stryker

LUCAS® 3, v3.1
chest compression system

Instructor guidebook
Classroom and hands-on training

Contents

Preface

Instructor notes

This guidebook is an introduction to the basic operations of the LUCAS chest compression system* and acts as a guide for conducting classroom and hands-on training in a manner consistent with training provided by Stryker.

Refer to the Instructions for Use (IFU) for complete directions for use, indications, contraindications, warnings, cautions and technical specifications. The IFU is included with each device.

All operators must read the complete IFU before operating the LUCAS chest compression system.

*This training is relevant for LUCAS 2, LUCAS 3 (v3.0 and v3.1). It does not include training on optional setup features (v3.1).

Chapter 1
Instructor training preparation

Instructor training preparation

Things to know before each training session

Who is your audience?

There may be a combined audience of both prehospital and hospital providers. It is helpful to know whether the audience you will be instructing will be EMTs, paramedics, nurses, etc., to tailor your examples and discussion to be the most relevant for the audience present.

How large is your audience?

- In order for the hands-on training to be the most effective, it is important to maintain an instructor to student ratio of 1:6 (one instructor to six students).
- Determine the need for additional trainers and make arrangements for resources such as LUCAS devices, manikins and training materials accordingly, prior to the training session.

Facility planning and logistics

Each training session will require a classroom setting for the "Introduction and device overview" large enough to accommodate the audience attending. In addition, there needs to be ample space for multiple small groups, with an instructor to student ratio of 1:6, to perform small group hands-on training and application practice. This may require reserving a second room for the hands-on training depending on space available in the classroom.

Training should follow the timing outlined below:

15 min.	Introduction
45 min.	Classroom training
10 min.	Break
120 min.	Small group hands-on training and application practice
5 min.	Break
30 min.	Training evaluation
15 min.	Q&A/additional hands-on (as needed)

Room layout

- Basic classroom layout should include tables and chairs for students to take notes and complete evaluations at the conclusion of the training.
- For the small group hands-on training, ensure enough floor space for hands-on training with a manikin.

Audio/visual needs

- There are several videos that will be played at the beginning of the classroom session. The room will need to be set up with a projector. A computer with internet access will allow streaming of the videos. If internet access is slow or limited the videos can be downloaded ahead of time.

Power

Ensure there is an adequate power supply and power strips for A/V equipment or in the event that LUCAS devices need to be charged.

What you need

Devices, accessories, manikins

- At least one LUCAS device and one manikin for every six students (e.g., class of 40 will require seven devices/manikins)
- Each LUCAS device in carrying case should have the following present:
  - Suction cup mounted to the piston
  - Patient straps (wrist straps), attached to support legs
  - Stabilization strap, present in carrying case with two support leg straps that buckle to support legs
  - Two charged batteries, one installed in device with spare in carrying case compartment
  - External power supply cord, present in case compartment
  - LUCAS device back plate
  - One additional suction cup
- One manikin for each LUCAS device

Training materials and handouts

(Contact your local Stryker representative for copies of these training materials:)

- LUCAS 3 device fits large patients
- LUCAS 3 device user performance evaluation form
- LUCAS 3 device training quiz
- LUCAS 3 device training answer key and annotated test
- LUCAS 3 device - First use preparation video
- LUCAS 3 device - Prehospital application video
- LUCAS 3 device - Hospital application video
- LUCAS 3, v3.1 - Implementation guide
- LUCAS 3 device quick reference guide - trifold
- Information on defibrillation and ventilation with the LUCAS device
- LUCAS 3 device instructor guidebook

Device preparation and readiness

Prior to each training session, ensure all LUCAS devices are checked and ready for use. Always complete device preparation to allow at least four hours for charging batteries.

1. Make sure a suction cup is attached to the piston.
2. Make sure the patient straps are attached.
3. Make sure the two support leg straps of the stabilization strap are buckled around the support legs with the buckles on the inside.
4. Make sure batteries are fully charged. When the LUCAS device is in the OFF mode, push the **MUTE** button. The battery indicator illuminates and shows the battery charge status.
5. Push and hold the **ON/OFF** button to turn on the device so the LUCAS device does a self-test. Make sure the **ADJUST** LED illuminates with no alarm or warning LED.
6. Push and hold the **ON/OFF** button for one second to power down the LUCAS device again.
7. Charge batteries as needed.
    - Installed in LUCAS device (power supply cord) – less than two hours
        - Put battery in the slot in the hood of the LUCAS device
        - Connect the power supply to the DC input on the side of the LUCAS device
        - The LUCAS device can be charged using the charge port in the back of the carrying case
        - Connect the power supply to the wall outlet
    - In the external battery charger (if available) – less than four hours
        - Put the battery in the slot of the battery charger
        - Connect the battery charger power cord to the wall outlet

Chapter 2
Classroom training: introduction and overview

Classroom training: introduction and overview

Introductions

Introduce lead trainer and support staff.

Confirm your audience (e.g., "By a show of hands, how many of you are EMTs? Paramedics? Nurses?" etc.)

Agenda review

Provide brief overview of the agenda for the training session:

- **Introductions**
- **Videos**
- **Introduction and overview of LUCAS device,** including intended use, indications and contraindications for use, main parts, etc.
- **Comprehensive device and operation overview**
- **Break** (15 minutes)
- **Small groups hands-on training and application practice**
- **Training evaluations**
- **Q&A**

Videos

There are three videos that can be played at the beginning of each training session. Have the videos prepared prior to starting the class. All videos available for streaming at https://www.strykeremergencycare.com/learn-and-train/videos/.

LUCAS 3 chest compression system - First use preparation

- This video provides an overview of the LUCAS device first time assembly, standard and optional accessories and device storage.

LUCAS 3 chest compression system – Prehospital application

- This video provides an overview of LUCAS device application in the EMS setting.

LUCAS 3 chest compression system – Hospital application

- This video provides an overview of LUCAS device application in the hospital setting.

Device overview

LUCAS chest compression system

The LUCAS chest compression system is a portable tool designed to overcome problems identified with manual chest compressions. The LUCAS device assists rescuers by delivering effective, consistent and continuous chest compressions as recommended in the American Heart Association Guidelines for CPR[1] and the European Resuscitation Council guidelines[2]. Both human[3,4] and experimental[5,6] studies have shown that the LUCAS device can produce coronary perfusion pressures (CPP) of over 15mmHg during prolonged CPR, better than manual CPR.

Intended use

LUCAS chest compression system is to be used for performing external cardiac compressions on adult patients who have acute circulatory arrest defined as an absence of spontaneous breathing and pulse, and loss of consciousness.

The LUCAS device must only be used in cases where chest compressions are likely to help the patient.

The LUCAS device is for use as an adjunct to manual CPR when effective manual CPR is not possible (e.g., transport, extended CPR, fatigue, insufficient personnel). (U.S. Only)

Contraindications

Do NOT use the LUCAS chest compression system in these cases:

- If it is not possible to position the LUCAS device safely or correctly on the patient's chest.
- Too small patient: If the LUCAS device alerts with three fast signals when lowering the suction cup, and you cannot enter the **PAUSE** mode or **ACTIVE** mode.
- Too large patient: If you cannot lock the upper part of the LUCAS device to the back plate without compressing the patient's chest.

Always follow local and/or international guidelines for CPR when you use the LUCAS chest compression system.

Personnel

It is recommended the LUCAS device is only used by persons with medical skills such as: first responders, ambulance personnel, nurses, physicians or medical staff, who have:

- Undertaken a CPR course according to the resuscitation guidelines (e.g., American Heart Association, European Council Resuscitation or equivalent)
- AND received training in using the LUCAS device

Side effects

The International Liaison Committee on Resuscitation (ILCOR) states these side effects of CPR:[7]

> "Rib fractures and other injuries are common but acceptable consequences of CPR given the alternative of death from cardiac arrest. After resuscitation, all patients should be reassessed and re-evaluated for resuscitation-related injuries."

Apart from the above, skin abrasions, bruising and soreness of the chest are common during the use of the LUCAS chest compression system.

Clinical as well as autopsy studies have shown that LUCAS device compressions are as safe and effective for the patient as manual CPR, and with the same type of side effects as for manual CPR.[8–10]

Main components

The main parts of the LUCAS chest compression system include;

- A **back plate** which is positioned underneath the patient as a support for the external chest compressions.
- An **upper part** which contains the proprietary and rechargeable battery and the compression mechanism with the disposable suction cup.
- A **stabilization strap** which helps to secure the position of the device in relation to the patient.
- A **carrying case.**

Each part of the LUCAS device and its operation will be covered in the next section, comprehensive in-depth device and operation overview.

Comprehensive in-depth device and operation overview

Instructor notes:
Begin with a complete LUCAS chest compression system packed in the carrying case on a table at the front of the room and visible to the attendees. As you review each component and aspect of operation, physically remove the component from the case and demonstrate to the audience.

Carrying case

The LUCAS device carrying case was designed to be compact, portable, durable and easy to deploy.

Instructor notes:
Begin by demonstrating the key components of the case; the hard shell, the top window and the rear charge port. Next demonstrate how to open the carrying case and turn on the device while still in the case.

