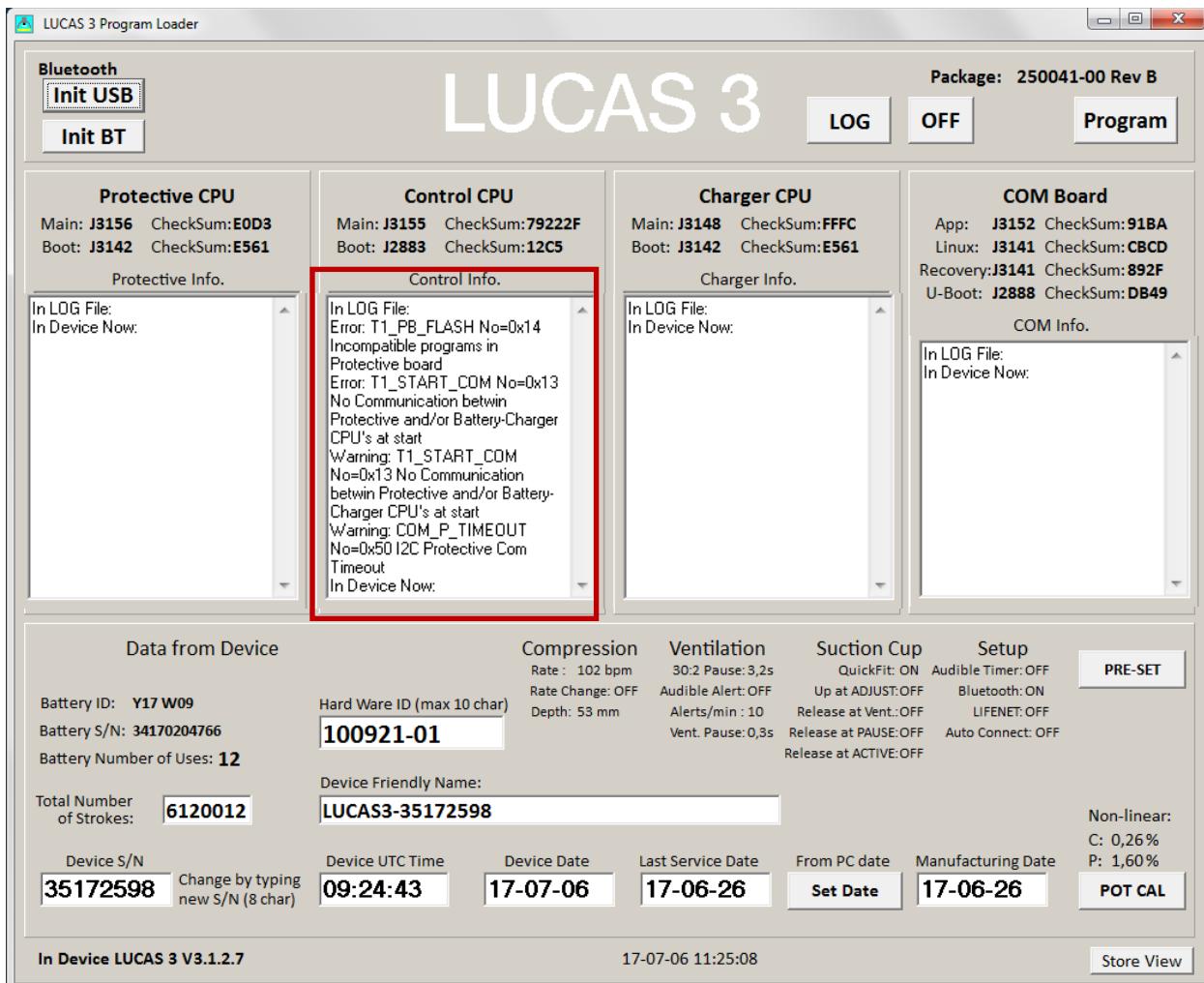
- Picture shows LOG File content on the left for LUCAS 3 Version 3.1 (Part No: 250041-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –



- Picture shows Error Codes in CPU window for LUCAS 3 Version 3.0 (Part No: 250039-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –



- Picture shows Error Codes in CPU window for LUCAS 3 Version 3.1 (Part No: 250041-00)

Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –

4. Then refer to [Error Codes](#) Tables for more information about how to handle the errors.

Set Device S/N, Date, and Data

This screenshot shows the "Set Device S/N, Date, and Data" screen. It has several input fields and buttons:

- Battery ID: Y16 W15
- Battery S/N: 34160300022
- Battery Number of Uses: 0
- Total Number of Strokes: 164 (highlighted with a yellow box)
- Device S/N: 35160021 (highlighted with a green box)
- Change by typing new S/N (8 char)
- Hard Ware ID (max 10 char): 100921-00 (highlighted with a yellow box)
- Device Friendly Name: LUCAS - 35160021 - Marketing (highlighted with a blue box)
- Device UTC Time: 19:31:40
- Device Date: 16-09-08
- Last Service Date: 16-07-27
- Set PC Date (highlighted with a red box)
- Non-linear: C: 0.31 % P: 1.60 %
- POT CAL
- In Device LUCAS3 V 3.0.3.5
- 16-09-08 12:54:18
- Store View

- LUCAS 3 Version 3.0 (Part No: 250039-00) –

Data from Device		Compression Rate : 102 bpm Rate Change: OFF Depth: 53 mm	Ventilation 30:2 Pause: 3,2s Audible Alert: OFF Alerts/min : 10 Vent. Pause: 0,3s	Suction Cup QuickFit: ON Up at ADJUST:OFF Release at Vent.:OFF Release at PAUSE:OFF Release at ACTIVE:OFF	Setup Audible Timer: OFF Bluetooth: ON LIFENET: OFF Auto Connect: OFF	PRE-SET	
Battery ID: Y17 W09	Hard Ware ID (max 10 char) 100921-01						
Battery S/N: 34170204766							
Battery Number of Uses: 12							
Total Number of Strokes: 6120012	Device Friendly Name: LUCAS3-35172598					Non-linear: C: 0,26% P: 1,60%	
Device S/N 35172598	Change by typing new S/N (8 char)	Device UTC Time 09:24:43	Device Date 17-07-06	Last Service Date 17-06-26	From PC date Set Date	Manufacturing Date 17-06-26	POT CAL
In Device LUCAS 3 V3.1.2.7		17-07-06 11:25:08				Store View	

- LUCAS 3 Version 3.1 (Part No: 250041-00) -

It's also possible to set the Device ID(S/N), Friendly Name, Time and Last Service Date, and reset total number of Strokes.

NOTE:

- When setting up Device Time, always use UTC-0 time
- Both Device Date and Last Service Date are in YY-MM-DD format
- Setup will be automatically saved to the device

Change Device S/N

The Device S/N (=Serial number of the device) can be set simply by typing in the wanted S/N (8 char), typically 3516XXXX. The S/N is automatically saved.

Set Latest Service Date

Set latest Service date by pressing **SET PC Date / SET Date**.

Store View

The Program Loader screenshot can be stored for future reference by clicking "Store View".



The screenshot will be saved in a sub-folder "Pictures" where the Program Loader folder is with the serial number as file name¹. At the same time the screenshot will be printed at the selected default printer. If no printer is connected, a message will appear which can be cancelled; the picture will be saved and can be printed at any time.

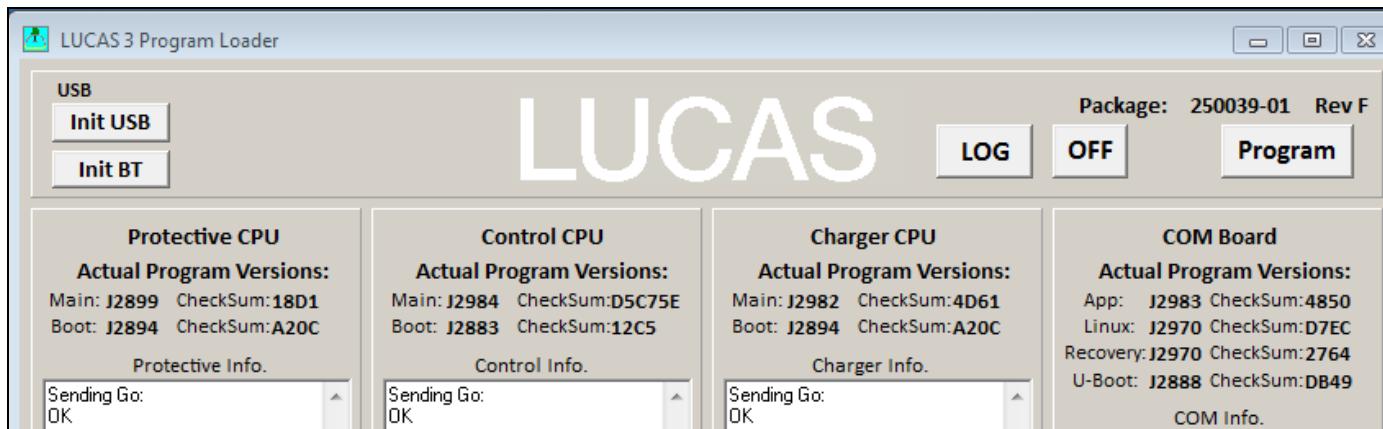
¹ An administrative right to the "LUCAS3 Tools" folder is necessary to save the screenshot. This can either be done by right-clicking the LUCAS® 3 program loader.exe file and chose "Run as administrator" every time you want a screenshot saved to the "Pictures" subfolder or by locating the "LUCAS3 Tools" folder on your computer, right-click the folder, chose Properties, choose the Security tab, highlight your "Users" name, e.g. Users (ANRESN-L1\Users), click Edit, chose your "Users" name again, then in the "Permissions for Users" window in the Allow column make sure that the Write-box is marked, then chose Apply. This allows the program to save screenshots to the "LUCAS3 Tools" folder and subfolders without having to run the LUCAS® 3 program loader.exe as Administrator.

Checksum

To identify the installed program version you can check the **CheckSum** values to match table below:

	Protective		Control		Charger		COM CPU			
Program ver:	Main	Boot	Main	Boot	Main	Boot	App	Linux	Recovery	U-Boot
3.0	18D1	A20C or E561	9D7F55	12C5	4D61	A20C or E561	46F7	D7EC	2764	DB49
3.1	The Change Order Numbers and CheckSum Numbers are automatically checked by Program Loader 250041-00									

Following picture shows the example where to see the **CheckSum** values on each CPU and COM Board from Program Loader.



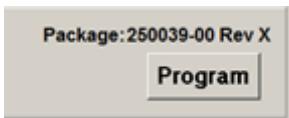
- LUCAS 3 Version 3.0 (Part No: 250039-00) -



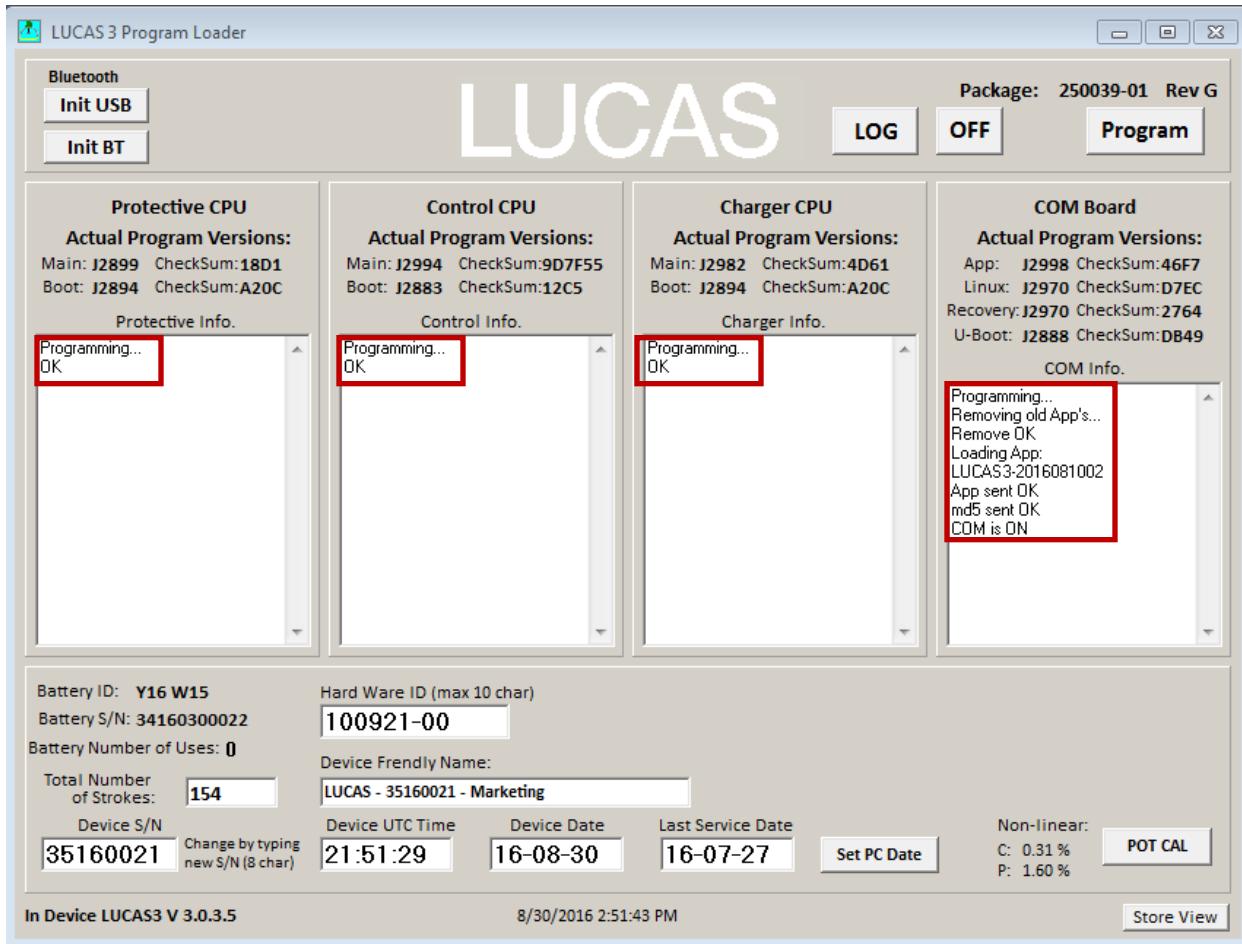
- LUCAS 3 Version 3.1 (Part No: 250041-00) -

Update LUCAS Software

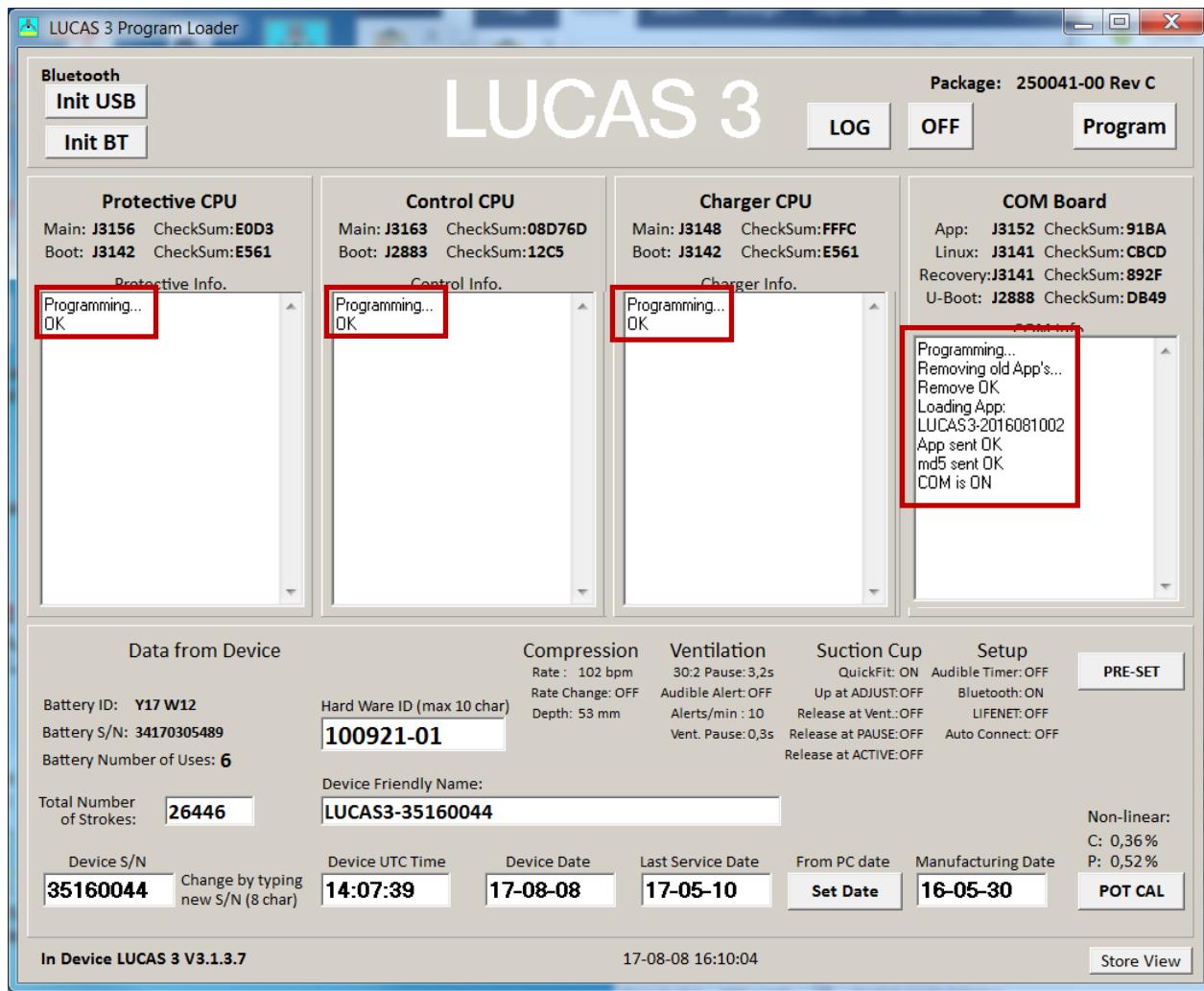
1. Click **Program** in the upper right corner to update LUCAS software.



The programming process will start and update the software for each CPU. **Note:** Do not disconnect the connection during the software update. When all four CPUs are updated, following window will appear. Each CPU window will have **OK** to indicate the update is complete.



- LUCAS 3 Version 3.0 (Part No: 250039-00) -

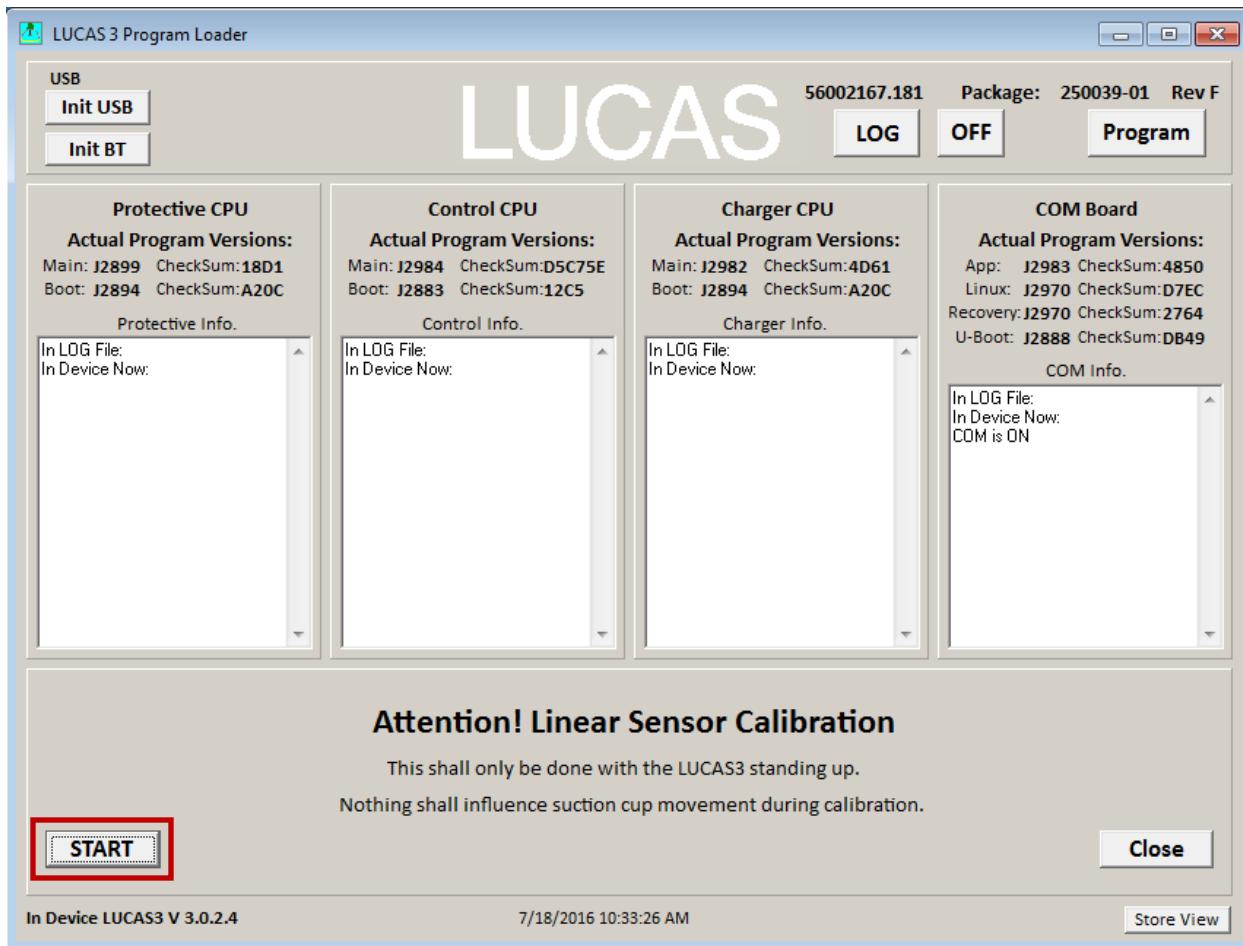


- LUCAS 3 Version 3.1 (Part No: 250041-00) -

Calibrate Linear Sensor

After software update is complete, Click **POT CAL** to calibrate Linear Sensor. Before you click the **Start** button please make sure that nothing can influence the movement of the suction cup, that the device is in its upright position and that the Suction Cup is approximately 20mm (~1 inch) down from its upmost position.

POT CAL



- Example LUCAS 3 Version 3.0 (Part No: 250039-00) -

- LUCAS 3 Version 3.1 (Part No: 250041-00) -

1. Click **START** to calibrate Linear Sensor.
2. When the Calibration process starts, the progress will be shown in the Control CPU's window. When the calibration is done, the result is shown in the lower right corner.

Control Info.

Calibrate Potentiometer:
11111111111111111111111111111111
11111111111111111111111111111111
11111111111111111111111111111111
11111111111111111111111111111111
11111111111111111111111111111111

- POT CAL In Progress -

Control Info.

Calibrate Potentiometer:
11111111111111111111111111111111
11111111111111111111111111111111
11111111111111111111111111111111
11111111111111111111111111111111
11111111111111111111111111111111

Done!

- POT CAL Done -

Non-linear: Potentiometer
C: 0.41 % P: 1.00 %

- POT CAL Values -

POT CAL
Acceptable Values:

C: < 6%
P: < 3.1%

3. Click **Store View** to print the result.

Failed calibration

Case 1:

If the value for Control exceeds 6% or if the value for Protective exceeds 3.1%, the device will make an alarm and an error code will be shown in the Control CPU's window, the sensor calibration has failed.

To recalibrate:

1. Mute the alarm
2. Check that nothing interferes with the movement of the suction cup
3. The device is upright
4. Click **POTCAL** to make a new calibration.

If the second calibration also fails it might be necessary to replace the Compression Module.

Case 2:

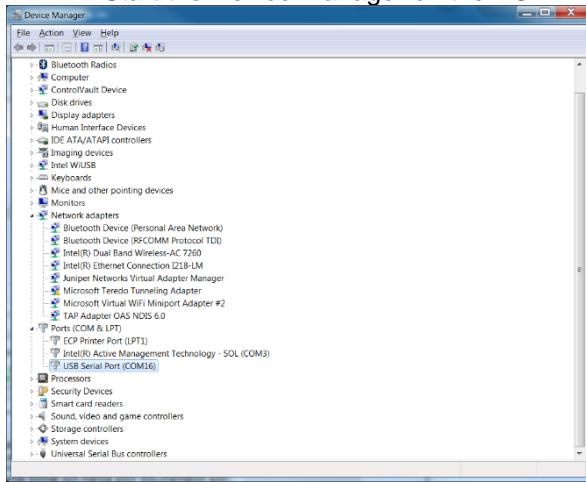
If this error "**Cup not moved to top**" showed in Control CPU window, manually move the suction cup down an inch and then click **POT CAL** again to recalibrate.

Update LUCAS 3 sw 3.0 to LUCAS 3 sw 3.1

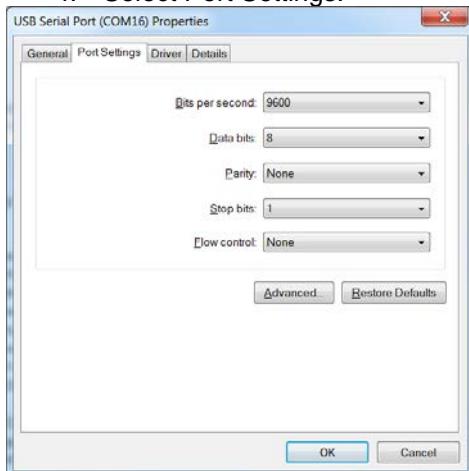
Setup

Note. First time the USB programming cable is used on the computer (PC), following has to be done:

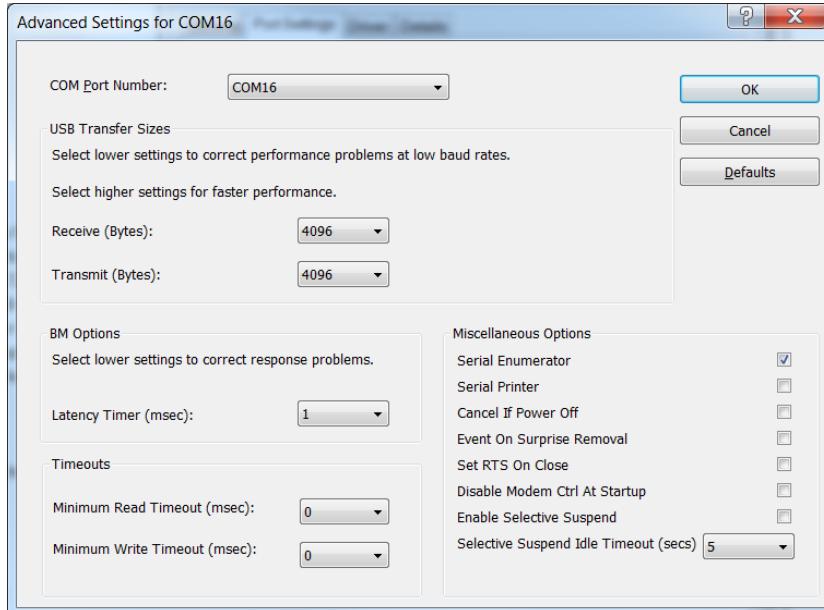
1. Connect the USB connector to the PC and let the PC install the driver for the USB programming cable
2. Start the Device manager on the PC



3. Expand Ports and select Properties for the used COM Port
4. Select Port Settings.



5. Select Advanced...



6. Change Latency Timer to 1 ms.

7. Press OK.

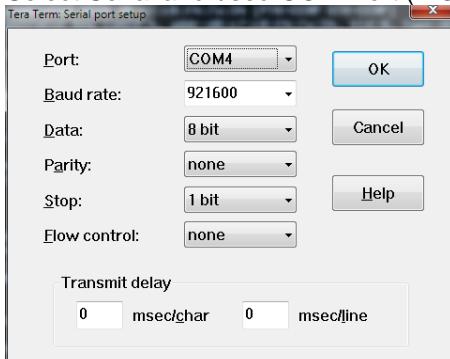
Close all windows and restart PC.

Open the Hood of the device (see instructions for Hood disassembly/reassembly) and connect the USB programming cable to connector X2 on the Com Board. Plug the USB connector to the computer and assemble the battery to the device.

Update and Test procedure

1. Start Tera Term software.

2. Select Serial and used COM Port (+ OK). Note that COM-port might be different



3. Select menu "Setup"-> Serial port...

4. Change Baud rate: to 921600 (+ OK).

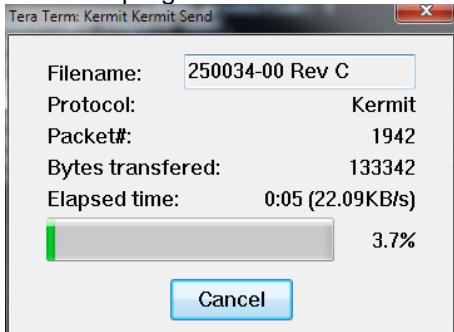
5. Place cursor in the Tera Term window.

6. Start Lucas device communication (by COM button) and press a key on the keyboard fast (within 3s).

7. Type "run loadng" + return.

8. Select menu "File"->"Transfer"->"Kermit"->"Send..." and select new Linux binary file to load (250042-00).

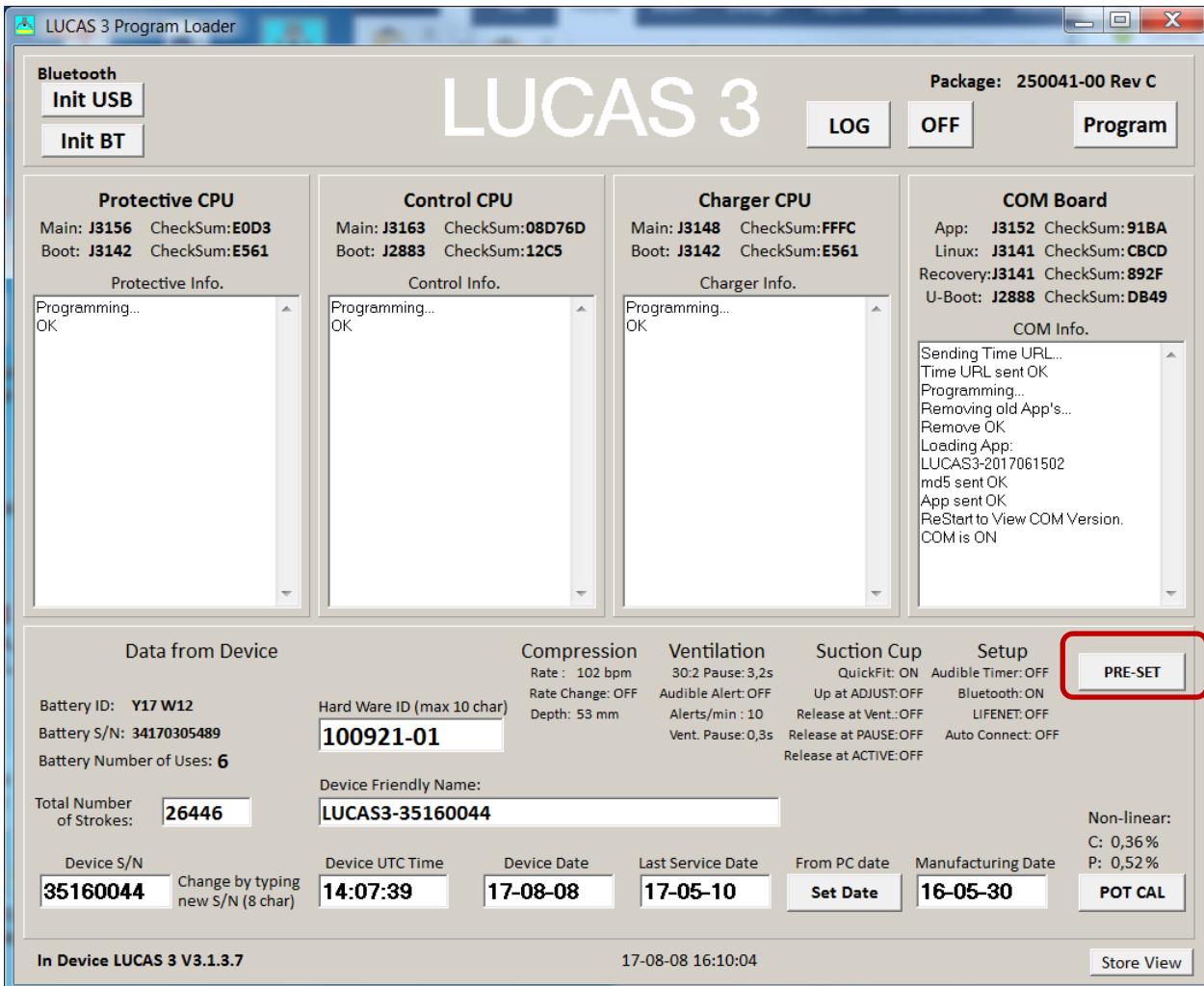
9. Wait until program loaded.



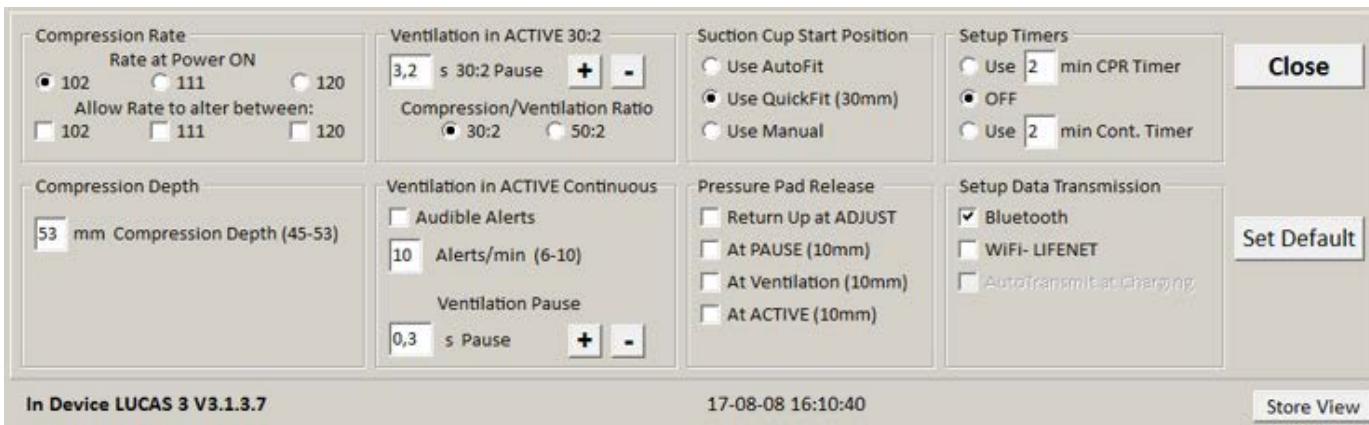
10. Wait until LINUX and App have started, Wait until "....." is started to be written.
11. Turn Off the LUCAS3 device by pressing ON/OFF key two times.
12. Disconnect the USB cable.
13. Assemble the LUCAS3 device.
14. Press the Transmit key on the LUCAS3 device and confirm that the blue LED is flashing.
15. Start the Service-tool software (LUCAS3_V3_1_RevX.exe) and press "Init BT"-button.
16. When the device and PC is paired, press the "Program"-button to program new Main software.
17. When the programming is completed, perform Linear sensor-calibration.
18. When the calibration is completed, press the "Off"-button.
19. Press the Transmit key on the device and confirm that the blue LED is flashing.
20. Start the Service-tool software (LUCAS3_V3_1_RevX.exe) with the latest revision and press "Init BT"-button.
21. When the device and PC is paired, verify the checksums are written in black text and **not** red that indicates that the software in the device not have the latest version.
22. Press the "Off"-button.
23. Run the device in continuous mode for at least one minute and turn it off.
24. Press the Transmit key on the device and confirm that the blue LED is flashing.
25. Start the Service-tool software (LUCAS3_V3_1_RevX.exe) and press "Init BT"-button.
26. When the device and PC is paired, verify that the LOG-file from the latest run has no errors or warnings.

Setup Options - LUCAS 3 Version 3.1 (Part No: 250041-00)

The Setup Options are configurable for a LUCAS 3 Version 3.1 device. To enter the configuration tool press the "PRE-SET" key.



The preset Options are depicted and described below. To enter the factory default setting, press the key "Set Default".



The compression parameters can be set according to IFU 3326785-1##, section 9.2 Compression parameters, refer to below.