While the LUCAS chest compression system is still in the case, push the power **ON** button for one second to allow the device to perform a self-test to make sure it is ready to operate before applying it to the patient. The case and power on procedure will be reviewed in more detail later during the **application demonstration**.

Back plate

Instructor notes:
Remove the back plate from the case, explain what the picture on the back plate means and where the claw locks attach.

The graphic on the back plate is intended to provide a reminder of where to orient the back plate in relation to the patient, and where to position the piston and suction cup. (Positioning of the piston and suction cup will be explained when reviewing the upper part of the LUCAS chest compression system.)

The carbon fiber LUCAS PCI back plate is intended specifically for use in the cath lab. It is fully radiotranslucent, with minimum shadows. The PCI back plate is compatible with LUCAS 2 and LUCAS 3 devices.

Standard LUCAS back plate

Optional LUCAS PCI back plate

The back plate should be placed under the patient, immediately below the arm pits, either by lifting the patient's upper body a small distance or by rolling the patient from side to side. Accurate positioning of the back plate makes it easier and faster to position the upper part and suction cup correctly.

The rods on each end of the back plate are where the claw locks on the support legs attach the upper part to the back plate.

The LUCAS device is specifically designed to be used with the LUCAS back plate. It cannot be applied directly to any other backboard or transportation device.

Carrying case contents

Instructor notes:
Set the back plate aside. Remove the upper part from the carrying case and set aside to review contents of the bag. Show the audience where each component is located in the carrying case.

In addition to the back plate and the upper part (including battery), the LUCAS device is delivered with:

- Two disposable suction cups—one will be attached to the LUCAS device, and one will be packaged and in the mesh storage compartment.

There is a storage compartment in the middle of the carrying case that can hold a spare battery and a battery charger.

The stabilization strap is also placed in the bag where it can be easily accessed. When returning the stabilization strap to the carrying case, loosen the strap and roll it for the next use.

Upper part

Instructor notes:
Highlight all of the components of the upper part of the LUCAS device. Point out each component and demonstrate. Note: some parts, such as the control panel, may be difficult to see from a distance. Explain that attendees will have a chance to review all of these components up close during the hands-on portion of the training.

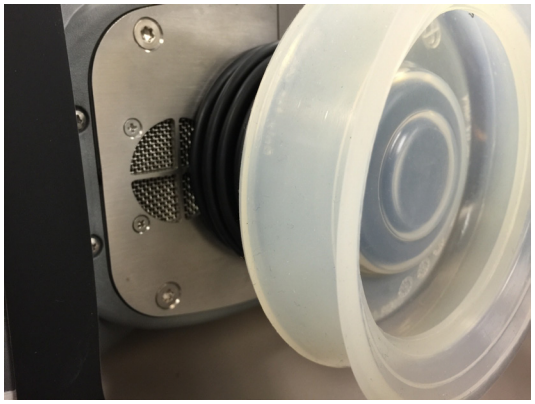
The hood of the LUCAS device contains the battery and the user control panel. Internally, the hood houses the compression module and all of the electronics of the LUCAS device.

Do not immerse the LUCAS device in liquid. The device can be damaged if liquid enters the hood.

Underneath the hood of the LUCAS device are the vent holes. Do not block the vent holes as this can cause the device to become too hot.

The LUCAS device has an IP43 rating, which is the level of ingress protection against particulate matter (first number) and liquid (second number). A rating of 3 for liquid indicates protection against spraying water, such that water falling as a spray at any angle up to 60 degrees from the vertical will not have a harmful effect. This is consistent with what you would expect from rainfall.

Instructor notes:
After showing the vent holes under the hood, point out the pressure pad at the end of the piston and suction cup.



Underneath the hood is the piston, which contains the pressure pad and the suction cup.

The pressure pad is at the end of the piston. The pressure pad acts as the heel of your hand when performing manual CPR, it is what makes contact with the chest when performing compressions. The compression point should be in the middle of the chest, at the same spot as for manual CPR and according to current Guidelines.

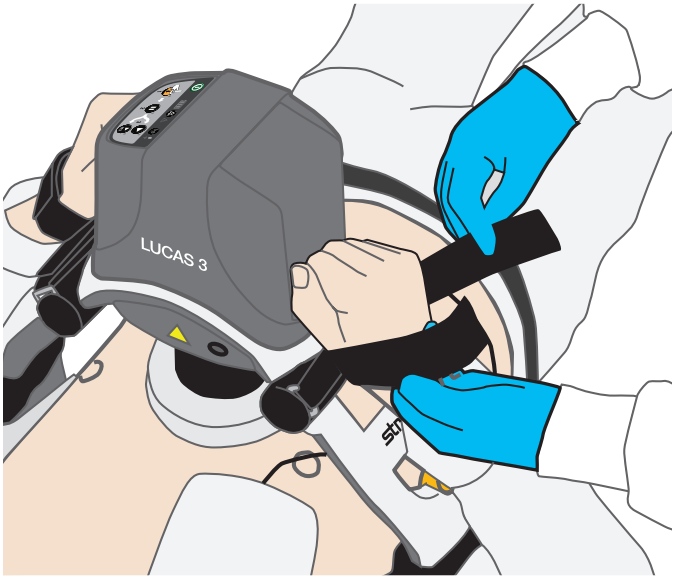
When the pressure pad in the suction cup is in the correct position, **the lower edge of the suction cup is immediately above the end of the sternum bone. The lower edge of the suction cup should not be placed over the tip of the sternum (xiphoid process), but over the lower edge of the main body of the sternum.**

If the pressure pad is not in the correct position, there is an increased risk of damage to the rib cage and the internal organs. Also, the patient's blood circulation is compromised.

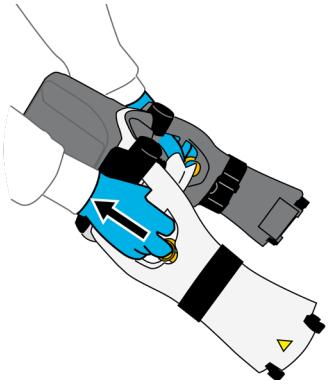
The suction cup is disposable and should be replaced after each use. To replace the suction cup, pull it off the black mounting tube and discard it. Bend a new suction cup back onto the tube and make sure it is safely attached.

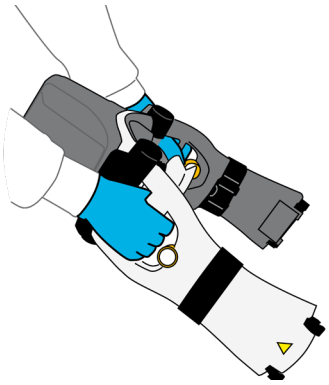
The **support legs** contain several components:

- The **patient straps** – When you move the patient, you can secure the patient's arms with the patient straps on the LUCAS device. This makes it easier to move the patient. Do not use the straps for lifting, and make sure that IV access is not obstructed.



- The **release rings** – The release rings operate the **claw locks**, which attach the upper part to the back plate. These are used for removing the LUCAS device from the back plate. However, before applying the upper part, you should pull the release rings once to make sure the claw locks are open, then release the rings.





It is important you release the rings when attaching the upper part to the back plate so the claw locks can click onto the back plate. Listen for the click and make sure the parts are correctly attached by pulling up on the device.

Instructor notes:
Point to the claw locks and demonstrate opening a closed claw lock by pressing one side closed, and pulling the release rings once to demonstrate opening the claw locks.

- **Support leg strap for the stabilization strap** – The stabilization strap helps secure the correct position during operation. Apply it while the LUCAS device is active to keep interruptions to a minimum. Delay the application of the stabilization strap if it prevents or delays any medical treatment of the patient.
- Once the device is active:
  - Remove the stabilization strap from the carrying case and extend the strap fully at the buckles.
  - Carefully position the cushion of the stabilization strap behind the patient's neck, as close to the patient's shoulders as possible.
  - Connect the buckles on the support leg straps to the buckles on the stabilization strap. Make sure straps are not twisted.
  - Hold the LUCAS device support legs stable and tighten the stabilization strap. Only tighten as much as needed to secure the device. Be careful not to pull the device out of position.

Instructor notes:
Attach the upper part of the LUCAS device to the back plate. In the next section you will demonstrate the too small patient alarm and explain the control panel.

Control panel

The control panel is intended to be simple and easy to use, and after you turn the device on, the steps are numbered 1 through 3.

The **ON/OFF** button is in the top left of the control panel in the gray bar. Push and hold this button for one second to power up or power down the LUCAS device. When the device powers up, it automatically does a self-test of the functions and the protective system. When the self-test is complete, the green LED beside the **ADJUST** key illuminates. This takes approximately three seconds.

- When you are using the LUCAS device, the very first thing you do, even before taking it out of the carrying case, is to press the **ON/OFF** button and turn the device on.

The orange button is the **ADJUST** button. It is also labeled with a "1". When you turn the device on, it automatically enters the ADJUST mode, which is used to adjust the position of the suction cup. When you push this button, you can manually move the suction cup up or down. To adjust the start position of the suction cup, manually push down the suction cup, extending the piston with two fingers onto the chest of the patient, ensuring the pressure pad touches the patient's chest.