Category	Specifications
Compression depth (nominal patient)	<p><u>Factory default setting</u> Patients with sternum height greater than or equal to 7.3 inches / 185mm: • 2.1 ±0.1 inches / 53 ±2 mm Smaller patients with sternum height less than 7.3 inches / 185 mm: • 1.5 to 2.1 ±0.1 inches / 40 to 53 ±2 mm</p>
	<p><u>Setup options</u> Compression depth can be set to a value between 1.8 and 2.1 ±0.1 inches / 45 to 53 ±2mm. Patients with sternum height greater than or equal to 7.3 inches / 185mm: • [set compression depth] ±0.1 inches / ±2mm Smaller patients with sternum height less than 7.3 inches / 185 mm: • 1.5 inches / 40mm to [set compression depth] ±0.1 inches / ±2mm</p>
Compression frequency	<p><u>Factory default setting</u> 102 ±2 compressions per minute</p> <p><u>Setup options</u> The device can be setup to provide a rate of any of the following values: 102, 111, 120 ±2 compressions per minute. The device can be setup to enable the operator to change rate during operation. The rate is changed by pushing the ACTIVE key (30:2 or continuous) during ongoing compressions.</p>
Compression duty cycle	50 ±5%
Compression mode ACTIVE continuous	<p><u>Factory default setting</u> Continuous compressions with ventilation LED alert 10 times per minute</p> <p><u>Setup options</u> The device can be setup to provide ventilation alerts of a value between 6 to 10 alerts per minute. The device can be setup to provide an audible ventilation alert (ON/OFF). The device can be setup to provide a ventilation pause duration of a value between 0.3 to 2 seconds. The device can be setup to enable the operator to change compression rate during operation. The rate is changed by pushing the ACTIVE key (continuous or 30:2) during ongoing compressions.</p>
Compression mode ACTIVE 30:2	<p><u>Factory default setting</u> 30:2 (30 compressions followed by a 3-second ventilation pause)</p> <p><u>Setup options</u> The device can be setup to provide a compression/ventilation ratio of any of the following ratios: 30:2 and 50:2 The device can be setup to provide a ventilation pause duration of a value between 3 to 5 seconds. The device can be setup to enable the operator to change compression rate during operation. The rate is changed by pushing ACTIVE key (continuous or 30:2) during</p>

	ongoing compressions.
Category (continued)	Specifications (continued)
Suction Cup Start Position	<p><u>Factory default setting</u></p> <p>QuickFit: The operator manually lowers the Suction Cup to the chest. When pushing the PAUSE key, coming from ADJUST mode, the LUCAS device fine-tunes the Suction Cup height position to the chest within a distance of 1.2 inches / 30 mm, and then the LUCAS device locks the Start Position.</p> <p><u>Setup options</u></p> <p>The device can be setup for QuickFit, AutoFit or Manual.</p> <p>AutoFit: The device automatically lowers the Suction Cup from its upper position down to the chest and finds and locks the Start Position. The device will do the AutoFit when the operator pushes PAUSE key coming from ADJUST mode.</p> <p>Manual: The operator manually lowers the Suction Cup to the chest. When pushing the PAUSE key, the LUCAS device locks the Start Position. No fine-tuning will occur.</p>
Suction Cup in ADJUST mode	<p><u>Factory default setting</u></p> <p>Manual: The Suction Cup has to be pulled up manually</p> <p><u>Setup options</u></p> <p>The device can be setup so that the Suction Cup automatically returns up from the chest when the operator pushes the ADJUST key coming from PAUSE or ACTIVE modes.</p>
Pressure pad in PAUSE mode	<p><u>Factory default setting</u></p> <p>The device stops compressions and locks the pressure pad in its Start Position.</p> <p><u>Setup options</u></p> <p>To allow for chest rise during ventilation, the device can be setup so that the pressure pad moves up 0.4 inch / 10 mm above the Start Position during PAUSE.</p>
Pressure pad during ventilation pauses in ACTIVE modes	<p><u>Factory default setting</u></p> <p>The device temporarily stops compressions and locks the pressure pad in its Start Position.</p> <p><u>Setup options</u></p> <p>To allow for chest rise during ventilation, the device can be setup so that the pressure pad moves up 0.4 inch / 10 mm above the Start Position during ventilation pauses.</p>
Pressure pad in ACTIVE modes	<p><u>Factory default setting</u></p> <p>The pressure pad returns to Start Position between each compression</p> <p><u>Setup options</u></p> <p>To allow for chest rise during asynchronous ventilation, the device can be setup so that the pressure pad moves up 0.4 inch / 10 mm above the Start Position at every compression.</p>

Category (continued)	Specifications (continued)
Audible timers	<p><u>Factory default setting</u> No timer (OFF)</p> <p><u>Setup options</u> The device can be setup to provide a recurring audible alert at a specified time interval of any value between 1 to 15 minutes. The audible alert is a short signal sequence. The timer can be setup as either CPR Timer or Continuous Timer: CPR Timer: The device only measures the time in uninterrupted ACTIVE (30:2 or continuous) modes. The CPR Timer stops and resets when the operator pushes PAUSE or ADJUST keys. The CPR Timer starts from zero again the next time the operator pushes the ACTIVE (30:2 or continuous) key. For example if CPR Timer is set for 2 minutes, the device will alert after every 2 minutes of compressions. Continuous Timer: The device measures the time continuously, independent of what mode the device is in. The Continuous Timer starts when the operator pushes the ACTIVE (30:2 or continuous) key the first time and will alert at the defined time interval until the device is powered off. For example if Continuous Timer is set for 2 minutes, the device will alert every 2 minutes until power off.</p>

Troubleshooting

In this session, it explains the common troubleshooting methods for LUCAS.

Troubleshooting Table

Situation	Visual LED indication	Audible signals	User action	
The LUCAS device is in the ON mode and there is more than 90% Battery capacity remaining.		Fully charged Battery: All 3 green Battery indication LEDs show a constant light.	None	None
The LUCAS device is in the ON mode and there is more than 60% and less than 90% Battery capacity remaining.		2/3 charged Battery: The 2 green Battery indication LEDs to the right show a constant light.	None	None
The LUCAS device is in the ON mode and there is more than 30% and less than 60% Battery capacity remaining.		1/3 charged Battery: The green Battery indication LED farthest to the right shows a constant light.	None	None
The LUCAS device is in the ON mode and there is less than 30% Battery capacity remaining (approximately 10 minutes of operating capacity).		Low Battery: The yellow Battery indication LED farthest to the right illuminates intermittently.	Medium priority alarm ■ ■ ■ (5s) ■ ■ ■ (5s)...	Replace the Battery or connect to the external power supply.
An external LUCAS Power Supply is connected and charging the Battery.		Charging Battery: The 3 green Battery indication LEDs show a "running" light.	None	None
An external LUCAS Power Supply is connected and the Battery is fully charged.		Fully charged Battery: All 3 green Battery indication LEDs show a constant light.	None	None
The Battery has been used more than 200 times with compressions of more than 10 minutes each or is older than 3 to 4 years.		End of Battery service life: The Battery indication LED farthest to the right shows yellow light instead of green, in all the above situations.	None	Dispose of Battery.
In the ADJUST mode.		The ADJUST LED shows a green light.	None	None
In the PAUSE mode.		The PAUSE LED shows a green light.	None	None

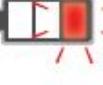
Situation	Visual LED indication	Audible signals	User action
In the ACTIVE (continuous) mode	The ACTIVE (continuous) key, the LUCAS device performs continuous chest compressions. The green LED signal will blink 10 times per minute	None	This is to alert for ventilation during ongoing compressions.
In the ACTIVE (30:2) mode	The ACTIVE (30:2) LED shows a green light with an intermittent LED during compressions number 26, 27, 28, 29 and 30.	Audible signal during compressions - - -	This is to alert the operator to ventilate the patient when the device temporarily stops the compressions at number 30.
When the Suction Cup is in a lower position than for the minimum patient (sternum height below 6.7 inches / 17 cm) and you cannot enter the PAUSE mode or ACTIVE mode, the patient is too small.	None	3 fast signals ■ ■ ■ (0.25s)	Immediately start manual compressions
Too large gap between the pressure pad and the patient's chest during operation. The patient will get too shallow compressions.	None	3 fast signals during operation ■ ■ ■ (0.6s)	Push ADJUST and readjust the Start Position to eliminate the gap. Restart the compressions.

LUCAS Malfunction Alarm

Below is a list on all alarms that can occur on the LUCAS. All these alarms are possible to mute for 60 seconds by

pressing MUTE button

The audible alarms were updated in LUCAS 3 with regards to sound patterns; please refer to Instructions for Use PN/CAT #: 3326785-0## / 26500-00#### and 3326785-1## / 26500-00#### LUCAS 3 Version 3.1 for information.

Priority	Reason	Visual LED indication	Audible alarms	Result
N/A	Rising temperature in the LUCAS device	None	Information Signal ■ ■ (4s) ■ ■ (4s)...	None
High Priority	Compression pattern outside limit (too deep, too shallow or timing failure)	 Intermittent red alarm LED	High Priority Alarm ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) LATCHING ALARM SIGNAL	Compressions stop
High Priority	Too high temperature in the LUCAS device	 Intermittent red alarm LED	High Priority Alarm ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) LATCHING ALARM SIGNAL	Compressions stop
High Priority	Hardware error	 Intermittent red alarm LED	High Priority Alarm ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) LATCHING ALARM SIGNAL	Compressions stop
High Priority	Too high Battery-temperature	 Intermittent red alarm LED  Red Battery alarm: The red Battery Indication LED farthest to the right blinks intermittently.	High Priority Alarm ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) LATCHING ALARM SIGNAL	Compressions stop
High Priority	Battery charge too low	 Intermittent red alarm LED  Red Battery alarm: The red Battery Indication LED farthest to the right blinks intermittently.	High Priority Alarm ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (...) ■ ■ ■ (2.5s) LATCHING ALARM SIGNAL	Compressions stop. The Battery must be recharged.

Error Codes

In the software, LUCAS 3 Program Loader, it is possible to read error codes from the device. Below tables show these codes and the explanation on how to find the cause and corrective actions.

Error Codes from Control CPU

Error Code	Explanation	Probable Cause	Module to check / replace	User Notification	LRG Text
T1_C_EE No=0x10	Control EE-Prom CheckSum data error	CPU fault	Replace Control board	High priority Alarm.	Internal fault - contact Technical Support
T1_C_RAM No=0x11	Control Preset CheckSum data error	CPU fault or communication faults	Use Service Tool to set default preset or replace Control board	High priority Alarm.	Internal fault - contact Technical Support
T1_START_COM No=0x13	No Communication between Protective and/or Battery-Charger CPU's at start	I2C communication faults. Halted Protective or Charger CPU.	Check cable between boards. Protective board.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_PB_FLASH No=0x14	Incompatible programs in Protective board	Change of boards.	Reprogram device.	High priority Alarm.	Internal fault - contact Technical Support
T1_CAL_EE No=0x15	Control Potentiometer Calibration data CheckSum fault	Un-calibrated or Too un-linear or CPU EE fault	Perform a new calibration. If un-linear fault replace compression module. If CPU EE fault replace Control board	Delayed (10s) High priority Alarm.	Internal fault - contact Technical Support
T1_C_INITCURR No=0x20	High Current detected at Start	Fault read current to motor or broken driver FET's. +/- 12V supply fault.	If needed replace Control board	After 3 start attempt, High priority Alarm.	Self-test fault
T1_P_STATE_1 No=0x21	Start of Release Test time out (from Protective)	Protective start Error's. I2C communication faults.	Check for Protective Error's. Cable between boards.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_C_RELEASE No=0x22	Current detected at release/disable test by Control	P45 module fault or in cable between boards.	Cable between boards. Protective or Control board.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_P_STATE_3 No=0x23	Start of Current Test time out (from Protective), Current detected by Protective	Current detected by Protective or I2C communication faults.	Check for Protective Error's. Protective board.	After 3 start attempt, High priority Alarm.	Self-test fault

T1_C_LOWCURR No=0x24	Too low Current at Current test	Motor not connected or broken. HALL sensor signal faults or Internal voltages.	Motor, HALL cable. Check for internal voltages faults. Control board	After 3 start attempt, High priority Alarm.	Self-test fault
T1_P_DISABLE No=0x25	Protective Disable at current test	P45 module fault or in cable between boards.	Cable between boards. Protective or Control board.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_P_POT No=0x27	Read Protective POT time out	I2C communication faults. Halted Protective CPU.	Cable between boards. Protective board.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_C_POT No=0x28	Pot value incorrect (Miss match at start) or not changed at moving.	Control and Protective POT value divergence > 10mm at start. POT fault or un- linear. Reference voltage faults.	Check POT values and POT cables. Compression module. Check for voltages faults.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_P_STATE_5 No=0x29	No end of Protective Current Test (time out)	Protective current read fault. I2C communication faults.	Check for Protective Error's. Protective board.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_B_OFF No=0x2A	No Battery Charger T1 test done (time out)	Charger CPU not done T1 test correct or I2C communication faults.	Check for Charger Error's. Protective board.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_C_DOWN No=0x2D	Control not moving down before REW test	Motor connections. Protective stop by disable line.	Motor. Check for Protective Error's.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_P_REW No=0x2E	Protective Time out at Rew test	Motor connections. Protective POT signal. Locked compression module.	Motor. Protective POT. Check for Protective Error's.	After 3 start attempt, High priority Alarm.	Self-test fault
T1_C_TOTOP No=0x2F	Control Time out at move to top	Motor and HALL connections. Locked compression module.	Motor. Compression module.	After 3 start attempt, High priority Alarm.	Self-test fault
INT_C_TEMP No=0x34	Too High internal board temp. > 85°C	Fan disconnected or jammed. Broken Temp sensor or internal reference faults.	Fan. Control PCB	High priority Alarm.	Too high temperature
INT_CODE No=0x36	Access of vital function Code fault (10ms)	Halted or disturbed Control CPU.	Control board.	High priority Alarm.	Internal fault - contact Technical Support

INT_C_POTCAL No=0x3D	Control Potentiometer linearity fault	Too un-linear Control potentiometer or influenced at calibration	Repeat calibration or replace compression module.	Delayed (10s) High priority Alarm.	Internal fault - contact Technical Support
INT_P_POTCAL No=0x3E	Protective Potentiometer linearity fault	Too un-linear Protective potentiometer or influenced at calibration	Repeat calibration or replace compression module.	Delayed (10s) High priority Alarm.	Internal fault - contact Technical Support
RUN_TIMEOUT No=0x40	Piston not moved during active (moving) mode (> 1s)	Disconnected motor (mechanical/electrical) or locked compression module.	Compression module. Motor connections.	High priority Alarm.	Disruption of Suction Cup
RUN_TOO_DEEP No=0x41	Piston too deep	Control potentiometer fault. Rough or influenced compression movement at run with no load. Hall signal missing.	Assure uninfluenced movement of the compression module (re-test). Check Hall. Replace motor or compression module.	High priority Alarm.	In Pause: Disruption of Suction Cup
				In Active: Compressions out of range	
RUN_TOO_SHALLOW No=0x42	Piston too shallow (50 consecutive strokes @ 100 bpm)	50 strokes < Target stroke length - 10mm (@ 100bpm). Too high load and/or too low battery voltage. Locked module.	Assure correct movement of the compression module. If needed replace the compression module.	High priority Alarm.	Compressions out of range
RUN_RATIO No=0x44	Piston Ratio fault (50 consecutive strokes)	Too high load. Ratio fault (Preset Ratio +/- 20%) at 50 consecutive strokes.	Check load.	High priority Alarm.	Compressions out of range
RUN_PROTECTIVE No=0x45	Halt or reverse by Protective System during active (moving) mode (> 1s)	Active mode disabled by the Protective system.	Check Protective error's for cause.	High priority Alarm.	
RUN_TIMEUP No=0x47	Time Up too long > 0.15s (50 consecutive strokes)	Large 13N release in active mode or mechanical locked compression.	Assure correct movement of the compression module. If needed replace the compression module.	High priority Alarm.	Compressions out of range

RUN_TIMEDOWN No=0x48	Time Down too long or too Shallow. (50 consecutive strokes)	Too high load and/or too low battery voltage. Motor fault.	Check load and motor.	High priority Alarm.	Compressions out of range
RUN_POTCAL No=0x4A	Potentiometer Calibration fault, not moved or pot read. (See ID in Control vector, at position 139).	Movement fault at calibration or large potentiometer fault	Check potentiometer connections and mechanical movement, repeat calibration.	At Calibration: High priority Alarm.	Internal fault - contact Technical Support
RUN_NO_POTCAL No=0x4B	Potentiometer not calibrated (See ID in Control vector, at position 139).	Not calibrated or other calibration fault.	Check for other fault or perform a new calibration.	Delayed (10s) High priority Alarm.	Internal fault - contact Technical Support
RUN_P_STOP No=0x4C	Protective system have stopped operation	Protective system error.	Check Protective system error codes for cause.	High priority Alarm.	

Warnings from Control CPU

Warning Code	Explanation	Probable Cause	Module to check / replace	User Observation	LRG Text
T1_START_COM No=0x13	No Communication from Protective and/or Battery-Charger CPU's at first start.	I2C communication startup faults. Delayed start of Protective or Charger CPU.	Check cable between boards or Protective board.	Prolonged startup test time.	
T1_C_INITCURR No=0x20	High Current detected at Start, next automatic restart worked well.	Fault read current to motor or unstable driver FET's +/- 12V supply.	If needed replace Control board.	Prolonged startup test time.	
T1_P_STATE_1 No=0x21	Start of Release Test time out (from Protective), next automatic restart worked well.	Protective start delayed. I2C communication startup faults.	Check Cable between boards. Protective board.	Prolonged startup test time.	
T1_C_RELEASE No=0x22	Current detected at release/disable test by Control at first start.	P45 module delayed or loose cable between boards.	Cable between boards. Check Protective voltages.	Prolonged startup test time.	
T1_P_STATE_3 No=0x23	Start of Current Test time out (from Protective) at first start. Current detected by Protective	Current first detected by Protective or I2C communication faults.	Cable between boards. Protective board.	Prolonged startup test time.	

T1_C_LOWCURR No=0x24	Too low Current detected at first Current test.	Motor wires loose. HALL sensor signal loose or delayed internal voltages.	Motor, HALL cable. Check for internal voltages warnings. Control board	Prolonged startup test time.	
T1_P_DISABLE No=0x25	Protective Disable at current test at first start.	P45 delayed or loose cable between boards.	Cable between boards. Protective or Control board.	Prolonged startup test time.	
T1_P_POT No=0x27	Read Protective POT time out at first start.	I2C communication delayed. Halted Protective CPU at first start.	Cable between boards. Check Protective warnings.	Prolonged startup test time.	
T1_C_POT No=0x28	Miss match at warm start.	Control and Protective POT value divergence > 10mm at warm start. POT fault or un- linear.	Preform a new POT calibration. Check for voltages faults.	LUCAS V2 operation.	
T1_P_STATE_5 No=0x29	No end of Protective Current Test (time out) at first start.	Protective current read fault at first start. I2C communication interference.	Check Protective voltages. Protective board.	Prolonged startup test time.	
T1_B_OFF No=0x2A	Battery Charger not answered T1 test done (time out) at first start.	Charger CPU not done T1 test correct or I2C communication faults.	Check Charger voltages. Protective board.	Prolonged startup test time.	
T1_C_DOWN No=0x2D	Control not moving down before REW test at first start.	Motor connections. Protective stop by disable line. High load at start test.	Motor. Check if start test is done with load.	Prolonged startup test time.	
T1_P_REW No=0x2E	Protective Time out at Reverse test at first start.	Motor connections. Protective POT signal. Locked compression module.	Motor. Protective POT. Use free piston movement at start test.	Prolonged startup test time.	
T1_C_TOTOP No=0x2F	Control Time out at move to top at first start.	Motor and HALL connections. Locked compression module.	Motor. Compression module. Use free piston movement at start test.	Prolonged startup test time.	
INT_P_5V No= 0x30	Protective 5V < 4.5V or > 5.5V	Cable between boards. Incorrect Protective 5V. Internal reference faults.	Check cable. Protective 5V. Control internal voltages faults. Protective board.	None.	
INT_C_5V No=0x31	Control 5V < 4.5V or > 5.5V	Electrical fault. Control board pin connected to back plate.	Control board. Check for other Control warnings.	None.	
INT_C_24V No=0x32	Control 24V < 18V	Battery fault. Internal reference faults.	Check other Control internal voltages faults. Test with a new charged battery.	None. LOG file stopped.	
INT_C_REF No=0x33	Control 2.5V Ref < 2V or > 3V	Electrical fault. Control board pin connected to back plate or POT +2.5V shortcut.	Check reference voltage or replace Control board.	None.	
INT_C_TEMP No=0x34	High internal board temp. > 70°C Warning	Fan disconnected or jammed. Broken Temp sensor or internal reference faults.	Fan. Control PCBA	Temperature warning signal.	High temperature

INT_POTBALL No=0x37	PotPos./Hall sensor mismatch after a correct start.	Control POT fault or un-linear. A start with 13N release. Rough compression movement.	Preform a new POT calibration. If warning repeated replace the compression module.	LUCAS V2 operation.	
INT_CURRENT No=0x38	Current fault	Mean current to motor >20A. Jam of compression module. Current read fault.	Motor. Compression module. Control board.	None.	
INT_P_REBOOT No=0x39	Protective reboot in active mode	Protective electrical fault.	Protective board.	Restart of startup test.	
INT_1msCODE No=0x3A	Warning Access of 1ms Code timeout.	Halted or disturbed Control CPU.	Control board.	None.	
INT_C_HALL No=0x3C	Motor Hall sensor fault.	Motor or Hall sensor cable fault.	Check Hall sensor cable or replace Motor.	Slow or weak compression s.	
RUN_ADJUST No=0x46	Incorrect Motor power at adjust mode	Too high Motor Power (>25W) at Adjust servo. Incorrect current read.	Motor. Control board.	Adjust servo switched off.	
RUN_13N No=0x49	13N release (force UP too high)	13N release > 10mm. Too high start position or mechanical locked compression movement.	Assure correct start and movement of the compression module. If needed replace the compression module.	13N release information signal (3 fast signals).	Start Position adjustment required
COM_P_TIMEOUT No=0x50	I2C Protective Communication Timeout	No I2C communication with Protective system >100s. I2C communication fault or halted Protective CPU.	Check cable between boards. Restart LUCAS3 and run for 30 minutes. If fault repeats replace Protective board.	Device cannot be started in active mode.	
COM_RTC No=0x53	Real Time Clock Fault	Real Time Clock read fault at start. SPI com fault or too low "BAT1" voltage.	Charge "BAT1" by starting the LUCAS3 and press PAUSE leave the machine ON for 30 minutes, set correct time and date with the LUCAS3.exe program. After this restart and check for COM_RTC warning. If needed replace the Control board.	LOG file date and time fault. Hot restart after battery switch not functional.	Internal fault - contact Technical Support
COM_SD_MEM No=0x54	Fault SD card Communication	SD card not inserted or broken.	SD card.	No LOG file created.	

COM_B_TIMEOUT No=0x55	I2C Battery Charger Communication Timeout	No I2C communication with Charger system >100s. I2C communication fault or halted Charger CPU.	Check cable between boards. Restart LUCAS3 and run for 30 minutes. If fault repeats replace Protective board.	Device cannot be operated. Switch off by removing battery.	
COM_I2C No=0x56	I2C faults too high	Disturbed I2C communication.	Check cable between boards. Protective or Control board.	Poor response to keystrokes.	

Error Codes from Protective CPU

Error Code	Explanation	Probable Cause	Module to check / replace	User Notification	LRG Text
T1_RAM	Internal RAM test detect fault at start.	Protective CPU fault.	Protective board	High priority Alarm.	Internal fault - contact Technical Support
T1_E2_PROM	Internal E2 prom test detect fault at start.	Protective CPU fault.	Protective board	High priority Alarm.	Internal fault - contact Technical Support
T1 PISTON REVERSE ERROR	Reverse test not done correct at start	Motor not moved correct or fault current read.	Protective board, check cable between boards or Control board (P45 fault)	After 3 start attempt, High priority Alarm.	Self-test fault
T1 PISTON RELEASE ERROR	Protective release line operation fault at start	Current detected at disable test or moved too low at enable test.	Check cable between boards, Protective board or Control board (P45 fault)	After 3 start attempt, High priority Alarm.	Self-test fault
TOO_DEEP COMPRESSION	Too deep compression detected in active mode.	Protective potentiometer fault. Jam of compression module at run with no load.	Check smoothness in Compression module, Protective potentiometer.	High priority Alarm.	In Pause: Disruption of Suction Cup
TOO_SHALLOW COMPRESSION	Too shallow compression detected in active mode. (50 consecutive strokes)	Protective potentiometer fault. Compression module runs with too high load.	Check load and Protective Potentiometer at different heights.	High priority Alarm.	In Active: Compressions out of range
INTERNAL TEMPERATURE	Protective board temperature detected > 85°C	Fan or Protective board sensor or voltages fault	Fan, Protective board. Check ambient temperature (below +40°C).	High priority Alarm.	Too high temperature

PISTON_TIME_OUT	Protective potentiometer not detected a movement of 50% stroke for 10s.	Protective potentiometer fault. Too high load. I2C communication fault at mode change.	Check load and Protective potentiometer at different heights. Check for communication timeouts.	High priority Alarm.	Disruption of Suction Cup
CONTROL_LIFETICK	I2C communication fault with Control CPU (Warning)	I2C communication fault at mode change. Other fault detected by Control.	Check if other fault is detected by Control. Check cable between boards.	None. Warning stored to LOG file.	
ALARM TYPE ROM TEST	Internal ROM test detect fault at start.	Protective CPU fault.	Protective board	High priority Alarm.	Internal fault - contact Technical Support
CHARGER_STOP	Charger fault detected (Motor disable)	See Charger errors	See Charger errors	High priority Alarm.	
CONTROL_STOP	Control fault detected (Motor disable)	See Control errors	See Control errors	High priority Alarm.	

Error Codes from Charger CPU

Error Code	Explanation	Probable Cause	Module to check / replace	User Notification	LRG Text
T1 RAM ALARM	Internal RAM test detect fault at start.	Charger CPU faults.	Protective board	High priority Alarm.	Internal fault - contact Technical Support
T1 E2 PROM ALARM	Internal E2 prom test detect fault at start.	Charger CPU faults.	Protective board	High priority Alarm.	Internal fault - contact Technical Support
T1 POWER OFF ALARM	T1 test not ended correct.	T1 fault detected by other CPU's	Check other faults.	After 3 start attempt, High priority Alarm.	Self-test fault
BATT HIGH TEMP ALARM	Battery temperature detected to be >70°C	Battery fault. Ambient temperature too high.	Battery	High priority Alarm.	Battery too high temperature (S/Nxxxxxxxx)
BATT EMPTY ALARM	Battery continues below 25V	Uncharged battery. Battery, DCIN or charging fault.	Battery, Protective board, DCIN adaptor	High priority Alarm.	Battery depleted (S/Nxxxxxxxx)
BATT 10 MIN ALARM	Battery continues below 25.3V	Uncharged battery.	Battery	Medium priority Alarm. Flashing orange battery LED (B1)	Battery low charge (S/Nxxxxxxxx)
T1 ROM ALARM	Internal ROM test detect fault at start.	Charger CPU faults.	Protective board	High priority Alarm.	Internal fault - contact Technical Support
T1 BATT COM ALARM	Battery communication fault	Connector fault.	Check connections. Unplug and insert battery, check for fault. Or replace battery.	None. Shall be shown at LOG file read.	Battery not recognized as Physio-Control proprietary (no S/N)

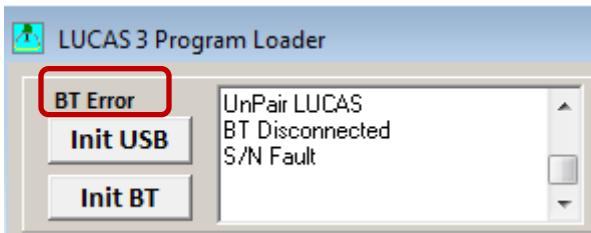
T1 BATT CS ALARM	Battery communication check- sum fault	Connector fault.	Check connections. Unplug and insert battery, check for fault. Or replace battery.	None. Shall be shown at LOG file read.	Battery not recognized as Physio-Control proprietary (no S/N)
T1 BATT COPYRIGHT ALARM	Incorrect copyright string read from battery	Incorrect battery type or communication fault	Check connections. Unplug and insert battery, check for fault. Or replace battery.	None. Shall be shown at LOG file read.	Battery not recognized as Physio-Control proprietary (no S/N)
TOO MANY USES	Inserted battery is used more than 200 times.	Worn out battery.	Battery	Orange battery LED (B1)	Battery replacement recommended (S/N xxxxxxxx)
TOO OLD BATTERY	Inserted battery is too old.	Too old battery used.	Battery	Orange battery LED (B1)	Battery replacement recommended (S/N xxxxxxxx)

User Errors

Indication	Probable Cause	Probable Consequence	User Observation	LRG Text
The new Start position was not accepted.	Too small patient Start. Checked by POT graph data > 133.	Too small patient, use manual compressions.	Not accepted start, information signal (3 fast signals).	Too small patient.
	Too fast mode change.	Repeated press on button.	Not accepted start,	
Cup moved/held down at PAUSE	Cup moved down 10mm by user at PAUSE or Too high start position result in 10mm 13N spring release at next PAUSE (after Active).	Too high Start position resulting too shallow compressions.	13N release information signal (3 fast signals).	Start Position adjustment required
Stop/Adjust direct to Active (RUN/30:2)	The user wants to start quickly.	-	Quick start.	
Max Quick Fit distance done.	Too high placed Cup above patient chest prior to start.	Too high Start position resulting too shallow compressions.	Free distance between chest and Cup.	
High Preload detected at Start position.	User pressed down the Cup during Start position set. Patient moved.	High down force at zero position.	Compressed chest.	
Audible Timer Alert.	Timer time out	Timer	Audible alert	Timer Alert.
Rate is changed.	ACTIVE mode and used ACTIVE button pressed to change Rate.	Compression frequency changed	Rate change	Rate change to xxx

Bluetooth Connection Error

When connecting LUCAS 3 via Bluetooth to **DT Express**, **LUCAS Report Generator** or **LUCAS Program Loader**, if connection errors happened repeatedly, the possible cause might be the Bluetooth driver on computer is not up to date.



To update the Bluetooth driver for the computer:

1. Find out the computer maker, model name and number
2. Download the latest version of the Bluetooth driver from the computer manufactory support website
3. Install the driver
4. Reboot the computer
5. Toggle the wireless switch off/on
6. Try to connect LUCAS 3 to computer again via Bluetooth
7. If BT Error cannot be fixed, contact SmartDesk for support

Troubleshooting Tips

With the help of the tables above, try to locate which module to check or replace.

Before replacing a board it's possible to connect the board hanging on the side of LUCAS. If the problem disappears when testing, then continue to replace the board.

It can be a good start to check that all connectors are connected and that internal cables are intact. In some cases a Multimeter instrument can be useful to do measurements with.

In [Appendix A \(wiring diagram\)](#), there is a wiring diagram that can be helpful for troubleshooting.

If the device doesn't start, first check the battery and if that's ok check the connections from the Hood and the User Control Panel.

Spare Parts and Accessories

Spare Parts

Catalog #	Description	Drawing #	Note
21576-000066	LUCAS 2 COMPRESSION MODULE 2.2	150401-20	Including motor
21576-000079	LUCAS 3 REFURBISHING KIT	160402-00	Carrying case, patient straps and stabilization strap
21576-000080	LUCAS 3 HOOD ASSEMBLY	160403-00	
21576-000094	HOOD, WITH USER PANEL, LUCAS 3 STRYKER	160403-01	
21576-000009	LUCAS 2 BELLOWS	150404-00	Including brackets
21576-000010	LUCAS 2 ELECTRIC FAN	150405-00	
21576-000068	LUCAS 2 ELECTRIC MOTOR 2.2	150406-20	Including drive belt
21576-000081	LUCAS 3 SUPPORT LEG	160408-00	Including angle shafts, strap holders, snap rings, and torsion-spring

21576-000095	LUCAS 3 SUPPORT LEG, STRYKER	160408-01	Including angle shafts, strap holders, snap rings, and torsion-spring
21576-000082	LUCAS 3 CONTROL BOARD	160409-00	Including bracket, and 3 plastic screws for communication board.
21576-000091	LUCAS 3 PROTECTIVE BOARD	160410-00	Including bracket
21576-000007	LUCAS 2 DRIVE BELT	150411-00	
21576-000055	BELT COVER	100654-00	
21576-000070	LUCAS 2 INTERNAL COMMUNICATION CABLE 2.2	150413-20	15-pin cable between control board and protective board
21576-000020	LUCAS 2 HOOD COMMUNICATION CABLE	150414-00	Flat cable between hood and protective board
21576-000025	LUCAS 2 BATTERY CONNECTOR BOARD	150415-00	Including O-rings
21576-000083	LUCAS 3 FRAME ASSY	160416-00	Main body with support legs mounted
21576-000089	LUCAS HOOD BRACKET	150420-00	
21576-000096	ASSEMBLY, FRAME, LUCAS 3 STRYKER	160416-01	Main body with support legs mounted
21576-000072	LUCAS 2 POWER INLET 2.2	150417-20	DC-inlet connector (main body) including cable
21576-000085	LUCAS 3 COMMUNICATION BOARD	160420-00	Includes communication board and 3 plastic screws.
21576-000097	LUCAS 3 VERSION 3.1 COMMUNICATION BOARD	160420-01	Includes communication board and 3 plastic screws.
21576-000087	LUCAS 3 ANTENNA ASSEMBLY	160422-00	Includes 2 cable ties and 2 transfer tapes
21576-000077	SPARE PART PADDING LUCAS3	160421-00	Shipping box padding material
21576-000076	SHIPPING BOX	100938-00	
21576-000093	SHIPPING BOX, STRYKER	100938-01	
21576-000084	LUCAS 3 MAIN BODY COMPLETE	160419-00	Main body without support legs
21576-000090	SD MEMORY CARD	150421-00	

Other Orderable Spare Parts

Catalog #	Description	Drawing #	Note
21576-000047	SCREW PT K40X12 WN 1452 A2	10150120-43	QTY: 4, Used to attach Hood to main body
21576-000049	WASHER 3X10X3.4 ARAN LOCK	10150085-29	QTY: 4, Used to attach Thread Plate to main body
21576-000050	AXEL-ANGLE SHAFT	240-3	QTY: 4, Used to attach Support Leg to Main Body

21576-000051	TORSION SPRING	240-9	QTY: 2, See Spring picture in How to Replace Support Leg
21576-000053	SCREW K40X14 WN1452	10150120-35	QTY: 6, For one Support Leg Assembly Used to attach two pieces of Support Leg
21576-000054	SCREW DELTA PT 40X22 WN5452 A2	10150461-00	QTY: 3, For one Support Leg Assembly Used to attach two pieces of Support Leg. These three screws are in the middle of the Support Leg.
21576-000056	SCREW MRT M3X6 A2 ISO 7045	1015007161	QTY: 4, Used to attach Control and Protective Board Assembly to the Compression Module Assembly
21576-000057	SERRATED LOCK WASHER M3 DIN 6798A	1015021803	QTY: 4, Used to attach Belt Cover to Compression Module Assembly
21576-000058	SCREW MRT M4x12 A2 ISO 7045	1015007178	QTY: 4, Used to attach Motor with Belt Wheel Assembly to Compression Module Assembly
21576-000059	SERRATED LOCK WASHER M4 DIN 6798A	1015021804	QTY: 1, Used between one screw and the Terminal
21576-000060	TERMINAL M4 AMP 181949	1067227820	QTY: 1, Used to attach Ground Cable from Hood Assembly
21576-000061	SCREW MFX-H M3x6 A2 DIN 965	724322040	QTY: 4, Used to attach Mesh and Threaded Plate on air intake side.
21576-000062	SCREW MFS M3x40 A2 DIN 963	723123842	QTY: 4, Used to attach Mesh, Fan Washer, Fan cable assembly and Threaded Plate.
21576-000063	SCREW MRX-H M3x50 A2 DIN 7985	724124040	QTY: 4, Used to attach Hood Assembly
21576-000064	SCREW MFT M5x20 A2	1015007248	QTY: 8, Used to attach Compression Module Assembly and Protective and Control board assembly (see row with Thread Plate) to Upper Part Assembly
21576-000065	SCREW MRT M3x12 A2 ISO 7045	1015007163	QTY: 2, Used for tightening the clamp on Bellows
21501-002853	TYPE LABEL	100940-00	QTY: 1, LUCAS 3 Type Label, placed on the leg
21576-000089	BRACKET, HOOD, LUCAS	150420-00	QTY: 1, metal bracket for fixation HOOD
21576-000090	CARD, MEMORY, SD	150421-00	QTY: 1, LUCAS SD Card for storing Log files, positioned on the Control Board
21501-002855	LABEL, UDI	100952-00	QTY: 1, LUCAS 3 UDI Label, placed on the opposite leg compared to the Type Label
21340-000846	SOFTWARE, LUCAS 3, 3.0	250039-00	
21340-000852	SOFTWARE, LUCAS 3, 3.1	250041-00	

Accessories

Catalog #	Description	Drawing #	Note
11576-000081	LUCAS CARRYING CASE, HARD SHELL	160200-00	
11576-000094	LUCAS CARRYING CASE, HARD SHELL VERSION 3.1	160200-01	
11576-000080	LUCAS BATTERY, DARK GRAY	160201-00	
21576-000074	LUCAS STABILIZATION STRAP	160203-00	
11576-000050	LUCAS 2 PATIENT STRAP (PAIR)	300021-00	
11576-000046	LUCAS 2 SUCTION CUP	100593-00	3-PACK
11576-000048	LUCAS 2 CAR CABLE	150206-00	12-28 V DC
11576-000083	LUCAS BATTERY CHARGER US	160207-00	
11576-000084	LUCAS BATTERY CHARGER EU	160207-01	
11576-000085	LUCAS BATTERY CHARGER GB	160207-02	
11576-000086	LUCAS BATTERY CHARGER AU	160207-03	
11576-000087	LUCAS BATTERY CHARGER JP	160207-04	
11576-000088	LUCAS BACK PLATE, SLIM	160208-00	
11576-000089	LUCAS BACK PLATE ANTI SLIP, SLIM BACK	160209-00	
11576-000055	LUCAS 2 POWER SUPPLY US	150210-00	
11576-000056	LUCAS 2 POWER SUPPLY EU	150210-01	
11576-000057	LUCAS 2 POWER SUPPLY GB	150210-02	
11576-000058	LUCAS 2 POWER SUPPLY JP	150210-03	
11576-000059	LUCAS 2 POWER SUPPLY AU	150210-04	
11576-000067	LUCAS 2 POWER SUPPLY SWZ	150210-05	
11576-000071	LUCAS 2 POWER SUPPLY CANADA	150210-06	
11576-000064	LUCAS PCI BACK PLATE	150211-00	(Radio translucent)
11576-000091	LUCAS BUMPER INTEGRATED SHAFT SEAL, BLACK, PAIR	160213-00	

Tools

These tools are used for performing service and maintenance of LUCAS 3.