Press the **PAUSE** button, labeled with a "2", to lock the piston in the start position. Also, use this when you want to stop the device and temporarily pause compressions but still want to keep the start position of the suction cup.

There are two **ACTIVE** modes on the device. One is **ACTIVE (continuous)** and the other is **ACTIVE (30:2)**.

In **continuous mode** the device will perform continuous compressions at 102 ± 2 compressions per minute; use this setting if the patient is intubated. The green LED next to the button for continuous mode will blink ten times per minute to alert for ventilation during ongoing compressions.

When you push the **ACTIVE (30:2)** button, the device will perform 30 compressions, then temporarily stop for three seconds to allow for giving two ventilations, and continues this cycle. An intermittent LED in combination with an alarm signal sequence on the 28th, 29th and 30th compression will alert the operator before each ventilation pause.

On the top of the control panel, in the middle of the gray bar, are the **MUTE** button and the **alarm indicator**.

Pushing the **MUTE** button will mute the alarm for 60 seconds. If you push this button when the device is powered OFF, the battery indicator will show the charge status of the battery.

On the **alarm indicator**, a red LED and alarm signal indicate a malfunction. If there is a malfunction while the device is performing chest compressions, push **ON/OFF** for one second to stop the device, remove the device, and perform manual CPR immediately to minimize interruptions in compressions.

If your protocols allow, you can attempt to reset the alarm once by pushing **ON/OFF**, removing and replacing the battery and following proper steps to deploy the device in the **APPLICATION DEMONSTRATION** section of this guide.

TRANSMIT data: This key is used to transmit data after the use of the LUCAS device. The device must be in power OFF mode to transmit data.

More information about data will be covered in the **'LUCAS 3, v3.1 - Implementation guide'**.

Caution - Radio frequency communications can affect other medical electrical equipment.

Battery

The battery is in the hood, opposite the control panel. The lithium polymer battery has a runtime of 45 minutes when fully charged. If the battery is fully depleted, it takes less than two hours to charge when the power supply cord is used, and less than four hours in the standalone battery charger.

In the center of the top row of the control panel is the **battery indicator**. Three green LEDs show the charge status.

- Three green LEDs means the battery is fully charged
- Two green LEDs means the battery is 2/3 charged
- One green LED means the battery is 1/3 charged

If you see one intermittent yellow LED and hear an intermittent alarm during operation, it means the battery has less than 30 percent capacity, or approximately 10 minutes of operating capacity left. (For a complete list of battery indicators, refer to the Instructions for Use.)

The status of the battery charge can be evaluated without removing the device from the carrying case. Simply pressing **MUTE** through the top window, will illuminate the battery indicator.

To minimize interruptions, having a charged spare battery in the carrying case is always recommended. When the battery gets low during operation, it can be replaced by a new one without turning the device off. To change the battery during operation:

1. Press **PAUSE** to temporarily stop compressions
2. Pull the battery out and then upwards to remove it
3. Install a fully charged spare and wait until the green **PAUSE** mode LED illuminates
4. Push either **ACTIVE (continuous)** or **ACTIVE (30:2)** to start chest compressions again

If the battery change takes less than 60 seconds, the LUCAS device Smart Restart feature remembers the settings and start position for 60 seconds. If the battery change takes more than 60 seconds, the device does a self-test and you must adjust the start position again.

If there is no spare battery present, the device can be connected to the power supply in all operating modes. **The battery must always be installed for the device to be able to operate, including when it is powered by the external power supply.** The power supply connects to the LUCAS device just below the hood. The device can run for as long as needed on a nominal patient chest when connected to the power supply.

It is recommended to replace the battery every three to four years or after 200 uses of more than 10 minutes each time.

Instructor notes:
Turn the LUCAS device on. Point out the self-test. Demonstrate moving the piston up and down.

Patient size

Remember, do not use the LUCAS device if the patient is too small (the LUCAS device alarms with three fast signals and you can't enter the **PAUSE** or **ACTIVE** modes) or if the patient is too large (you can't lock the upper part to the back plate without compressing the patient's chest).

When the LUCAS device was launched in the United States, a survey of four different EMS systems on the use of the device on over 300 patients showed that it fit 95 percent of patients. Of those who didn't fit, 3 percent were too large and 2 percent were too small.[11] This was also confirmed in the LINC Trial, a large, randomized controlled trial including 2,589 patients in Europe who received LUCAS device chest compressions.[10]

The LUCAS device will fit patients with:

- Chest width up to 44.9 cm / 17.7 inches
- Sternum height of 6.7 to 17 - 30.3 cm / 11.9 inches

The use of the device is not restricted by patient weight.

If the device does not fit on the patient, remove the device and immediately perform manual CPR.

Instructor notes:
Make sure the LUCAS device is on. Demonstrate the too small patient alarm by slowly pulling the suction cup down until device alarms with three fast signals. Slowly lift the suction cup until the signals stop and then leave the suction cup there to demonstrate the approximate sternum height of a patient that is too small for the device.

Preparation for next use

To remove the LUCAS device, press the **ON/OFF** ⏻ button for one second to power off the device. If a stabilization strap is attached, remove the cushion of the stabilization strap from the support leg straps and loosen the stabilization strap for next use. Then, pull the release rings to remove the upper part from the back plate.

After each use you should remove the suction cup, and clean the device and straps and let it dry. You should also replace the battery with a fully charged one and mount a new suction cup.

Clean all surfaces and straps with a soft cloth and warm water with a mild cleaning agent or disinfectant agent:

- 70 percent isopropyl alcohol solution
- 45 percent isopropyl alcohol with added detergent
- Quaternary ammonium compound
- 10 percent bleach
- Peracetic (peroxide) acid solutions

Follow the handling instructions from the manufacturer of the disinfectant.

When putting the device back in the carrying case, ensure the DC input is placed downward. Putting the LUCAS device in this position makes it possible to charge the device through the carrying case charger access port and to check battery charge status through the carrying case top window. Loosen the stabilization strap and place it in the bag so it is ready to go the next time you deploy the device. Slide the back plate into the pocket in the lid of the carrying case. Close the lid of the case and zip it closed.

A full list of steps to prepare the LUCAS device for the next use is in the IFU.

Application demonstration

Instructor notes:
Put a half manikin (Brad™ CPR Manikin or comparable) on the floor or table and ask for a volunteer to help by performing manual chest compressions while you apply the LUCAS device.

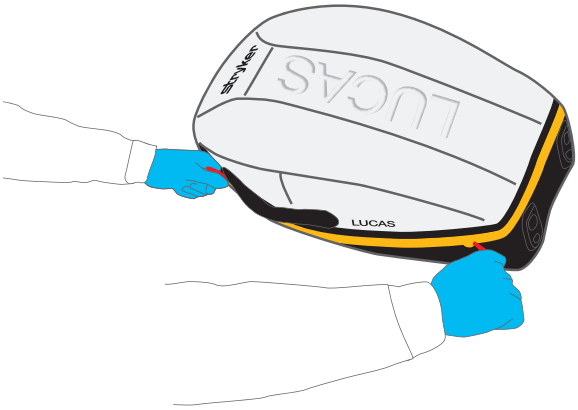
Arrival at the patient

After confirming the patient is in cardiac arrest, manual CPR should be started immediately until the LUCAS device is ready.

Unpack the LUCAS device

The LUCAS carrying case was designed to be quick and easy to deploy.

- Using the large zipper handles, unzip the case.



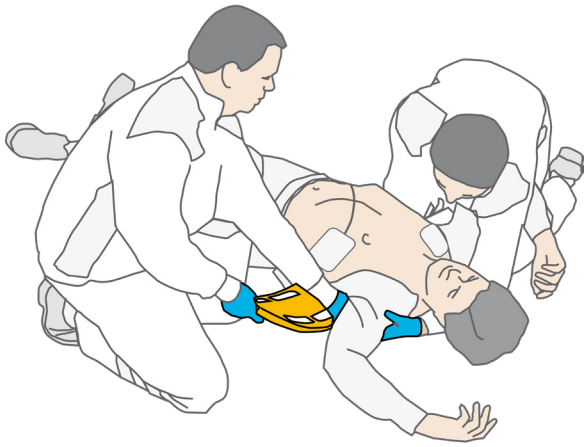
- While the device is still in the bag, push the **ON/OFF** button for one second to power on the device. You will hear a few tones while the device does its self-test to make sure it's ready to operate before applying to the patient.

Apply the LUCAS device to the patient

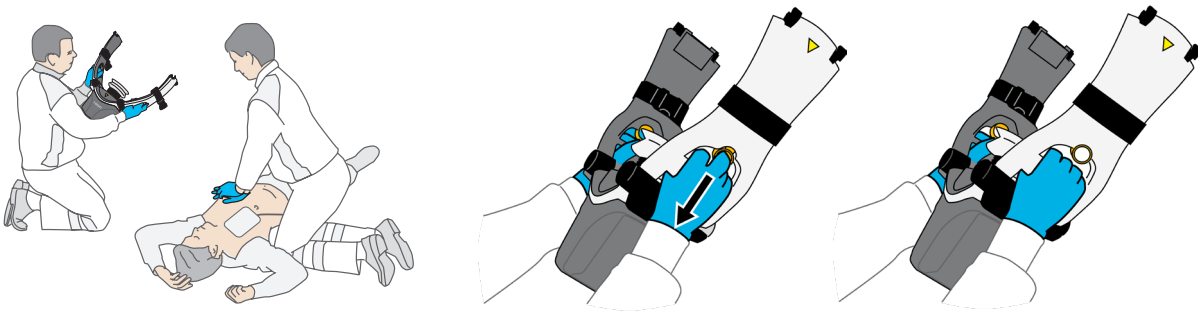
Always apply the device with minimal interruptions in compressions. This can be done in two brief pauses.