Standard Tools

1. Torx Screwdriver T10, T20, T25 (or set of Torx Keys)
2. Philips Screwdriver PH1
3. Small Flat Screwdriver
4. Flat Screwdriver 5.5x0.8 mm
5. Adjustable Torque Screwdriver with minimum range of 0.6-4.0 Nm
6. Bits Philips 1 (PH1)
7. Bits Flat 5.5x0.8 mm (5.5)
8. Bits Torx 10 (T10)
9. Bits Torx 20 (T20)
10. Bits Torx 25 (T25)
11. Hammer
12. Mandrel Cutting
13. Pliers Adjustable
14. Pliers ESD
15. Protection kit
16. Micro SD card reader
17. USB to USB mini Cable
18. Non-knurled flat nose plier
19. USB programming cable
20. REDEL extracting tool

Special Tools

Description	Art. No:	Picture
Hood Holder Bracket Service Tool	100838-00	
Mandrel, LUCAS Hinge Insertion (Optional Tool)	300040-00	
USB Programming Cable	160423-00	

Substances

Description	Catalog #
Thread Lock Fluid	11996-000220
PTFE Spray Lubricant	21576-000023
Carry Ball Screw Grease	21576-000018
Compressed Air, Can	21300-001335

Software

Description	Catalog #
LUCAS® 3 Program Loader 3.0	21340-000846
LUCAS® 3 Program Loader 3.1	21340-000852
LUCAS® 3 Report Generator	Free download from LIFENET
DT Express	Free download from LIFENET

Preventive Maintenance

Maintenance Procedure

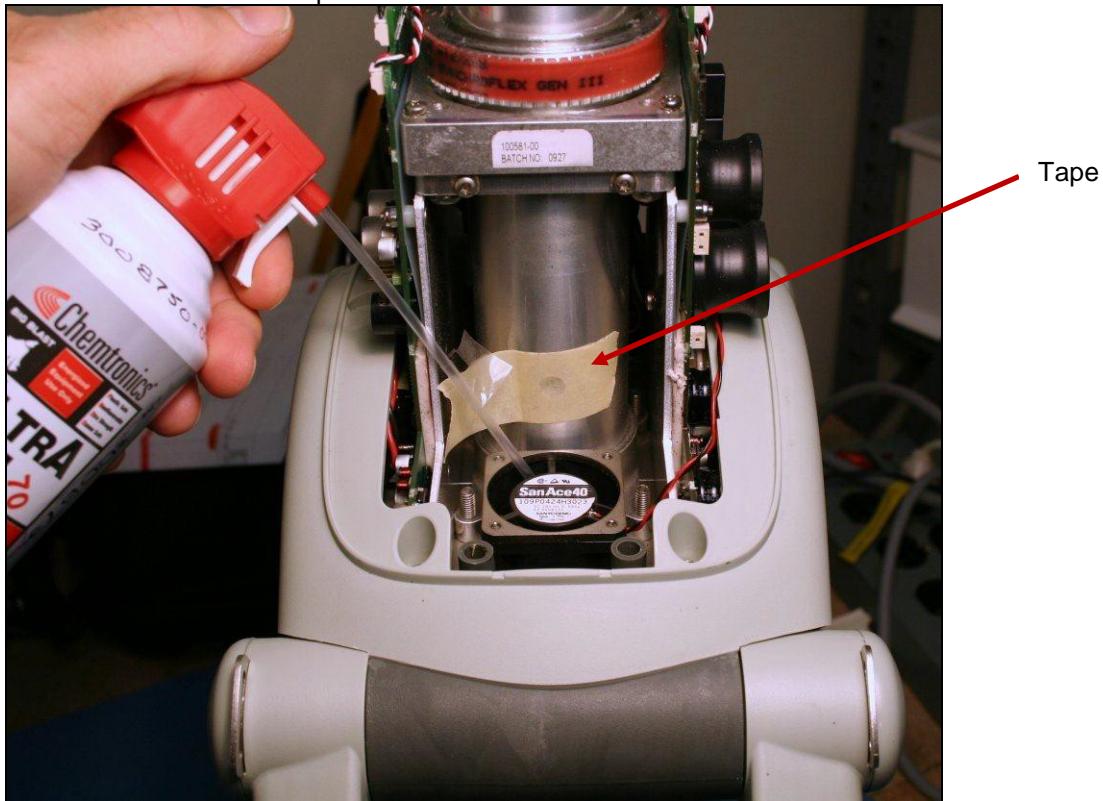
NOTE: Use PIP checklist 3326789 Rev C to record PIP results during the maintenance procedure.

Step	Routine	Description	Ref. /
1	Cleaning	Clean the device according to IFU, replace if necessary	6.1 in the IFU
2	Check/Replacement Bellows	Check Bellows is intact and clean, replace if necessary according to How to Replace the Bellows	
3	Check/Replacement Suction Cup	Check Suction Cup is intact and clean, replace if necessary	6.2 in the IFU
4	Check/Replacement Patient Straps	All fabrics (Patient Straps, Stabilization Strap and the Carrying Bag) are checked with the aspect of cleanliness and that the Velcro and buckles isn't worn and fulfils its function. Replace if necessary.	6.3 in the IFU
5	Check/Replacement Stabilization Strap		6.4 in the IFU
6	Check/Replacement Carrying Bag		
7	Check/Update Software	Check the software version in the device and update if possible according to LUCAS® 3 Program Loader	
8	Check for Errors and Warnings	Start the device and let it run for a minute to check that no errors or warnings occur according to Electronics Test	
9	Clean Fan and Mesh Grill	According to Clean Electric Fan and Mesh Grill	
10	Compression Module Lubrication	According to Compression Module Lubrication	
11	Claw lock lubrication	According to Claw Lock Lubrication	
12	Function Check	Perform a function check according to Function Check	

Clean Electric Fan and Mesh Grill

Cover the Carrier Ball Screw hole with a piece of tape to keep dust out of lubrication area.

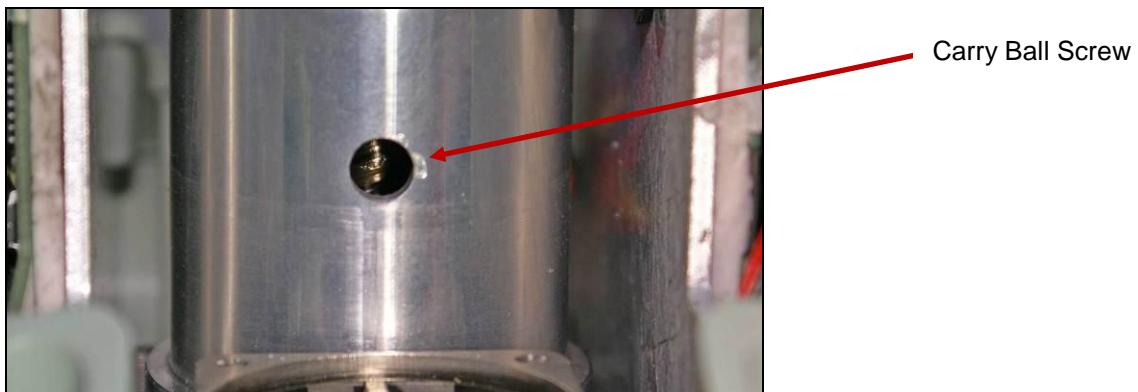
From the inside of the device, clean the Fan and Mesh Grill with compressed air. Clean dust from areas on the device that require lubrication. Remove tape from Carrier Ball Screw hole.



Compression Module Lubrication

Use only specified Carry Ball Screw Grease (21576-000018)

With the hood off pull down the Piston and the Adjustment Tube until the Carry Ball Screw is visible in the Lubrication Hole.



Apply the grease onto the Carry Ball Screw with the syringe (0.5 ml).

Move the piston manually up and down 5 times over the full range to work the grease in.

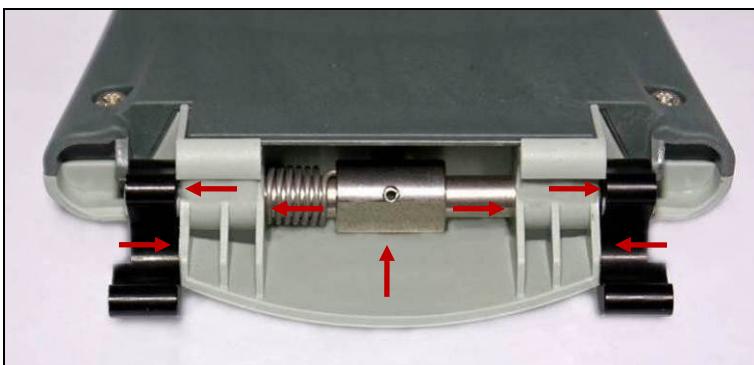


Claw Lock Lubrication

Use PTFE Spray Lubricant (21576-000023)

Spray a small quantity of lubricant on all movable parts (gliding surfaces of the claws, where the axle goes into the plastic and the locking pin), see picture below.

Open and lock the mechanism continuously to work in the lubricant.



Replacing Parts or Modules in LUCAS

How to Apply Thread Lock Fluid

The normal amount of Thread Lock Fluid should be corresponding to the diameter of the screw and the Thread Lock Fluid should be applied at the lower end of the screw, see picture below:



This general description shall apply on all use of Thread Lock Fluid on LUCAS according to this manual.

How to Replace the Hood

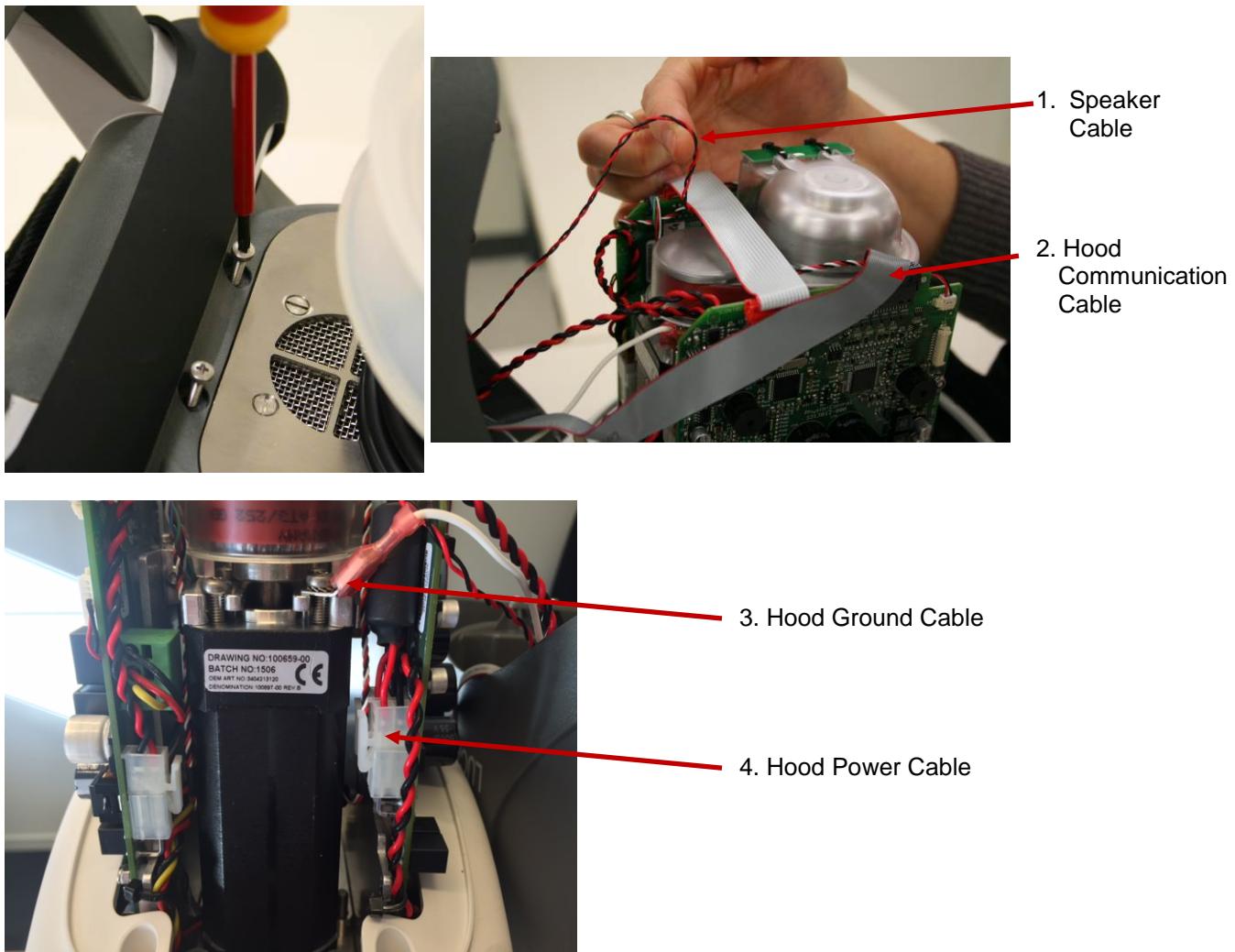
WARNING: Take Off The Battery Before Opening The Device!

NOTE: Do not connect the battery to hood cover unless the Hood Holder Bracket Service Tool is installed. The weight of the battery in a hood cover can damage the wires or connections.

Use caution when examining or operating the device without its covers.

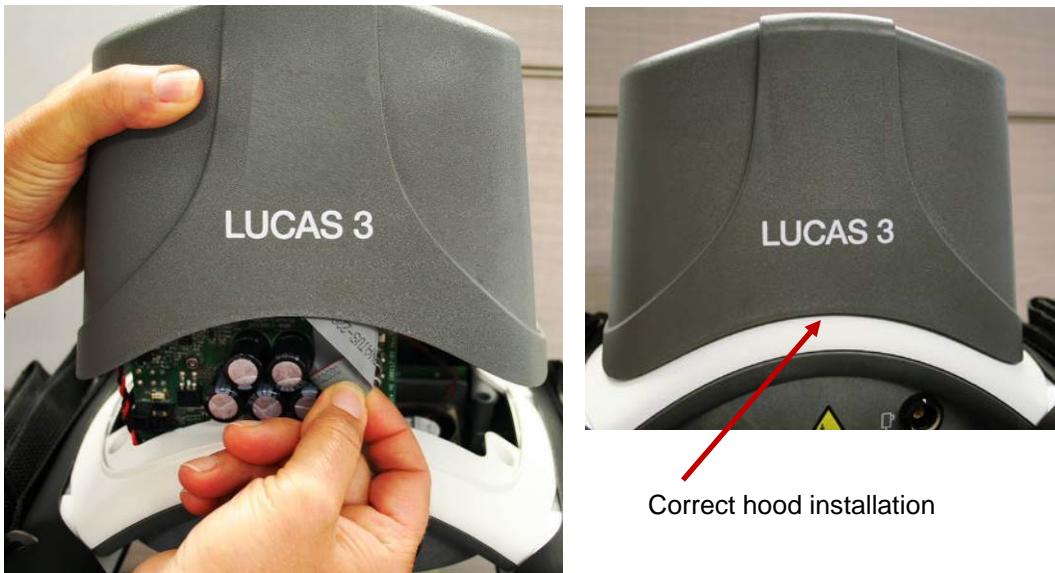
1. Disassembling

- Remove all four screws for the hood with Phillips Screwdriver *PH1*. Set aside screws for reuse during assembly.
- Carefully lift off the Hood and disconnect the four cables between the Hood and the Protective PCB
 1. Speaker Cable (connected to Control PCB)
 2. Hood Communication Cable (connected to Protective PCB)
 3. Hood Ground Cable (connected to Electric Motor Terminal)
 4. Hood Power Cable (connected to Protective PCB)



2. Reassembling

- Connect the four cables according to **Disassembling**. Make sure that the Hood Ground Cable connector is mounted in front of the ferrite of the Hood Power Cable to keep the ferrite from moving (see picture above).
- Put the Communication Cable in front of the Protective PCB shown in the picture below, and carefully put the hood back in place, make sure not to damage any cables.



- Lock the four screws with thread lock fluid and tighten to 5.3 in-lbs / 0.6 Nm with a Torque Screwdriver *PH1*.

3. Test

Perform a Function Check according to [Function Check](#).

How to Replace the Bellows

1. Disassembling

- Take off the suction cup
- Remove the clamp by removing the two screws with a *Torx 10 (T10)* or *Torx 20 (T20)* Screwdriver.



- Remove the Bellows ring, start by treading the bellows over the ring, then continue to take off the ring as showed in the picture.



- Remove the Bellows by treading it over the Piston.

2. Reassembling

- Carefully thread the Bellows over the piston and position it as far up as possible.



- Place the clamp and fixate the bellows by tightening the two screws to 9.0 in-lbs / 1.0 NM with a Torque Screwdriver *Torx 10 (T10)* / or 13.0 in-lbs / 1.5 NM with a *Torx 20 (T20)* depending on Bellows Clamp. The clamp should be positioned as far up as possible.



- Place the Bellows ring above the retaining ring.
- Thread the edge of the Bellows over the Bellows ring.



- Put back the Suction Cup.

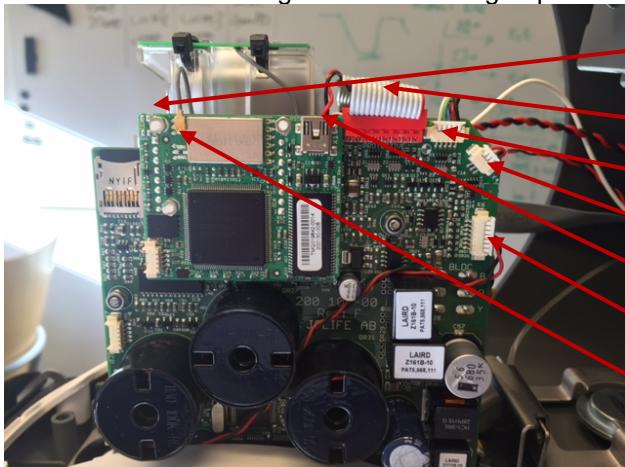
3. Test

Perform a Function Check according to [Function Check](#).