1. Remove the back plate from the carrying case.

2. Temporarily stop manual CPR while placing the back plate under the patient, immediately below the armpits. You can use several procedures to do this: either lift the patient's torso and slide the back plate under from the head, or log roll the patient and slide the back plate in from the side.



3. Start manual CPR again.
4. Hold the handles on the support legs to remove the LUCAS device upper part from the case. Pull the release rings once to make sure that the claw locks are open, then let go of the release rings.



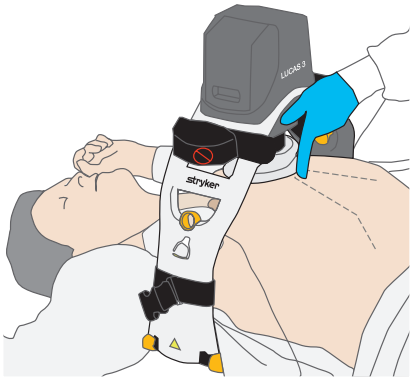
5. Attach the support leg that is nearest you to the back plate.

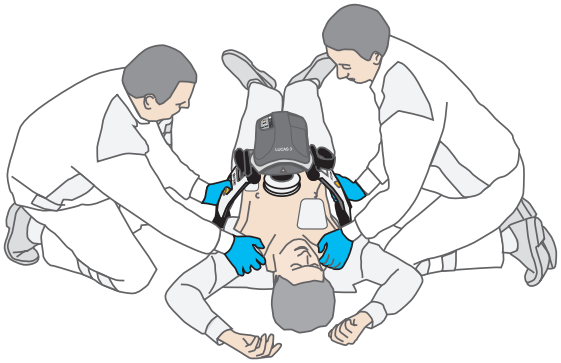
6. Move the other support leg through the arms of the responder doing manual CPR and stop manual CPR while you attach the support leg to the back plate. Ask your partner to assist with attaching the second support leg if needed. Listen for a click.
7. Pull up once to make sure the parts are correctly attached.

Adjustment and operation

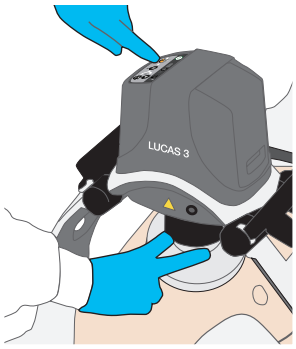
Remember, the compression point should be at the same spot for manual CPR according to the Guidelines. When the pressure pad in the suction cup is in the correct position, **the lower edge of the suction cup is immediately above the end of the sternum, but not over the xiphoid process.**

1. Use your finger to make sure the suction cup is immediately above the end of the sternum. If necessary, move the device by pulling the support legs to adjust the position.





2. Adjust the height of the suction cup to set the start position. This is the position where the LUCAS device will start its two-inch compressions, and the point where it will return the chest for full recoil.



   - Make sure the LUCAS device is in **ADJUST** mode
   - Push the suction cup down with two fingers until the pressure pad touches the patient's chest without compressing it
   - Push **PAUSE** to lock the start position
   - Check for proper position. If you need to reposition:
     - Push **ADJUST**, pull the suction cup up, move the device by pulling the support legs, push the suction cup down until the pressure pad touches the chest, then push **PAUSE** once back in place
   - Push either **ACTIVE (continuous)** or **ACTIVE (30:2)**

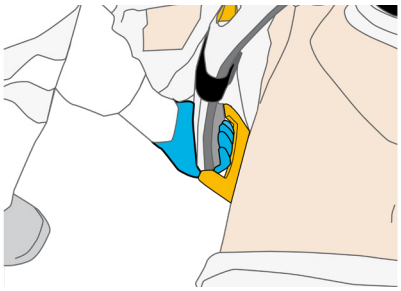
Notes:

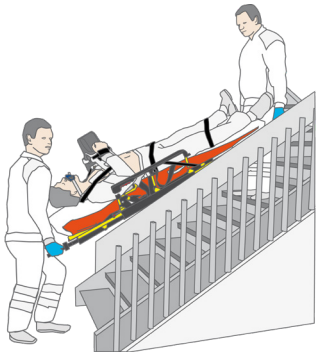
- The LUCAS device has a "quick fit" feature, so if the pressure pad is pushed down too hard, or not touching the chest fully, the device will adjust the pressure pad by up to 30 mm /1.2 inches in either direction to the correct start position.
- Some users will use a marker to draw a line on the chest around the top and/or bottom of the suction cup to help monitor placement during operation.

The stabilization strap helps secure the correct position during operation. Apply it while the LUCAS device is active to keep interruptions to a minimum. Delay the application if it delays any medical treatment of the patient. The stabilization strap is not a neck stabilization strap but a device stabilization strap. The stabilization strap can fit and be put on the outside of a c-collar.

Moving the patient

When you move the patient, you can secure the patient's arms by placing their wrists in the patient straps on the LUCAS device. This makes it easier to move the patient, but DO NOT lift the patient by the patient straps. Make sure that IV access is not obstructed.





To move a patient, the LUCAS device can be used on a backboard, carrying sheet or other transportation device. After you have made a decision about what equipment you will use and where to put the transportation device, you can prepare to lift the patient.

(**Note**: The LUCAS device cannot be connected directly to a backboard. The back plate must be used. The whole system can be used on top of a backboard or other transportation device.)

Those at the patient's side can put one hand below the claw locks under the support leg and with the other hand, hold the patient's belt, pants or under the thigh.

To lift the patient:

1. Push **PAUSE** to temporarily stop compressions.
2. Lift and transfer the patient to a stretcher or other transportation device (backboard, carrying sheet, vacuum mattress or similar).
3. Make sure the suction cup is in the correct position on the patient's chest.
4. Push one of the **ACTIVE** buttons to start compressions again.

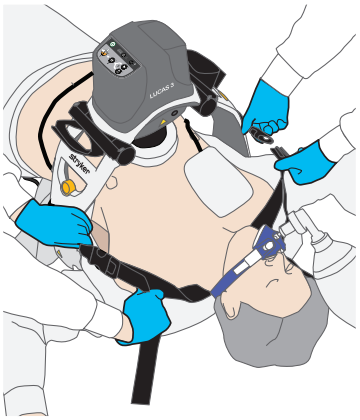
The device can be active when you move the patient, including at an angle, as long as the device and the patient are safely positioned on the transportation device and the device stays in the correct position and angle on the patient's chest.

Always monitor the position of the suction cup. If the position changes during movement, immediately push **ADJUST** to adjust the position. Always use the stabilization strap to help secure the correct position.

Defibrillation

Defibrillation can be performed while the LUCAS device operates.

- You can apply the defibrillator electrodes before or after the LUCAS device has been put in position, but you should never delay defibrillation of a shockable rhythm to apply the device.
- Position the electrodes and wires so they are not underneath the suction cup. If there are already electrodes on the patient, make sure they are not under the suction cup. If they are, apply new electrodes.
- Perform defibrillation according to the instructions from the defibrillator manufacturer.



After defibrillation, make sure the suction cup is still in the correct position. If necessary, adjust the position.

Always follow your protocols regarding defibrillation.

Note:

- Chest compressions interfere with ECG interpretation. Push **PAUSE** to temporarily stop compressions before you perform a rhythm check with a manual defibrillator or analysis with an AED. Once ECG rhythm check or AED analysis is complete, you can immediately press either **ACTIVE (continuous)** or **ACTIVE (30:2)** to continue compressions to help make the interruption as short as possible.

Ventilation

The optimal method of managing the airway during cardiac arrest will vary depending on the provider experience, EMS or healthcare system protocols, and the patient's condition.

With a non-secured airway (e.g., bag-valve-mask), use the **ACTIVE (30:2)** mode so the LUCAS device performs 30 compressions then pauses for three seconds to allow for two ventilations. With a secured airway (e.g., endotracheal tube), ventilation and chest compressions do not need to be synchronised and ventilations can be provided without pausing compressions. Use the **ACTIVE (continuous)** mode. A green LED will blink 10 times per minute to alert for ventilation. Current AHA and ERC Guidelines[1,2] recommend 10 ventilations per minute and limited tidal volume to achieve chest rise. Avoid rapid or forceful breaths.

Always follow your protocols regarding ventilations for patients with a secured airway in place.

Q&A, 15 minute break

Instructor notes:
Prepare for transition to small group hands-on training and application practice. Depending on the number of students, divide the room into groups of no more than six students for every instructor by counting off around the room sequentially up to the number of groups (e.g., if there are 36 people in the class, there will be six groups of six, so have each person count sequentially up to six, then start over). The numbers correspond to the group they will be in after the break.

Chapter 3
Small group: hands-on training and application practice

Small group: hands-on training and application practice

The small group hands-on training and application practice is intended to ensure each student exhibits competency and is comfortable with the operation and application of the LUCAS device to be able to reproduce the hands-on training for their peers.

Learning objectives

Upon completion of the small group hands-on training, students will be able to:

- Locate all buttons and indicators on the control panel and describe their function
- Explain the difference between the two active operating modes of the LUCAS device
- Demonstrate proper placement of the back plate
- Understand how to minimize interruptions to manual CPR during LUCAS device application
- Apply the upper part of the LUCAS device to the back plate and demonstrate proper positioning of the suction cup
- Demonstrate how to adjust the position of the suction cup if necessary
- Describe the function of the stabilization strap and demonstrate its application
- Demonstrate how to change the battery during operation
- Verbalize/demonstrate post-use data transmission, including what tool is used and what data is captured
- State the considerations for defibrillation when using the LUCAS 3 device
- Understand the importance of resuming manual CPR if the device alarms or does not operate properly
- Successfully complete the LUCAS 3 device user performance evaluation
- Reproduce the hands-on training for their own staff

Roles, responsibilities and expectations

Instructors:

Instructors will lead a group of no more than six students and evaluate their performance as they apply the LUCAS device. Instructors should emphasize that high-quality CPR with minimal interruptions is the goal, and the device should always be complemented by minimally interrupted high-quality manual CPR before and during application. Instructors are expected to demonstrate the application of the device according to the following guide and the user performance evaluation. The instructor will complete a user performance evaluation for each student once the student feels confident applying the device and has demonstrated device application at least three times. The instructor will provide feedback on each student's performance, including any steps in the user performance evaluation that were missed or performed incorrectly, and will require the student starts from the beginning until all steps are completed.

Students:

Students are expected to be engaged and actively participate in the small group hands-on training. They will be expected to ask questions during the detailed overview if clarification is necessary. Students are required to apply the LUCAS device until they exhibit competency and confidence in the operation and application of the device after no less than three times applying the device. Finally, they will take the role of instructor to demonstrate their ability to train others in the application of the device.

Instructor notes:
Each instructor for the small group hands-on training will need the following materials:

- One LUCAS device with all of the accessories included in the carrying case
- One Brad CPR manikin (or comparable training manikin)
- Handouts for each student:
  - LUCAS 3 device fits large patients
  - LUCAS 3 device user performance evaluation form
  - LUCAS 3 device chest compression system training quiz
  - LUCAS 3 device training answer key and annotated test
  - LUCAS 3 device - First use preparation video
  - LUCAS 3 device - Prehospital application video
  - LUCAS 3 device - Hospital application video
  - LUCAS 3, v3.1 - Implementation guide
  - LUCAS 3 device quick reference guide - trifold
  - Information on defibrillation and ventilation with LUCAS device
  - LUCAS 3 device instructor guidebook

Detailed step-by-step overview

The following outline is intended to help guide instructors through the key points to be covered during the demonstration.

- General overview
  - User control panel
  - Active operating modes
  - Battery and battery indicator, external pow
  - Removing the LUCAS device, replacing suction cup
  - Data capture and review
- Operation
  - Case placement, powering ON the device, and applying the back plate
  - Removing upper part from case and attaching to back plate
  - Adjusting/readjusting the suction cup and positioning on chest
  - Active modes and associated prompts
  - Stabilization strap
  - Defibrillation
  - Patient transportation
  - Changing battery during the LUCAS device operations
  - Data transmission and review

Instructor notes:
With users following along on the user performance evaluation, walk through each step before doing a live action, full-speed demonstration.

Each numbered step below corresponds with a step in the **User performance evaluation** form.

Start with the LUCAS device in the carrying case, next to the Brad manikin and ask for a volunteer to perform manual CPR on the manikin:

1. Opens case; presses **ON/OFF** ⏻, for one second to start self-test and power up the LUCAS 3 chest compression system.

- **Key points:**
  - Carrying case was designed to be fast and easy to deploy.
  - To open, grab the zipper handles and unzip the case.
  - Make sure users see how the device is oriented in the bag, point out that the charge port is facing down to ensure the device can be charged while in the case, and where the **ON/OFF** ⏻ button is located.
  - You'll hear several tones when the device is turned on. These sounds are a self test.
  - Note: The LUCAS device powers down automatically after 5 minutes in the **ADJUST** mode.

2. Removes back plate from the case.
3. Verbalizes "stop manual CPR" to other rescuer.
4. Places back plate under patient, immediately below patient's armpits.

- **Key points:**
  - Reiterate the back plate can be oriented in either direction and the graphic is only intended to provide a reminder of where to orient the back plate in relation to the patient, and where to position the piston and suction cup.
  - To place the back plate, you can either lift the patient's torso and slide the back plate under from the head or log-roll the patient and slide the back plate in from the side.
    - If using a Brad manikin (or comparable), demonstrate lifting the torso.
  - Explain that an accurate position of the back plate makes it easier and faster to position the suction cup correctly.

5. Verbalizes "Resume manual CPR" to other rescuer.
6. Lifts upper part of LUCAS 3 device from case and pulls once on the release rings to check the claw locks are open, then lets go of rings.

- **Key points:**
  - **Let go of the release rings when attaching the upper part to the back plate.** Pulling them once is only to ensure that the claw locks are open and will snap onto the back plate. To demonstrate why you pull the release rings before attaching the upper part, manually close one of the claw locks and show what happens when the release rings are pulled.
  - Demonstrate that an effective way to remove the LUCAS device from the carrying case is for the user to place their thumbs in the top opening of the handle, and while grasping the handle, one finger can be placed in release rings so that removing the device and ensuring the claw locks are open can be done in one fluid motion.

7. Connects the upper part to the backboard – starting on the side closest to user. Listens for click.

- **Key points:**
  - The purpose of attaching the side closest to the user first is to allow manual compressions to continue with minimal interruptions while the person applying the LUCAS device swings the other support leg through the other rescuer's arms.
  - If necessary, the other rescuer, when they are stopping manual CPR, can grab the support leg and help guide it into position.

8. Pulls up once to ensure attachment.
9. Positions the suction cup immediately above the end of the sternum in the center of the chest and adjusts if necessary.

- **Key points:**
  - Demonstrate physically feeling for the end of the sternum and guiding the suction cup into place.
  - Demonstrate how to adjust the position of the suction cup by grasping both sides of the suction cup and lifting when device is in **ADJUST** mode.

10. Pushes the suction cup down using two fingers with the device in **ADJUST** mode until the pressure pad inside the suction cup touches the patient's chest.
11. Pushes **PAUSE** to lock start position.
12. Presses **ACTIVE (30:2)** or **ACTIVE (continuous)** .

- **Key points:**
  - Reiterate that 30:2 should be used with an unsecured airway (i.e., using a bag valve mask) and users can switch to continuous without having to pause compressions once an advanced airway is in place.

13. Fully extends the stabilization strap at the buckles.
14. Places the cushion of the stabilization strap under patient's neck.
15. Connects buckles on support cushion straps to device straps.
16. Tightens support cushion straps firmly.

- **Key points**:
  - Reiterate the purpose of the stabilization strap is to help secure the correct position during operation, and should not be tightened more than needed.
  - Delay the application of the stabilization strap if it prevents or delays any medical treatment of the patient.

17. Check for proper position of suction cup, adjusting if needed.

- **Key points:**
  - Some people will use a marker and draw a line on the chest around the top and/or bottom of the suction cup to help monitor placement during operation.
  - The rescuer managing the airway can help inspect the position of the suction cup from the head, making sure it is centered on the chest.

Instructor notes:
After walking through each step, with LUCAS device still applied to the manikin, demonstrate changing the battery during operation (hot swap) and where the external power supply is connected if necessary.

With LUCAS device operating in one of the ACTIVE modes:

1. Retrieve a charged spare from the carrying bag
2. Pause the compressions and remove the battery
3. Insert the new battery and press **ACTIVE** once the green LED next to the **PAUSE** button is lit

- **Key points:**
  - Point out the port for the external power supply.
  - Explain the device can operate for prolonged periods while on external power but emphasize that a battery always needs to be installed in the device for it to operate.
  - Explain you must detach the power supply cord by pulling back on the plastic connector. Do not pull the cable directly as this can damage the charging port.

Instructor notes:
After demonstrating changing the battery during operation, pause compressions and discuss the considerations for defibrillation while using the LUCAS device.

With LUCAS device paused, emphasize the following:

1. Make sure no pads or wires are under the suction cup. If the patient already has pads applied they may need to be replaced.
2. During a rhythm check or AED analysis you'll need to stop compressions by pressing the **PAUSE** button (manual or mechanical compressions interfere with rhythm analysis).
3. To minimize interruptions and resume CPR as soon as possible, you can charge and defibrillate the patient without removing the LUCAS device and while compressions are ongoing.

- **Key points:**
  - Compressions cause artifact in the rhythm – as soon as rhythm check or AED analysis is complete, compressions can be resumed.
  - After shock is delivered, you should always check placement of the suction cup to make sure it hasn't moved out of place. This is why using a marker to mark the placement of the suction cup can be helpful.