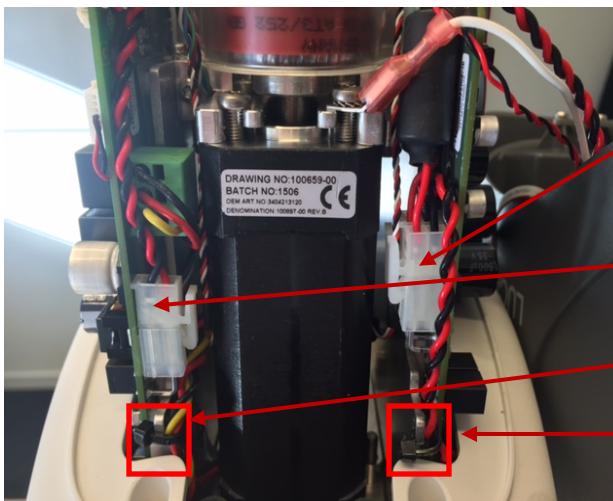
How to Replace the Compression Module

1. Disassembling

- Take off the Suction Cup and remove the Bellows according to **Disassembling** instruction in [How to Replace the Bellows](#).
- Remove the Hood according to instructions in [How to Replace the Hood](#).
- Disconnect the following cables according to pictures below



1. Protective Linear sensor Cable (on the back side of Protective PCB)
2. Communication Cable
3. Motor Rotation Sensor Cable
4. Control Linear sensor Cable
5. Speaker Cable
6. Fan Cable
7. Antenna Cable

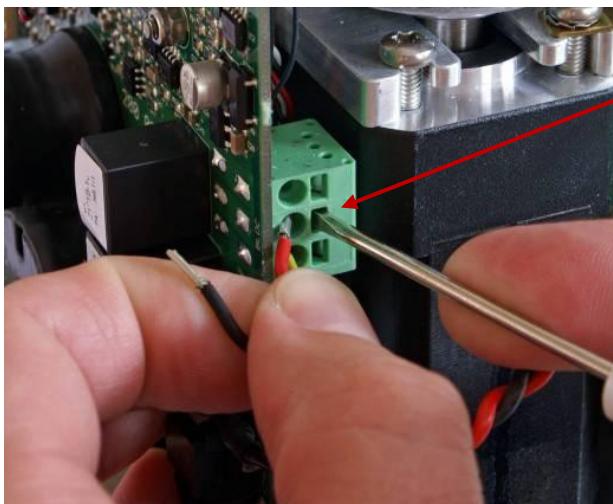


8. Protective Power Cable

9. Control Power Cable

Remove if taking out Compression Module

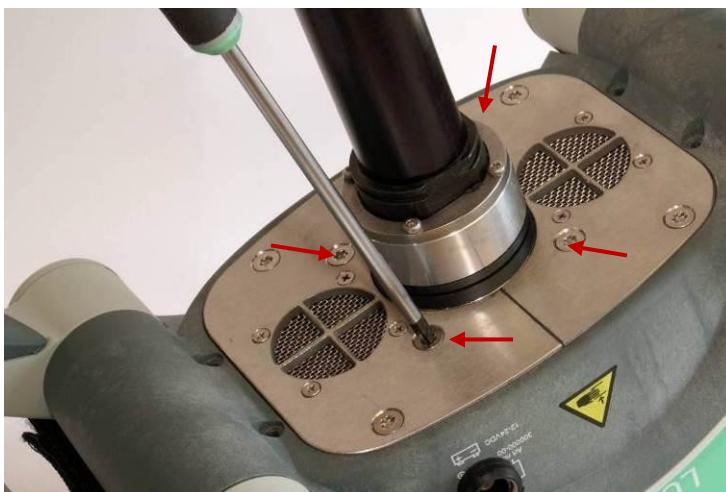
Remove if taking out Protective PCB



10. Motor Power Cable; use a small flat screwdriver to remove the cables, three wires:

Black (top)
Red (middle)
Yellow (bottom)

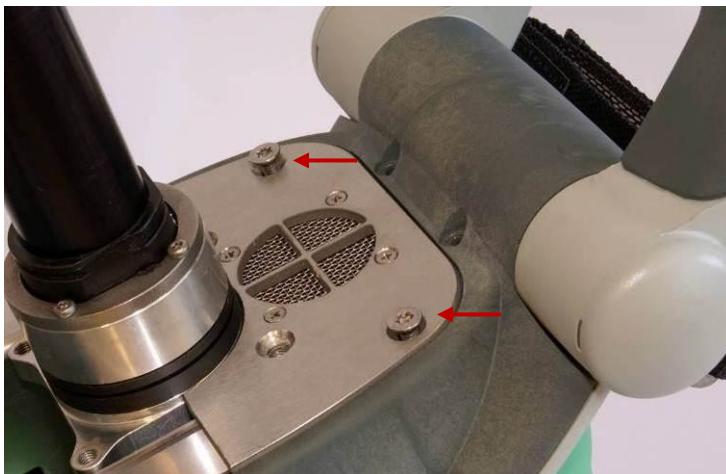
- From beneath, remove the four screws that hold the Compression Module with a *Torx 25 (T25)* Screwdriver.



- Remove the two screws that hold the Fan Bracket with a *Torx 25 (T25)* Screwdriver, and remove the bracket.



- Loosen the two remaining screws on the other bracket without removing them.



- Remove the four screws that hold the PCB brackets against the Compression Module, two screws on each side according to the pictures below with a *Torx 10 (T10)* Screwdriver





- Carefully spread the PCB boards and lift out the Compression Module, make sure that no cables get stuck or harmed especially the Linear sensor Cables.



2. Reassembling

- Carefully lower the Compression Module down between the PCB's.
- Position the PCB boards and fasten the Compression Module in the PCB brackets, use thread lock fluid and tighten to 9.0 in-lbs / 1.0 Nm with a Torque Screwdriver *Torx 10 (T10)*.
- Put back the Fan Bracket, use thread lock fluid and tighten to 35 in-lbs / 4.0 Nm with a Torque Screwdriver *Torx 25 (T25)*.
- Fasten the Compression Module with four screws, use thread lock fluid and tighten to 35 in- lbs / 4.0 Nm with a Torque Screwdriver *Torx 25 (T25)*.
- Unscrew the two screws on the bracket that are loose, apply thread lock fluid and tighten to 35 in-lbs / 4.0 Nm with a Torque Screwdriver *Torx 25 (T25)*.
- Re-connect all cables according to picture in **Disassembling**.
- Replace removed Cable Ties (if applicable).
- Put back the Hood according to **Reassembling** instruction in [How to Replace the Hood](#).
- Put back the Bellows according to **Reassembling** instruction in [How to Replace the Bellows](#).
- Put back the Suction Cup.

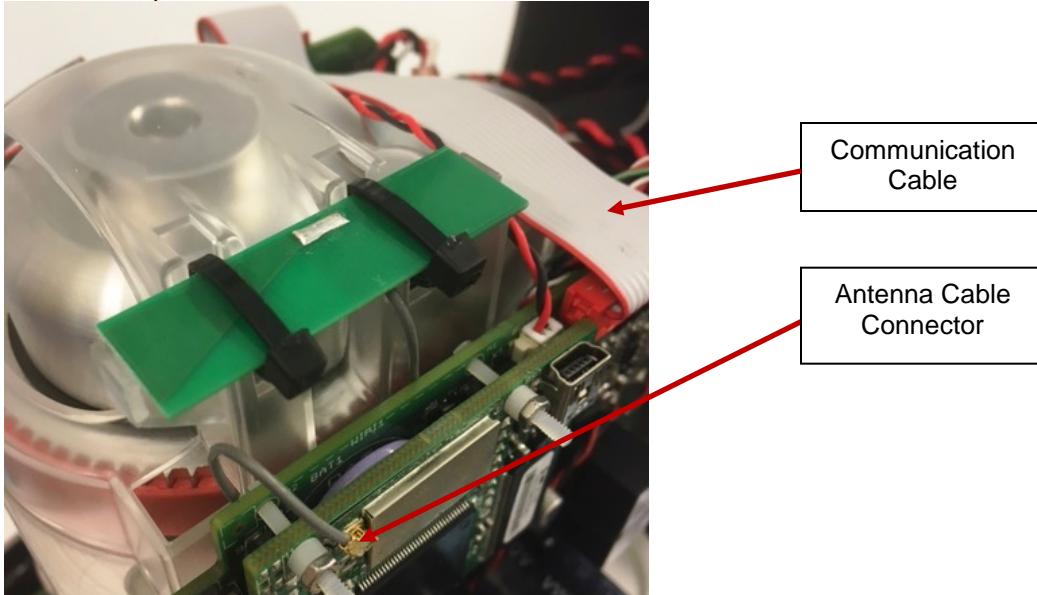
3. Test

Perform a Function Check according to [Function Check](#).

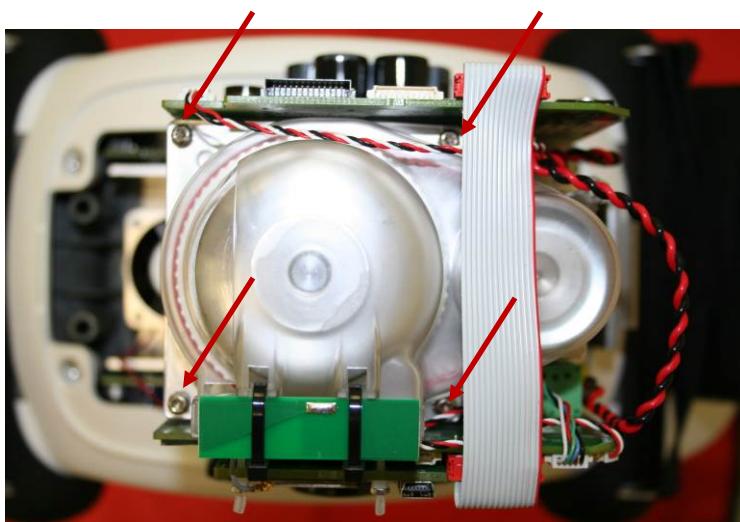
How to Replace the Drive Belt

1. Disassembling

- Remove the Hood according to **Disassembling** instruction in [How to Replace the Hood](#)
- Disconnect the Antenna Cable Connector and the Communication Cable from the Communication Board as shown in picture below



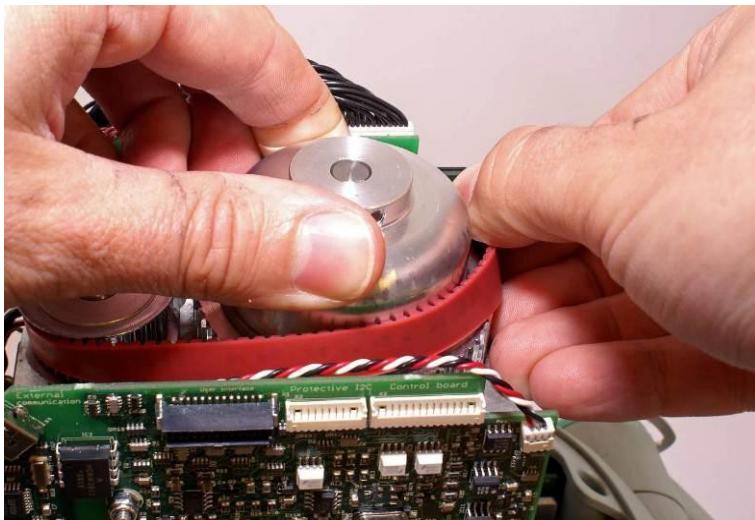
- Remove the Belt Cover by removing the four screws with a *Torx 10 (T10)* Screwdriver; be careful not to lose the washers.



- Cut the Belt with *cutting plier* and remove it.

2. Reassembling

- Thread the new Belt over the small Belt Wheel first.
- Continue to Thread it over the Large Belt Wheel and turn the wheel at the same time to get the belt in place.



- Fasten the Belt Cover according to the picture in **Disassembling**. Tighten the screws to 9 in-lbs / 1.0 Nm with a Torque Screwdriver *Torx 10 (T10)*. **Note: Do not use any Thread Lock Fluid!**
- Connect the Antenna Cable Connector to the Communication Board and tuck away the antenna cable beneath antenna and between belt cover and Control PCBA.
- Connect the Communication Cable.
- Put back the Hood according to **Reassembling** instruction in [How to Replace the Hood](#).

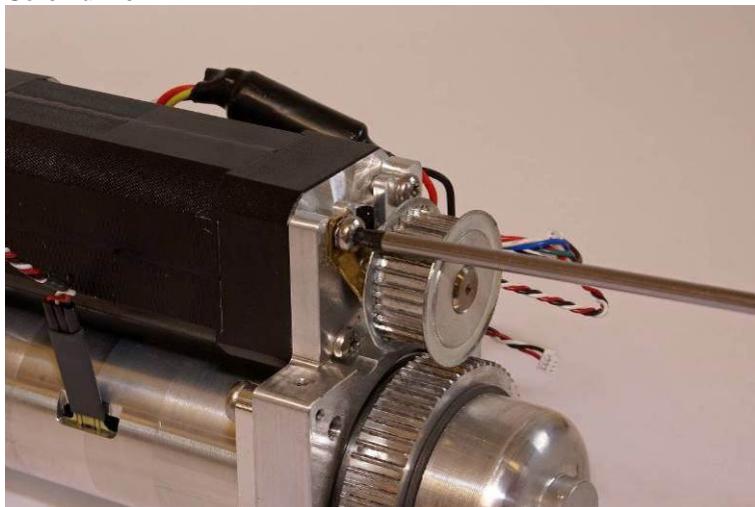
3. Test

Perform a Function Check according to [Function Check](#).

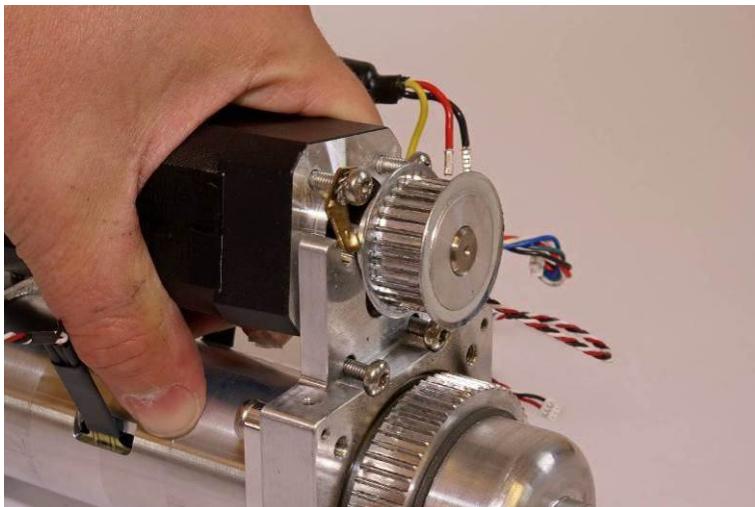
How to Replace the Electric Motor

1. Disassembling

- Follow **Disassembling** instructions in [How to Replace the Compression Module](#) to take out the Compression Module.
- Remove the Drive Belt according to **Disassembling** instruction in [How to Replace the Drive Belt](#).
- Take note of how the terminal for Hood Ground Cable is angled.
- Remove the inner two screws and loosen the outer two screws holding the Motor with a *Torx 20 (T20)* Screwdriver.

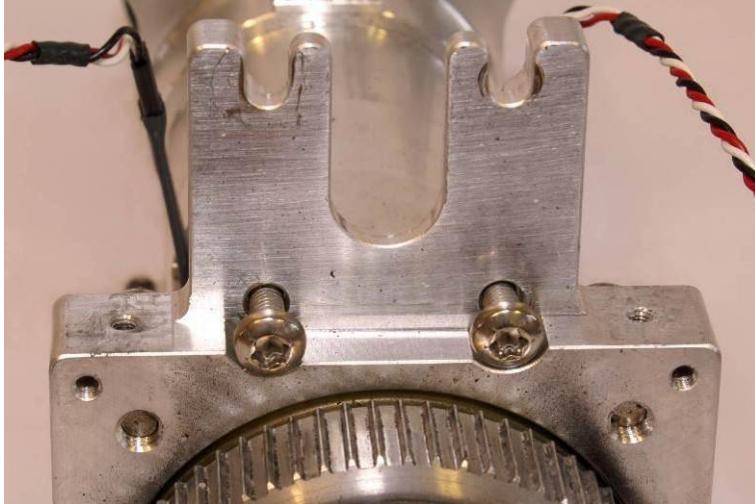


- Slide the Motor out from its bracket.

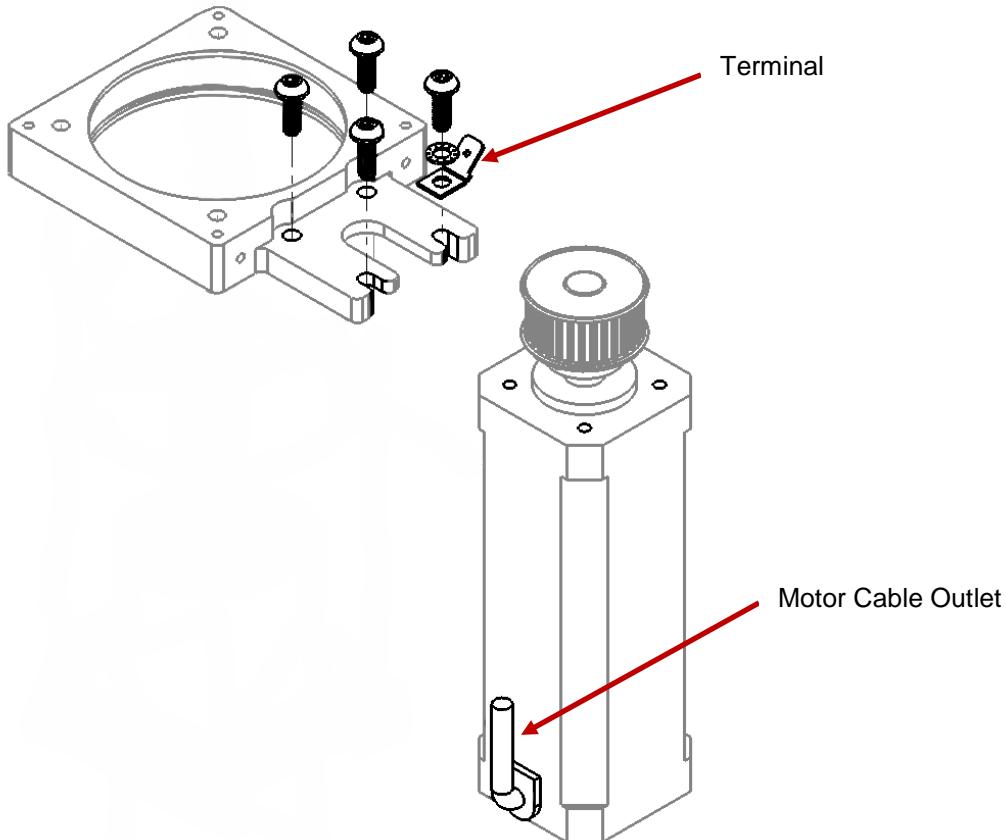


2. Reassembling

- Apply Thread Lock Fluid on two of the screws and place them in the bracket according to picture below



- Apply Thread Lock Fluid to the other two screws and put them on the Motor together with the lock washer and terminal. Make sure that the cable outlet is oriented as figure below.
- Slide the Motor onto the Bracket and tighten the screws to 18.8 in-lbs / 2.0 Nm with a Torque Screwdriver *Torx 20 (T20)*, and make sure to angle the terminal so the ferrite of the Hood Power Cable is secured behind the Hood Ground Cable connector.



- Put back the Drive Belt according to **Reassembling** instruction in [How to Replace the Drive Belt](#).
- Put back the Compression Module according to **Reassembling** instruction in [How to Replace the Compression Module](#).
- Put back the Hood according to **Reassembling** instruction in [How to Replace the Hood](#).
- Put back the Bellows according to **Reassembling** instruction in [How to Replace the Bellows](#).
- Put back the Suction Cup.

3. Test

Perform a Function Check according to [Function Check](#).

How to Replace the Control PCBA

1. Disassembling

- Before disassembling and changing any PCB and if possible; connect a laptop and perform "Store View" using [LUCAS® 3 Program Loader](#).
- Follow **Disassembling** instructions in [How to Replace the Compression Module](#) to take out the Compression Module.
- Remove the two remaining screws from beneath and lift out the PCB carefully.
- **Warning:** Always use ESD protection when handling PCBs!
- Remove SD-card from old Controller PCB. Check that the SD-card is intact and readable/writeable. If SD-card is working properly keep it for the new Controller PCB.
- Remove Communication PCB according to the **Disassembling** Instruction in [How to Replace the Communication PCB](#)



2. Reassembling

- Put back the Communication PCBA according to **Reassembling** instruction in [How to Replace the Communication PCB](#)
- If the SD-card from the old PCBA is working properly insert the old SD-card into the new PCBA, otherwise keep new SD-card installed.
- Put the new Controller PCBA in place and fasten loosely with two screws together with the Bottom Plate with a *Torx 25 (T25)* Screwdriver.
- Put back the Compression Module according to **Reassembling** instruction in [How to Replace the Compression Module](#)
- Put back the Hood according to **Reassembling** instruction in [How to Replace the Hood](#).
- Put back the Bellows according to **Reassembling** instruction in [How to Replace the Bellows](#).
- Put back the Suction Cup.

3. Programming

- Connect a laptop and program the Controller PCBA according to [LUCAS® 3 Program Loader](#).
- Check that “Device S/N”, Time and Date, “Total Number of Strokes”, “Hardware ID” and “Device Friendly Name” are correct (if possible check against “Store View” performed in Disassembling step). If “Store View” was not possible set: “Device S/N” (e.g. 35160021) and “Hardware ID” (e.g. 100921-00) according to Type Label, “Total Number of Strokes” to 0 (zero) and “Device Friendly Name” to “LUCAS3-“ + serial number according to Type Label.

4. Test

Perform a Function Check according to [Function Check](#).

How to Replace the Protective PCBA

1. Disassembling

- Before disassembling and changing any PCBA and if possible; connect a laptop and perform “Store View” using [LUCAS® 3 Program Loader](#).
- Follow **Disassembling** instructions in [How to Replace the Controller PCB](#) to take out the Protective PCBA.
- **Warning:** Always use ESD protection when handling PCBAs.

2. Reassembling

- Put the new PCBA in place and fasten loosely with two screws together with the Bottom Plate with a *Torx 25 (T25)* Screwdriver.
- Put back the Compression Module according to **Reassembling** instruction in [How to Replace the Compression Module](#)

- Put back the Hood according to **Reassembling** instruction in [How to Replace the Hood](#).
- Put back the Bellows according to **Reassembling** instruction in [How to Replace the Bellows](#).
- Put back the Suction Cup.

3. Programming

- Connect a laptop and program the Protective PCB according to [LUCAS® 3 Program Loader](#).
- Check that “Device S/N”, Time and Date, “Total Number of Strokes”, “Hardware ID” and “Device Friendly Name” are correct (if possible check against “Store View” performed in Disassembling step). If “Store View” was not possible set: “Device S/N” (e.g. 35160021) and “Hardware ID” (e.g. 100921-00) according to Type Label, “Total Number of Strokes” to 0 (zero) and “Device Friendly Name” to “LUCAS3-“ + serial number according to Type Label.

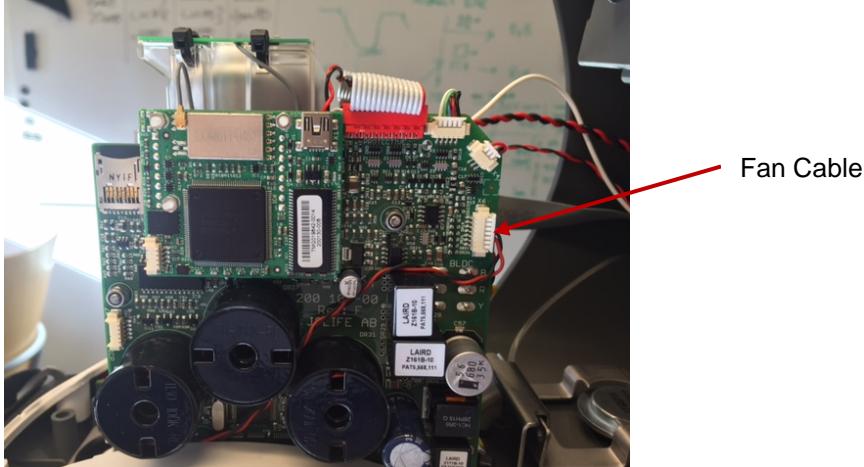
4. Test

Perform a Function Check according to [Function Check](#).

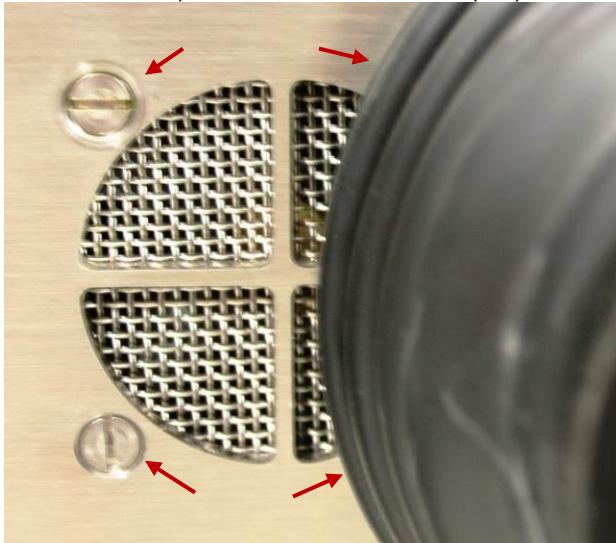
How to Replace the Electric Fan

1. Disassembling

- Lift of the hood by following **Disassembling** instructions in [How to Replace the Hood](#), it's not necessary to disconnect the cables.
- Disconnect the Fan Cable on the Control PCB



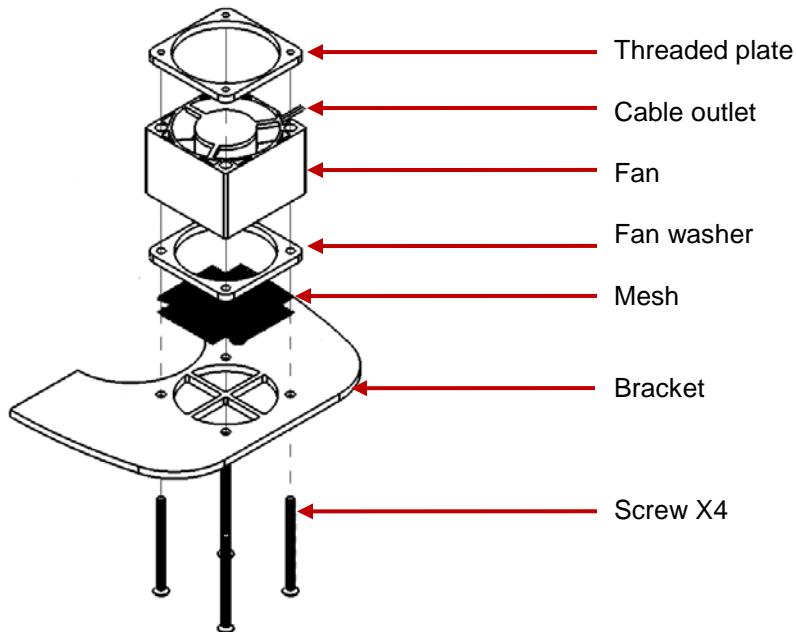
- Remove the four screws that hold the Fan (under the battery side, two more screws are hidden under the rubber bellows) with a *Flat 5.5x0.8 mm (5.5)* Screwdriver.



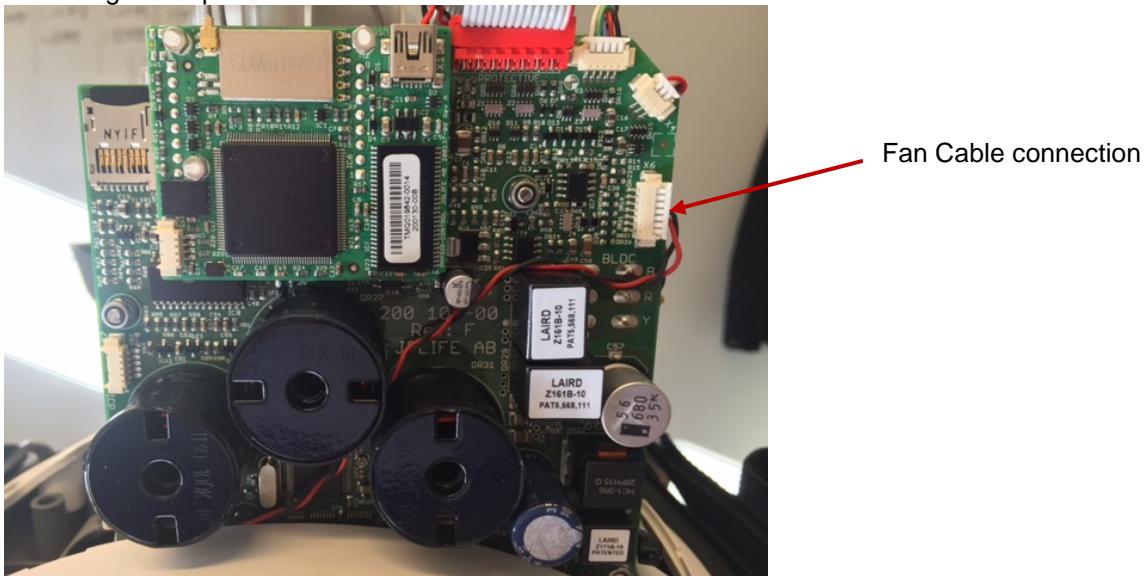
- Take off the Threaded plate and lift out the Fan.

2. Reassembling

- Make sure all parts are assembled as picture below. The screws shall be locked with thread lock fluid and tightened to 9 in-lbs / 1.0 Nm with a Torque Screwdriver *Flat 5.5x0.8 mm (5.5)*.



- Connect the Fan Cable to the “Optional” connector on the Control PCB. Place the cable between the coils according to the picture below.



- Put back the Hood according to **Reassembling** instruction in [How to Replace the Hood](#).

3. Test

- Perform a Function Check according to [Function Check](#).
- When the device is in active mode let it run, after approximately 10 minutes the fan should start. Now set the device in adjust mode, the fan should continue running. Check that there is no unusual sound from the fan. When the temperature inside the hood has decreased to 30°C (86°F) the fan should stop. Continue with the Function Check.

How to Replace the Support Leg

This procedure can be used for replacing the Support Leg or replacing the Axel-Angle Shaft.

1. Disassembling

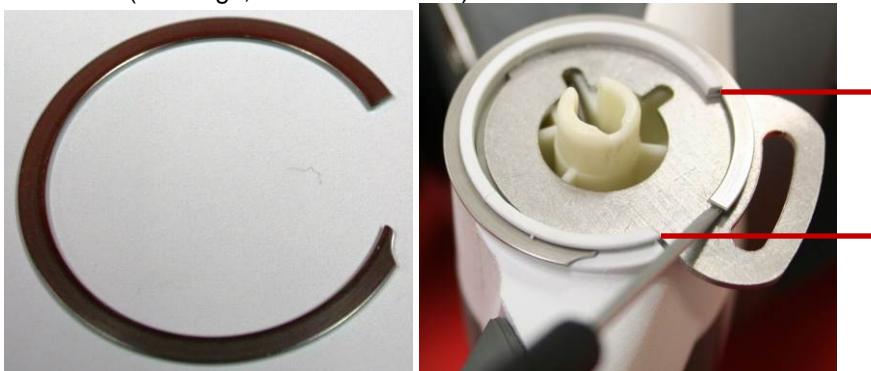
- Remove the Patient Strap.



- Remove the Bumper.



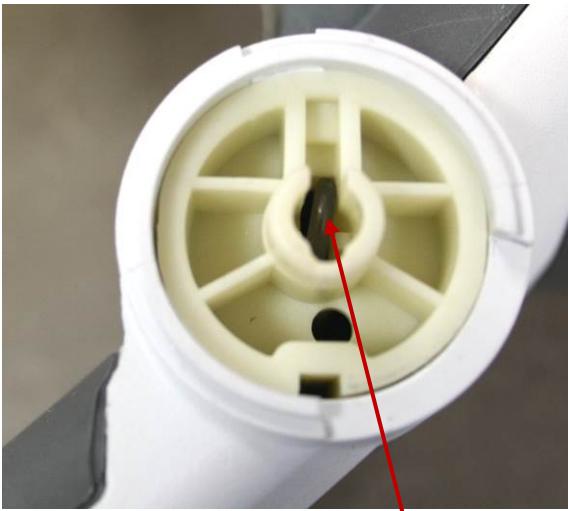
- Remove Snap Ring by turning the open end of ring to the open edges of the leg, shown in the picture; and take it out (two rings, one on each side).



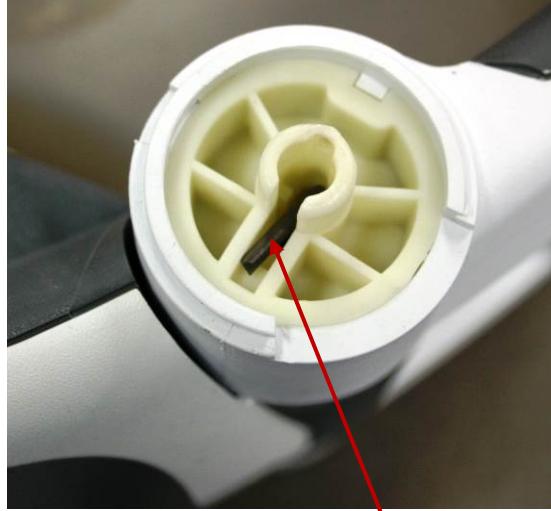
- Remove the Patient Strap Holders (two, one on each side).



- Lay LUCAS on the side of table with nothing blocking the shaft underneath. The round end of spring should be facing up according to the pictures below.



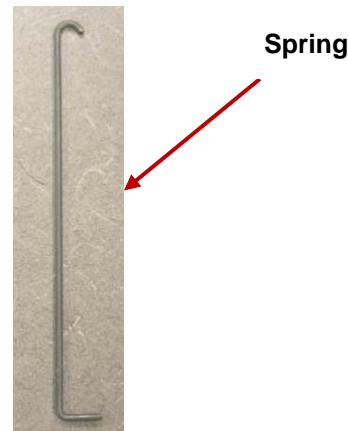
Spring with a round end facing up (non-press fitted side)



Spring with a flat end facing down (press fitted side)

- Knock the **Spring** out with a *Hammer* and a *Mandrel* or similar tool. Tap the spring downwards with the mandrel and hammer until it falls loose.

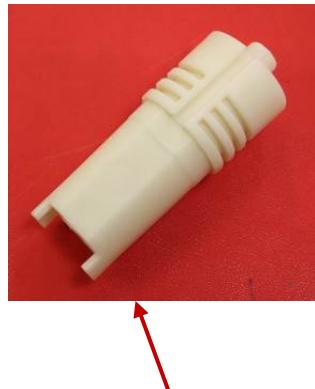
Knock the **Spring** from round end out of shafts.



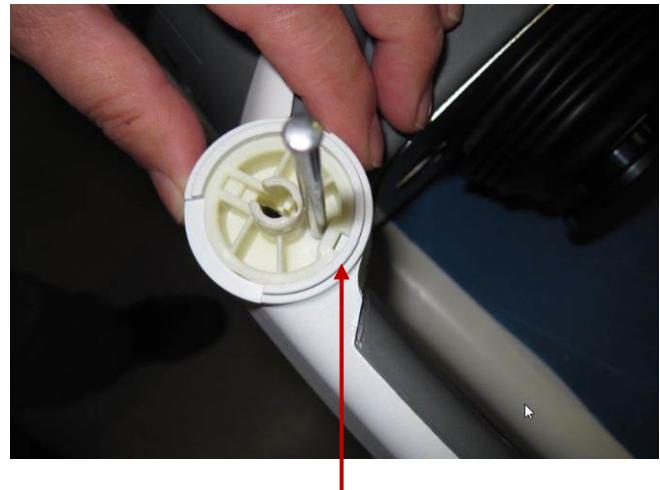
- When the **Spring** is removed from the Angle Shaft, turn the device over so the press fitted side is facing up. Using the metal Pin or similar tool and Hammer, push the bottom, non press-fitted Angle Shaft out of Support Leg. Always knock out the non press fitted Angle Shaft first.



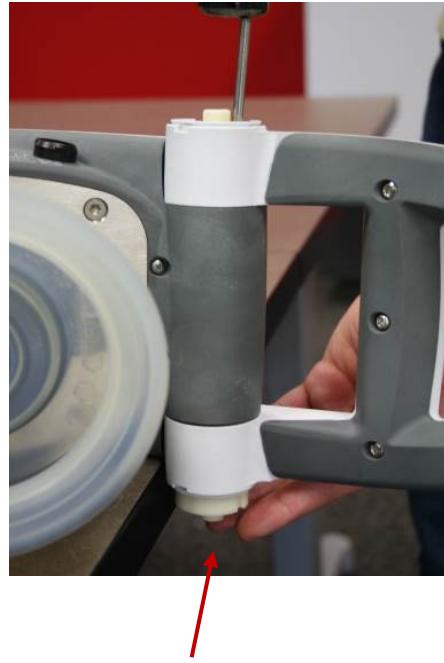
Metal Pin



Angel Shaft



Press Fitted Side with Key



The bottom, non-press fitted
Angel Shaft

- Turn the leg on the other side; and use the Angel Shaft Tool (optional tool) or similar tool with a Hammer to knock out the press fitted Angle Shaft, which is fitted into the Main Body.



Use this end to install

Use this end to remove



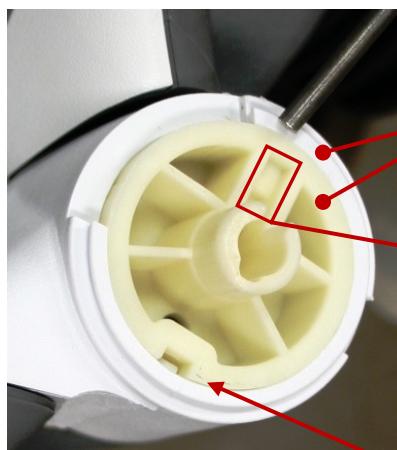
- Mandrel, LUCAS Hinge Insertion (Optional Tool) -

- Remove the Support Leg.



2. Reassembling

- With LUCAS still on the side, place the new support leg fully extended out from LUCAS.
- Insert the Angle Shafts; start with the one that is press fitted into the Main Body, oriented as picture below. Knock it down so that it is completely flush into the Support Leg.



On the same level

During this reassembling step, the keyways for the **Spring** should always be pointing towards the Compression Module on both shafts.
Note: Notch of the Angle Shaft pointing toward the claws.

- Turn LUCAS over on the other side and insert the non-press fitted Angle Shaft by hand force until it stops. Ensure that the keyways for the spring are aligned with each other.
- Insert the **Spring** with the rounded end first, all the way down through both Angle Shafts. Use a Mandrel to fully seat the spring into the Angle Shaft.



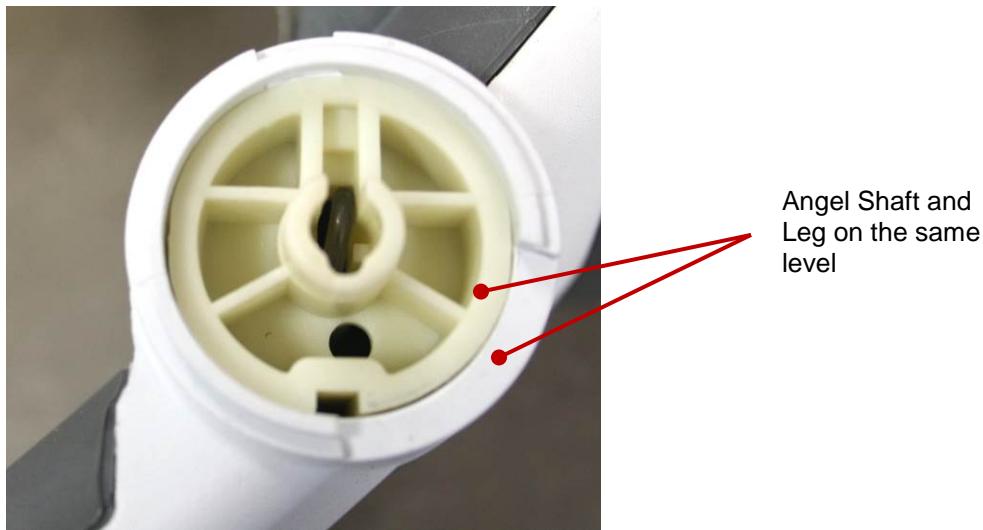
- Turn the leg inwards to its correct position.