Instructor notes:
Before placing LUCAS device back into the carrying case to prepare for student applications, discuss cleaning and demonstrate how to remove the suction cup.

Press and hold ON/OFF ⏻ for one second to power down the LUCAS device, and emphasize the following steps to prepare device for the next use:

1. Before placing LUCAS device back in the bag, clean it as necessary.

- **Key points:**
  - All surfaces and straps can be cleaned with a soft cloth and warm water with a mild cleaning agency or disinfectant agent, such as a 70 percent isopropyl alcohol solution.
  - A full list of cleaning solutions is found in the IFU.
  - Don't immerse the LUCAS device in liquid. It can be damaged if liquid enters the hood.

2. To remove the suction cup, peel it off of the black mounting tube. Bend a new suction cup onto the black mounting tube and make sure it's fully seated and safely attached by spinning the suction cup and giving it a gentle tug.
3. To transmit post-event data from the LUCAS device, ensure it is turned off, then press the **TRANSMIT** button. Further instructions about data transmission can be found in the **'LUCAS 3, v3.1 - Implementation guide'** insert.
4. Remember to place the LUCAS device with the charge port facing down into the case. This ensures the battery status can be checked through the top window and the device can be charged while remaining in the carrying case.

Real-time application demonstration

Instructor notes:
After providing the detailed, step-by-step demonstration of the LUCAS device, demonstrate the entire application process without explaining each step so students can see the application in real-time.

After the full speed demonstration, each student will take turns applying the device. When students exhibit competency and confidence in the operation and application of the device after no less than three applications, use the student's user performance evaluation to evaluate their performance.

Student device application

Each student will take turns practicing applying LUCAS device with a partner performing manual CPR during the initial steps of device application.

Each student should apply LUCAS device at least three times, and until they are comfortable and confident applying the device.

After each student has applied LUCAS device at least three times, confirm whether they feel comfortable and confident applying device. If there are any aspects of device application the students are not comfortable with, review and demonstrate them again with the group.

Instructor notes:
Emphasize to the group the form is intended to provide constructive feedback on their LUCAS device application and is not meant to be punitive. The goal is to prepare instructors for their peers, by ensuring knowledge and competency with the LUCAS device.

For students who need extra time or assistance, inform them there will be an opportunity at the end of the training to spend extra time practicing LUCAS device application.

Completing the user performance evaluation

Ask each student to provide you with their LUCAS 3 device user performance evaluation form.

As each student demonstrates applying the LUCAS device, follow along on their user performance evaluation form and mark whether each step was completed.

Using a stopwatch or the stopwatch feature on a cell phone, time the student's application of the device, starting the timer right after step six when manual compressions stop for attachment of the upper part. Stop the timer at step 12, as soon as they press either **ACTIVE (30:2)** or **ACTIVE (continuous)** and start LUCAS compressions. **The goal is to complete steps seven through 12 in less than 20 seconds to minimize interruptions to chest compressions at device application.** Note this time on the form. If the time is >20 seconds, repeat the evaluation of the student.

After each application, review the steps the student did well, then provide positive, constructive feedback on any steps they did not complete. After reviewing any missed steps, give the student the option of repeating the application again or waiting until others have completed their evaluation before making another attempt.

Note: There will be extra time at the end of the training for additional practice for those who are not comfortable or who were unable to complete Steps seven through 12 in less than 20 seconds.

After completing the LUCAS 3 device user performance evaluation form for each student, they will now take the role of instructor and teach the instructor how to apply the LUCAS device.

Student teach-back

Students must demonstrate their ability to perform the detailed step-by-step overview of how to apply the LUCAS device prior to the end of the hands-on training and application practice.

Each student will take turns acting as the instructor while the instructor takes the role of the student.

Instructor notes:
As each student teaches LUCAS device application, ask questions as needed to ensure the student covers each step appropriately.

At the conclusion of the hands-on training and application practice, return to the classroom for training evaluation.

Chapter 4
Training evaluation

Training evaluation

Instructor notes:
Before the training evaluation begins, distribute copies of the training evaluation and feedback form and the LUCAS device training quiz.

The training answer key and annotated test should be distributed once the quiz has been completed and answers reviewed with the class.

The training evaluation includes each student completing an evaluation and feedback form and training quiz, and receiving an annotated answer key and performance evaluation.

LUCAS 3 device training quiz: This is a 20 question quiz, including 10 multiple choice and 10 true/false questions related to important information covered during the training. Students must complete the quiz individually.

When all quizzes have been completed, review the answers to the quiz as a group, using the answer key as a guide. The students will also be provided with a **LUCAS 3 device training answer key and annotated test**. This is a version of the training quiz that includes the correct answers highlighted in yellow. Under each question there is an explanation of the answer from the IFU, including the page numbers where the answers can be found.

LUCAS device training evaluation and feedback form: Students are strongly encouraged to complete this form and leave it with the instructor (or other person designated on the day of the training) prior to departing to provide feedback on the training conducted and offer comments and/or suggestions for improvements.

Students are encouraged to do refresher trainings at least once a year.

Appendix A
Important contacts

Important contacts

Customer service

Phone: 1.800.442.1142 (U.S.), 800.895.5896 (Canada)
Hours of operation: 5 a.m. to 4 p.m. PST
Web: strykeremergencycare.com > Service & support > Customer service

Technical support

Phone: 1.800.442.1142
Hours of operation: 6:00 AM to 4:00 PM PST
Web: strykeremergencycare.com > Service & support > Technical support

Sales and service support

For sales and service related needs, please contact your local Stryker representative. You can use the "Find a sales rep" feature on our website (strykeremergencycare.com > Service & support > Find a sales rep).

General LUCAS 3 device inquiries

Product Manager, LUCAS chest compression system
LUCAS@stryker.com

Appendix B
Frequently asked questions

Frequently asked questions

The following are frequently asked questions related to the LUCAS device. For all pricing or ordering-related questions, refer to Appendix A: Important Contacts and contact your local Stryker representative. For product-related questions not addressed below, please contact: strykeremergencycare.com. Select your country at the top of the page and select 'contact us' or send an email to a LUCAS device product manager at LUCAS@stryker.com.

Q: Can the LUCAS device be used on pediatric patients?

A: The LUCAS device is not indicated for use on pediatric patients. It is indicated for "performing external cardiac compressions on adult patients who have acute circulatory arrest…" Patients eligible for treatment with the LUCAS device include adult patients who fit the device, with a sternum height of 17.0 to 30.3 cm / 6.7 to 11.9 inches.

Always follow local protocols for definition of adult versus pediatric patients.

Q: Can the LUCAS device be used on a pregnant patient?

A: In case of special circumstances such as pregnant women, there are no specific LUCAS device recommendations, but the caregiver should refer to the current American Heart Association (AHA) or European Resuscitation Council (ERC) Guidelines.

The 2020 AHA Guidelines state in Part 3: Adult Basic and Advanced Life Support:[1]

- Priorities for pregnant women in cardiac arrest should be provision of high-quality CPR and relief of aortocaval compression through left lateral uterine displacement.
- Because pregnant patients are more prone to hypoxia, oxygenation and airway management should be prioritized during resuscitation from cardiac arrest in pregnancy.
- Team planning for cardiac arrest in pregnancy should be done in collaboration with the obstetric, neonatal, emergency, anesthesiology, intensive care, and cardiac arrest services.

Always follow local protocols and/or international Guidelines for CPR when you use the LUCAS device.

Q: Can the LUCAS device be used on trauma patients?

A: There is no contraindication for trauma. Traumatic injuries can be of varying types and severities, so the professional rescuer who is treating the individual patient must use clinical judgment to determine when or when not to provide chest compressions.

The LUCAS device must only be used in cases where chest compressions are likely to help the patient.

Q: Is it OK to use the LUCAS device if the patient is a woman with breast implants?

A: We do not have any clinical data on how the LUCAS device affects breast implants.

Q: Can we use the LUCAS device on a patient who has had a sternotomy?

A: The 2020 AHA Guidelines have published the following recommendations for cardiac arrest after cardiac surgery:[1]

- External chest compressions should be performed if emergency resternotomy is not immediately available.
- In a trained provider-witnessed arrest of a post-cardiac surgery patient, immediate defibrillation for VF/VT should be performed. CPR should be initiated if defibrillation is not successful within 1 minute.
- For patients with cardiac arrest after cardiac surgery, it is reasonable to perform resternotomy early in an appropriately staffed and equipped ICU.
- Open-chest CPR can be useful if cardiac arrest develops during surgery when the chest or abdomen is already open, or in the early postoperative period after cardiothoracic surgery.
- In post-cardiac surgery patients who are refractory to standard resuscitation procedures, mechanical circulatory support may be effective in improving outcome.

Taking this information and the LUCAS Instructions for Use into consideration, the physician or medical director can best determine whether it is appropriate to use the LUCAS device for patients with cardiac arrest after cardiac surgery.

Q: I've heard the LUCAS device provides such good circulation to the brain that patients can "wake up" while they are still in cardiac arrest. What do we do if this happens?

A: A potential consequence of high-quality CPR (correct depth, rate, minimum of interruptions) is increased blood flow to the brain and the heart, which may result in CPR-induced consciousness in individual patients.[12] There have been numerous anecdotal reports of patients becoming alert while still in cardiac arrest during LUCAS compressions, only to become unconscious again when the device is paused. An observational study on 328 out-of-hospital patients treated with LUCAS found that 16% of the patients showed motoric symptoms (grimaces, restlessness, trismus and/or open eyes) during LUCAS compressions, despite still being in cardiac arrest.[13]

In circumstances such as this, there are no specific LUCAS device recommendations. You must follow your local protocols and/or medical direction.

The International Liaison Committee on Resuscitation (ILCOR) doesn't currently have any recommendations for either pharmaceutical or physical management of CPR-induced consciousness.[14]

Overall, the incidence and management of CPR-induced consciousness are not well described. An article published in *Resuscitation* reported the results of a systematic review that aimed to identify cases in published literature where CPR-induced consciousness is mentioned.[15] The review identified reports describing 10 patients who experienced CPR-induced consciousness, using both manual and mechanical CPR methods. In all of the cases, purposeful arm movements were observed. There were also reports of agonal breaths, eye opening and localizing painful stimuli. Cases also include both verbal and non-verbal communication with the rescuers. A few patients were even able to understand and adhere to instructions given to them, and there were also instances of agitation and attempts to push the rescuer away.

In four of the 10 cases, sedation was used, including use of morphine, diazepam and Midazolam.

The conclusion of the literature review is as follows:

> "CPR may induce consciousness but this is infrequently reported in the medical literature. Treatment strategies for CPR-induced consciousness varied widely, and included physical restraint, administration of benzodiazepines and/or opiate, or no specific management. The incidence, implications and prognostic value of CPR-induced consciousness remains unknown. Increased awareness by rescuers of the presence of CPR-induced consciousness and development of consensus-based guidelines to treat this condition are required."[15]

Always follow your local protocols.

Q: Can the LUCAS device be used at an angle, such as when going up and down stairs?

A: Yes. The LUCAS device can be used at an angle, as long as the device and the patient is safely positioned on the transportation device and device stays in the correct position and angle on the patient's chest (refer to the IFU Section "Lift and move the patient"). If the position of the suction cup changes, immediately push **ADJUST** and adjust the position. Always use the LUCAS stabilization strap to help secure the correct position. Some customers mark the start position of the suction cup on the chest with a pen to simplify identification of suction cup migration. Fixation/straps might be required. Always ensure the patient is properly strapped to the transportation device, according to locally approved procedures.

Q: Can the LUCAS device be used in a helicopter?

A: The LUCAS 3 device has been tested according to EN 13718-1:2014 Medical vehicles and their equipment - Air ambulances Part 1: Requirements for medical devices used in air ambulance. This includes random vibration and shock tests during operation, and stored in bag, in accordance with IEC 68-2-64 test Fh with RTCA/160G, section 8, category U/U2 as reference; and lEC 60068-2-29, test Eb with RTCA/160G, section 7 as reference, as well as drop and low pressure tests.

In addition, the LUCAS 3 device has also been tested according IEC 60601-1-2 for electromagnetic compatibility – which is a similar test as RTCA/DO-160F section 21 categories L, M and H tests done on the LUCAS 2 device.

The LUCAS 3 device retains the same form, fit and function as the LUCAS 2 device and tests done show the LUCAS 3 and LUCAS 2 devices have similar type of electromagnetic performance.

The LUCAS 2 device has been tested according to section 21 in the RTCA/DO-160F, environmental Conditions and Test Procedures for Airborne Equipment which is a standard for environmental test of avionics hardware. The LUCAS 2 device complies with the radiated emission (category L) and with the conducted emission (category L, M and H). This means the LUCAS 2 device does not influence nor is influenced by the flight environment in this test.

More tests might be required for use in different helicopters or within different organizations. In addition, the LUCAS 3 and LUCAS 2 devices have been tested in a number of other tests such as road ambulances and other set ups.

Q: Can we use the LUCAS device in the rain?

A: The LUCAS device has an IP43 rating, which is the level of ingress protection against particulate matter (first number) and liquid (second number). As defined in international standard IEC 60529 (Ed. 2.1, clause 4.1) a rating of 3 for liquid indicates protection against spraying water, such that "water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect".

Do not immerse the LUCAS device in liquid. The device can be damaged if liquid enters the hood.

Q: Can the LUCAS device be attached directly to a backboard?

A: The device must be attached to the LUCAS back plate and cannot be directly attached to a backboard or stretcher. The LUCAS device is designed, tested and validated to be used only with the LUCAS back plate.

Q: Do we need to pause the LUCAS device to intubate?

A: A manikin study has shown it is possible to intubate during LUCAS compressions.[16] Depending on skill level, experience and the individual patient, providers may be able to intubate without pausing the LUCAS device.

Q: What do we do first, apply LUCAS device or defibrillate the patient?

A: LUCAS is an adjunct to manual CPR. Always, and immediately, start manual CPR at cardiac arrest. Early ECG analysis, and defibrillation if indicated, is linked to good outcomes. The LUCAS device can be applied with minimal interruption to CPR, however, application of the device should not delay defibrillation of a patient in a shockable rhythm or cause excessive interruptions in CPR. This should be considered when incorporating the LUCAS device into your cardiac arrest resuscitation protocol.

A growing number of protocols from LUCAS device users describe well-defined timing for the application of the device and steps to minimize CPR interruptions and avoid delays in defibrillation, including:

- Performing one or two full cycles of manual CPR prior to using the LUCAS device
- Requiring a defibrillator or AED to be applied before the LUCAS device
- Using a two-step application process, targeting longest pause of 10 seconds or less (placing the back plate during a planned pause, then attaching the upper part in a second planned pause)[17]

Always follow your local protocols when using the LUCAS device.

Q: Can defibrillation be performed while the LUCAS device is running and plugged into the external power supply?

A: Defibrillation can be performed while the LUCAS device operates and is gaining power through the external power supply. The battery must always be installed for the LUCAS device to be able to operate, also when powered by the external power supply.

- Defibrillation electrodes can be applied before or after the LUCAS device has been put in position.
- Perform the defibrillation according to the instructions from the manufacturer of the defibrillator.

- Position the defibrillation electrodes and wires so that they are not under the suction cup. If there are already electrodes on the patient, make sure that they are not under the suction cup. If they are, you must apply new electrodes.
- After defibrillation, make sure that the position of the suction cup is correct. If necessary, adjust the position.

Q: Does LUCAS provide active compression decompression during use?

A: LUCAS allows for chest recoil, but not active compression decompression beyond the baseline start position which is determined at the onset of care.

Q: Can there be anything between the LUCAS suction cup and the patient's chest?

A: There should be nothing between the LUCAS suction cup and the patient's chest. Position the defibrillator electrodes and wires so that they are not under the suction cup. If they are, you must apply new electrodes. If there is gel on the patient's chest (e.g. from ultrasound examination), the position of the suction cup can change during use. Remove all gel before you apply the suction cup for clean adhesion.

If the position of the suction cup changes during operation or during defibrillation, immediately push ADJUST and adjust the position. And start LUCAS again. Always use the LUCAS stabilization strap to help secure the correct position.

Q: How do we purchase extra suction cups, replacement straps or other accessories?

A: Contact your local Stryker representative or Customer Service for replacement accessories. Or visit our online store at www.strykeremergencycare.com/store (US Only).

Q: If the AHA or ERC guidelines change to recommend a different compression depth or rate, will the LUCAS device be updated?

A: Stryker is committed to implementing the latest standards of care in our products, and has a solid track record of offering updates to our products to meet the AHA/ERC Guidelines. Stryker will evaluate the feasibility and regulatory requirements of updates and changes on a case-by-case basis.

Q: How much force does the LUCAS device apply to the patient's chest?

A: Individual chests require different forces to be compressed 53 mm / 2.1 inches. LUCAS monitors each compression, senses and automatically adapts the force required to reach the correct compression depth on each patient.

Q: How quickly do the LUCAS batteries deplete during storage?

A: Depletion time can vary and may be influenced by ambient temperature and the age of the battery. To ensure the LUCAS device is always prepared for the next use, the battery should be checked weekly and after each use to make sure it is fully charged. When the LUCAS device is OFF, press the **MUTE** button. The battery Indicator illuminates and shows the battery charge status.

Q: When the LUCAS device is not in use, can we leave the power supply cord plugged into the device for extended periods of time without harming the battery or device?

A: The LUCAS device can be left charging without harming the device or the battery. When the battery is fully charged, it will trickle charge.

Q: How long will the LUCAS device operate when running on the external power supply?

A: There is no specified limit. When operating on the external power supply on a typical patient, the LUCAS device can run continuously for as long as needed.

Q: Can we swap out the LUCAS battery while the device is running on the external power supply?

A: Yes, press PAUSE and exchange the battery to a new one. The battery must always be installed for the LUCAS device to be able to operate, also when powered by the external power supply. If the battery indicates low charge (blinking yellow LED), change to a charged spare LUCAS battery. On a typical patient, the external power will allow LUCAS to run for as long as needed without depleting the battery.