- Ensure the L shaped end of the spring is properly seated inside the Angle Shaft.



- Carefully hammer down the Angle Shaft with a hammer and the Angle Shaft Tool (Optional Tool) or similar tool. The surface of the Angle Shaft should be on the same level as the Support Leg. Double check the L-shaped side of the spring to make sure it is still seated in the Angle Shaft. A mandrel can be used to tap it into place if not fully seated.



- Put the Patient Strap Holder in place (two sides).
- Install Snap Ring according to the picture below (two sides), place the open end of the ring downwards.



- Slide the Bumper up over the support leg (note the direction of the bumper, skirt edge should be on the bottom).
- Thread the Bumper over the shaft and the patient strap holder on both sides.



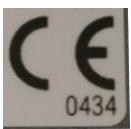
- Slide the Bumper up over the patient strap holders.
 - Skirt edge on the bottom

- Mount back the Patient Strap.



Type Label and SN

- If the replaced Support Leg has a Type Label with SN, and if possible, try to move the existing label on to the new Support Leg. If that doesn't work, contact Physio Control to get a new label with the same SN and Notified Body number.



The Notified Body number “0434” as shown in picture above may be “2460”.

3. Test

Do the following tests to verify that the repair/replacement has been performed correctly:

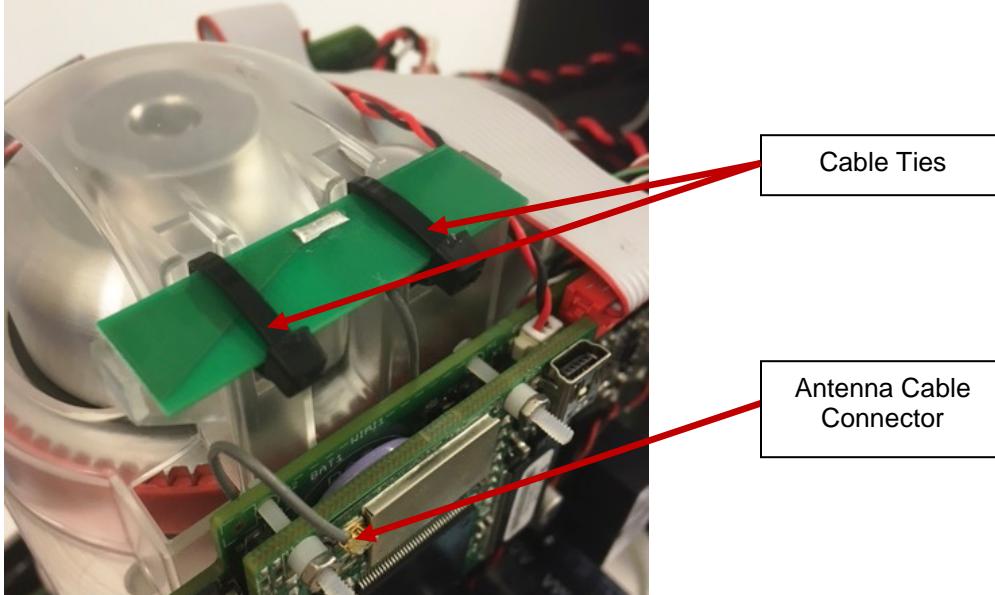
- Check the locking function by locking and unlocking against the Back Plate.

- Check the function of the torsion spring by folding and unfolding the Support Legs.
- Perform a Function Check according to [Function Check](#)

How to Replace the Antenna

1. Disassembling

- Remove the Hood according to instructions in [How to Replace the Hood](#).
- Cut out two cable ties



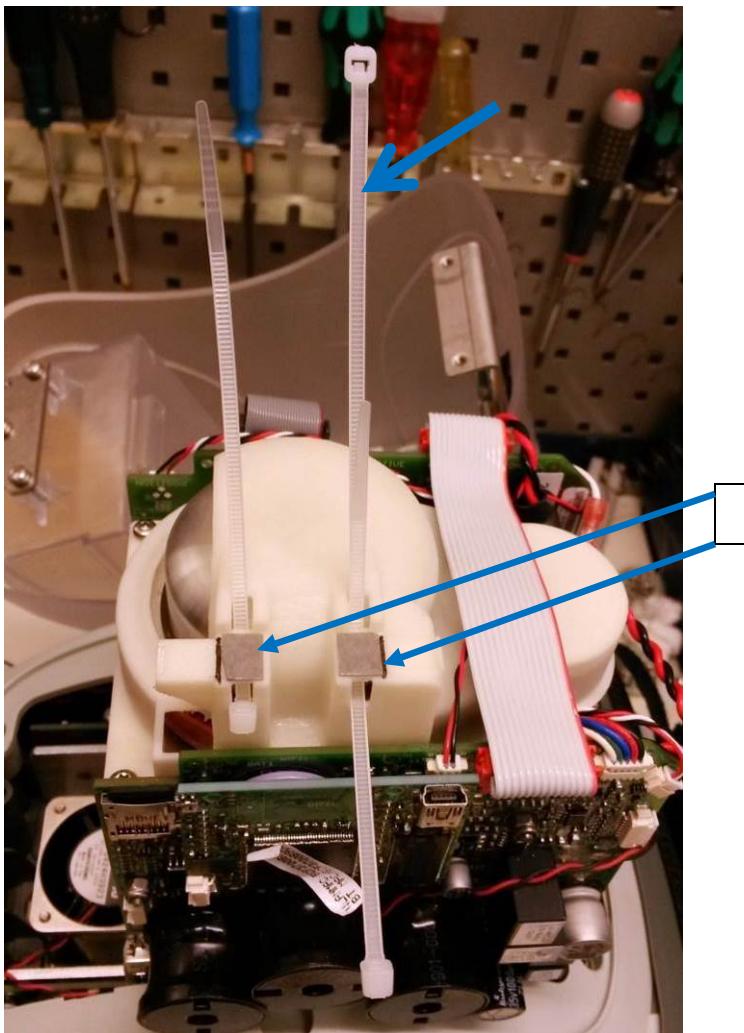
- Disconnect the antenna cable connector from Communication Board
- Remove the antenna board from the belt cover

2. Reassembling

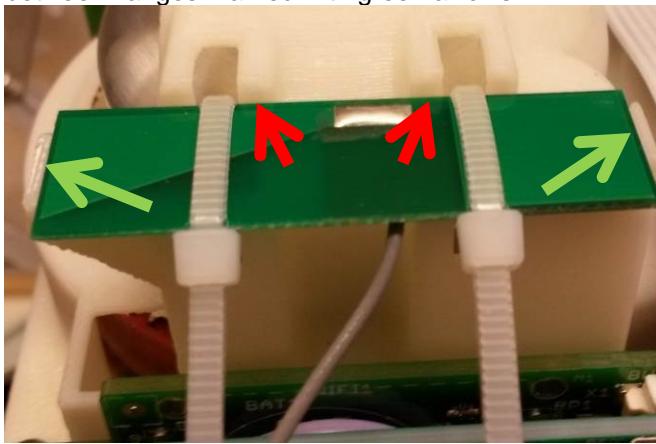
- Pre-bend two cable ties at the bend line marked in red as shown in the picture
- Bend the tip of the cable tie to make it easier go through the hole



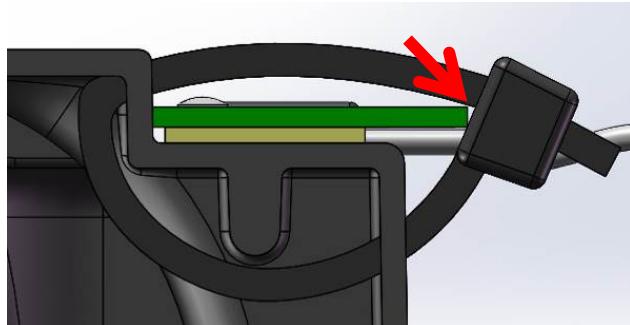
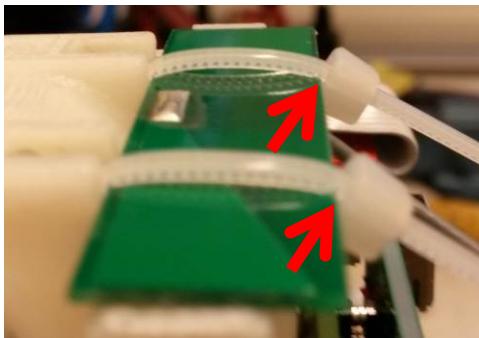
- Use a third cable tie (marked with blue arrow in the picture) to guide the cable tie through the holes



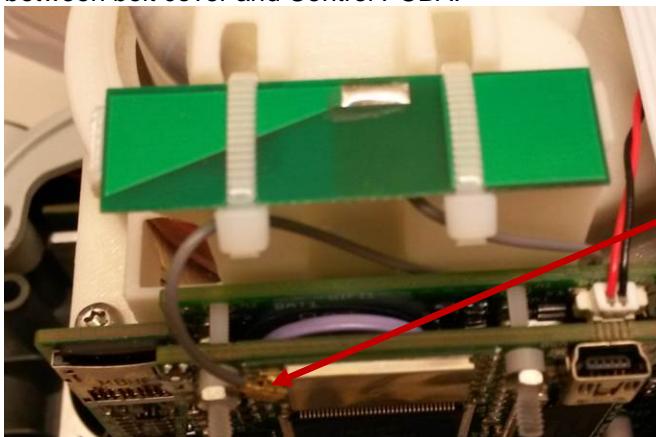
- Apply transfer tapes (approximate 7x8mm, 2x) to the belt cover, and remove the tapes protective top layer.
- Place the antenna on top of the transfer tapes and against the surfaces marked with red arrows and in between flanges marked with green arrows.



- Close and tighten the cable ties by hand until the antenna is secured as shown in the pictures below, with the cable tie closing position against the edge of the antenna board.



- Cut off the excess cable tie tails
- Connect antenna to the Communication Board and tuck away the antenna cable beneath antenna and between belt cover and Control PCBA.



Antenna Cable
Connector

- Put back the Hood according to **Reassembling** instruction in [How to Replace the Hood](#).

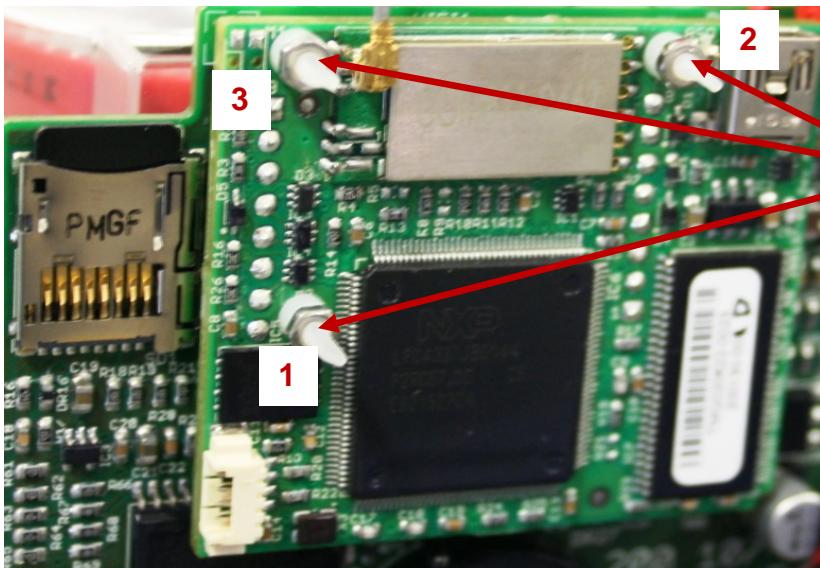
3. Test

- Perform a Function Check according to [Function Check](#)

How to Replace the Communication PCB

1. Disassembling

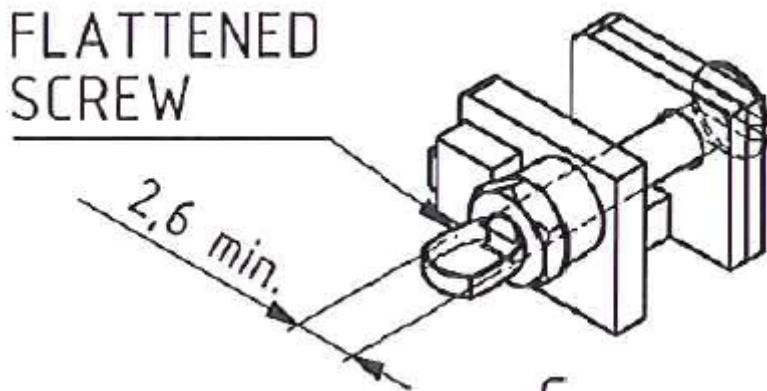
- Before disassembling and changing any PCB and if possible; connect a laptop and perform "Store View" using [LUCAS® 3 Program Loader](#).
- Follow **Disassembling** instructions in [How to Replace the Controller PCB](#) to take out the Controller PCB.
- Use a plier carefully cut off 3 plastic screws that hold the communication PCB on Controller PCB
- Save the plastic spacers and the nuts for reuse



- Remove the Communication PCB

2. Reassembling

- Put the new Communication PCB in place with the new plastic screws, plastic spacers, and the nuts
- Finger tightens screws by holding screw head lightly with fingertip until all items are tight against each other and no play is visible. Do not overtighten.
- Then use tools to tighten screw and nut $\frac{3}{4}$ of turn (270), tightening order according to the numbers shown in the picture
- Flatten screws (3x) using a non-knurled flat nose plier right up against the nut shown in the picture below



- Put back the Controller PCB according to **Reassembling** instruction in [How to Replace the Controller PCB](#)

3. Programming

- Connect a laptop and program the Protective PCB according to [LUCAS® 3 Program Loader](#).
- Check that "Device S/N", Time and Date, "Total Number of Strokes", "Hardware ID" and "Device Friendly Name" are correct (if possible check against "Store View" performed in Disassembling step). If "Store View" was not possible set: "Device S/N" (e.g. 35160021) and "Hardware ID" (e.g. 100921-00) according to Type Label, "Total Number of Strokes" to 0 (zero) and "Device Friendly Name" to "LUCAS3- + serial number according to Type Label.

4. Test

- Perform a Function Check according to [Function Check](#).

Replacing the Power Inlet

1. Disassembling

- Follow the instructions in Section Replace the Compression Module.
- Follow the instructions in Section Replace the Controller PCB
- Follow the instructions in Section Replace the Protective PCB

Warning: Always use ESD protection when handling PCB's!

- Remove the four Torx 20 screws to remove the Main Body Lid.



- Use the extraction tool to remove the wires from the Power Inlet.
- With the wires removed you can now remove the nut and Power Inlet.



2. Reassembling

- Install the Power Inlet with the white arrow on top.



- Install the Power Inlet nut and tighten to 9 in-lbs / 1.0 Nm.



- Insert the Power Inlet wires with the red on top.
- Install the Main Body Lid and tighten all four *Torx* 20 screws to 13 in-lbs / 1.5 Nm
- Re-install the Compression Module, Controller PCB, Protective PCB, and Hood.

3. Test

- Perform a Function Check according to Section Function Check.

Replacing the Main Body/Frame Assembly

4. Disassembling

- Follow the instructions in Section Replace the Compression Module.
- Follow the instructions in Section Replace the Controller PCB
- Follow the instructions in Section Replace the Protective PCB
- Follow the instructions in Section Replacing the Power Inlet.

- If replacing the Main Body follow the instructions in Section Replace the Support Legs.

Warning: Always use ESD protection when handling PCB's!

5. Reassembling

- Re-install the Power Inlet using instructions in section Replacing the Power Inlet.
- Install the Main Body Lid and tighten all four Torx 20 screws to 13 in-lbs / 1.5 Nm.
- Re-install the Compression Module, Controller PCB, Protective PCB, and Hood.
- If removed, re-install the Support Legs.

6. Test

- Perform a Function Check according to Section Function Check.

Function Check

Introduction

LUCAS® 3 is an advanced system consisting of both mechanics and electronics. After each repair or maintenance a Function Check should be performed to establish all vital functions of the device.

Mechanics Test

With the device turned off perform the following tests:

7. Piston Check

- Pull the Suction Cup down and up to check that the Decompression Spring moves smoothly and without any unusual noise.
- Pull the Suction Cup down and continue to slowly pull down until the Carry Ball Nut has reached its lower position, check that it runs smoothly and without unusual noise.
- Attention: If you push too fast you will feel resistance in steps because the Electrical Motor is affected, instead push slowly in one long stroke.
- Push the Suction Cup back up to its top position, check that it runs smoothly and without unusual noise.

8. Claw Lock Mechanism Check

- Check for play between the Release Ring and the Support Legs:
- Pull the Release Ring gently to **unlock** the mechanism and **open** the Claws.
- Move your finger around in the Release Ring; verify that you can detect some play between the Ring and the Support Leg. You should be able to hear a rattle from the play in the Ring when moving the Release Ring from side to side. If the Support Ring is tight against the Support Leg with no play, then the check has failed.



- Check for the ability of the Claw Mechanism to remain locked:
- Press the Claw Lock towards the center point of the Support leg (closed position) with your thumbs.
- When locked, press hard with two thumbs on the two claws as shown in the picture below. If the claw mechanism unlocks, then the check has failed.



Electronics Test

Turn on the device and perform the following tests:

1. Check that the Internal Function Test is performed and that the ADJUST LED shows a green light.
2. Change mode to ACTIVE (30:2) and check that the ACTIVE (30:2) LED shows a green light. Let the device run for approximately two minutes and listen for unusual noise. Check that there is an audible alert sound prior to the ventilation pause (each 30 strokes at default settings) together with an intermittent LED.
3. Change mode to PAUSE and check that the PAUSE LED shows a green light.
4. Change mode to ACTIVE (continuous) and check that the ACTIVE (continuous) LED shows a green light. The LED will then blink each ten strokes (ventilation alert).
5. Change mode to ADJUST, pull the Suction Cup down to test the Adjustment Servo. Push the Suction Cup back up to its top position. Check that it runs smoothly.
6. Connect a charger to the device and check that the charging sequence begins (the battery LED's show a "running" light). Disconnect the charger.
7. Turn the device off.
8. Testing Transmit mode by following [Connect the device via Bluetooth](#) to make connect to a PC using LUCAS® 3 Program Loader.
 - If the device has undergone Maintenance and has passed the Function Check press "Set PC Date" to change "Last Service Date".
 - If the device has undergone a Repair without Maintenance, do NOT press "Set PC Date" (a connection between the device and laptop still has to be established to check that the communication is working).
 - Press **OFF** in LUCAS® 3 Program Loader to switch off the Bluetooth communication. Check the Bluetooth light is off.

Accessories

LUCAS Battery Charger

The battery charger is sold as an accessory.

For more information about different country specific variants see the list of [Accessories](#). There are no serviceable parts in the battery charger, if broken replace with a new.



LUCAS Car Cable

The car cable is sold as an accessory with the product cat #: 11576-000048.



LUCAS Power Supply

The power supply is sold as an accessory.

For more information about different country specific variants see the list of [Accessories](#). There are no serviceable parts in the power supply, if broken replace with a new.



Appendix A (wiring diagram)