Q: What is the typical runtime for a fully-charged LUCAS battery?

A: Typical runtime for a fully charged LUCAS battery is 45 minutes.

Q: If unused, how long does the charge in a fully charged battery last when left in the carrying case?

A: About 1 year. However, you should always check the battery charge level at least weekly or after each use to ensure it is fully charged and ready for the next use.

Q: If unused, how long does the charge in a fully charged battery last in the LUCAS device?

A: About 3 months. However, you should check the battery status and device weekly or after each use to ensure the device is ready for the next use.

Q: Can I deploy and turn on the LUCAS device in a grain silo?

A: No. Do not use the LUCAS device in conjunction with flammable agents.

Q: How do I keep the back plate from sliding on hard surfaces?

A: Optional back plate grip tape is available from your sales representative.

Q: Our system often operates in very cold environments. Is there a temperature range the LUCAS device must operate in?

A: The temperature ranges for the device are as follows, and are also included in Section 9 of the IFU:

- Operating temperature:
  - 0°C to +40°C / +32°F to +104°F
  - -20°C / -4°F for 1 hour after storage at room temperature
- Storage temperature:
  - -20°C to +70°C / -4°F to +158°F

For complete device environmental specifications, see Section 9.4 of the IFU.

Q: Are the operating and storage temperatures of the battery the same as for the LUCAS device?

A: The operating temperature of the battery is the same as for LUCAS device when it is installed in the device. The storage temperature of the battery when not installed in the device is: 0°C to +40°C / +32°F to +104°F.

For complete battery environmental specifications, see Section 9.6 of the IFU.

Q: Does the LUCAS device perform two-inch compressions on every patient that fits in the device?

A: LUCAS device will perform compressions at a depth of 53 ±2 mm / 2.1 ±0.1″ on patients with a sternum height greater than 185 mm / 7.3″.

The smallest patients (patients with a sternum height of 170 to 185 mm / 6.7″ to 7.3″) will receive 40 to 53 mm / 1.5″ to 2.1″ compressions.

Q: Does the LUCAS device affect the placement of an IO/IV?

A: IV – When you move the patient, you can secure the patient's arms with the patient straps on the LUCAS device. This is optional, and may make it easier to manage and move the patient. Make sure that IV access is not obstructed. If the IV is placed in the back of the hand, wrist, or the antecubital (bend of the elbow) and the LUCAS patient straps are used to secure the patient's wrists to the device, then there may be interference with the IV. Moving the LUCAS patient straps from the patient's wrist to the forearm instead may help avoid this interference. For the hand IV, moving the strap to the forearm may prevent venous circulation being cut off at the wrist. For the antecubital IV, moving the strap to the forearm may prevent the bend of the elbow from occluding the flow of the IV fluids.

IO – For an IO placed in the tibial plateau (in the leg just below and inside the knee), there are no issues for IO patency by LUCAS. For an IO placed in a humeral head (in the shoulder), the more you move the arm, the more likely the IO can be displaced due to the fact the needle can hit the socket or clavicle (causing displacement). If the patient's arms are secured with the LUCAS patient straps first, there is less movement of the arm to cause displacement of the IO.

Appendix C
The LUCAS device in the cath lab

The LUCAS device in the cath lab

The LUCAS chest compression system facilitates the transportation of the patient to the cath lab, and allows for catheterization and cath lab intervention during ongoing LUCAS device chest compressions. An emerging strategy for treating refractory VF cardiac arrest patients where there is a suspicion of the underlying STEMI, is to transport the patient directly to the cath lab for an emergency PCI.[18] The LUCAS device is also used as a backup tool in the cath lab in the event a PCI patient goes into a refractory, CPR-requiring cardiac arrest during a coronary intervention.[19]

The 2020 AHA and 2021 ERC Guidelines on resuscitation in the cath lab

Manual CPR during PCI is very difficult, involving compromises on circulation, intervention and/or rescuer safety. Both the AHA & ERC guidelines discuss the difficulties of manual chest compressions in certain settings:

> "The use of mechanical CPR devices may be considered in specific settings where the delivery of high-quality manual compressions may be challenging or dangerous for the providers, as long as rescuers strictly limit interruptions in CPR during deployment and removal of the device."
>
> "…the use of mechanical CPR devices by trained personnel may be beneficial in settings where reliable, high-quality manual compressions are not possible or may cause risk to personnel (i.e., limited personnel, moving ambulance, angiography suite, prolonged resuscitation, or with concerns for infectious disease exposure)."
>
> - 2020 American Heart Association Guidelines for CPR[1]

The AHA has given the use of mechanical CPR during PCI a class IIb recommendation based on LUCAS publications alone, and the LUCAS device is designed for use in the cath lab.

> "It may be reasonable to use mechanical CPR devices to provide chest compressions to patients in cardiac arrest during PCI" (Class IIb, LOE C-EO)
>
> - 2015 American Heart Association Guidelines for CPR[20]

ERC recommended in 2015:

> "It is of extreme importance that chest compressions are not interrupted for angiography. On an angiography table with the image intensifier above the patient, delivering chest compressions with adequate depth and rate is almost impossible and exposes the rescuers to dangerous radiation. Therefore, early transition to the use of a mechanical chest compression device is strongly recommended."
>
> European Resuscitation Council Guidelines 2015[21]

In the 2021 ERC Guidelines, with respect to the cardiac catheterisation laboratory, the ERC stated:

> "Consider mechanical chest compression and circulatory support devices (including ECPR)."
>
> European Resuscitation Council Guidelines 2021[22]

The LUCAS device in the cath lab

The LUCAS device is mainly made of radiotranslucent materials (transparent to x-ray), except for the hood and the piston, and a fully radiotranslucent cath lab back plate that does not interfere with the angiogram is available.

The cath lab back plate is made out of carbon fiber, which is lightweight and very strong. It can be pre-positioned in unstable patients, without compromising angiographic imaging, and allowing for quick set up in case of refractory/non-shockable arrest. The standard yellow back plate can be used as well, however the ridges of the back plate design will appear as shadows in the imaging/views of the coronary arteries.

The anterior-posterior design of the LUCAS piston means that cranial and caudal angulation views are necessary when performing angiography during the time the LUCAS device is in place. Because of its radiotranslucency except for the hood and the piston, the LUCAS device allows for all oblique projections except the straight anterior-posterior. This means the following projections can be obtained in monoplane:

- LAO cranial/caudal oblique
- RAO cranial/caudal oblique
- Straight caudal
- Straight lateral
- Straight cranial

See the **common angiographic views with LUCAS device** section of this guide for examples of angiographic views obtained with LUCAS device in place.

Applying the LUCAS device on the cath lab table

The LUCAS device is applied to the patient using the steps in the IFU. Prior to placing the device into service in the cath lab, we encourage users to practice and familiarize themselves with maneuvering the imaging equipment while the LUCAS device is in place.

Continuing the intervention during LUCAS device compressions

The interventionalist CAN catheterize, balloon and stent the patient during ongoing compressions. During stent positioning, LUCAS device might be paused to ensure a precise positioning.

LUCAS device with other circulatory supports used in the cath lab

The LUCAS device can work as a "bridge" to left ventricular assist devices (LVADs) or other extracorporeal circulation support devices or surgery, such as extracorporeal membrane oxygenation (ECMO). This means it may "buy time" for the patient by providing vital circulation while these other devices are set up for use.

Prolonged resuscitation in the cath lab

The LUCAS device facilitates prolonged rescue attempts in the cath lab. The AC power cord can be used to prolong the operation time. There was a case out of Minneapolis, MN, in which the LUCAS device provided compressions on a patient for two hours and 45 minutes. The patient survived with no neurological deficits.[23]

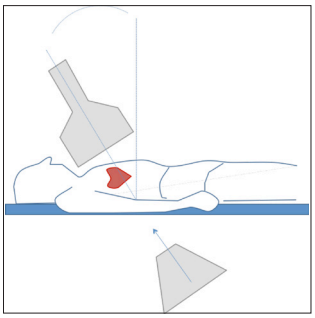
Common angiographic views with the LUCAS device

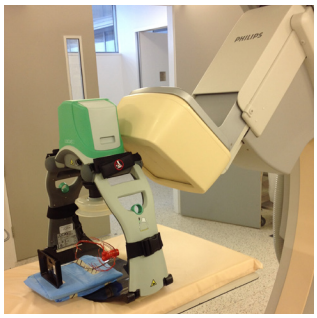
The following images are from a test performed at Liverpool Hospital cardiac catheterization lab in New South Wales, Australia.[24] The most common angiographic views were performed using Philips® Interventional Fluoroscopy System with a LUCAS device, set up with the carbon fiber back plate. A Wire Heart (Bayer Pharmaceuticals) consisting of wire coronaries attached to a plastic aorta on a metal stand with plastic base was used to depict the coronary arteries. This test showed that the LUCAS device provided clear working views in RAO-PA and RAO-PA caudal planes with workable lateral views.

Although the photographs below show a LUCAS 2 device, there is no difference in views as the LUCAS 3 device support legs and PCI plate are similar to those of the LUCAS 2 device.

Cranial view

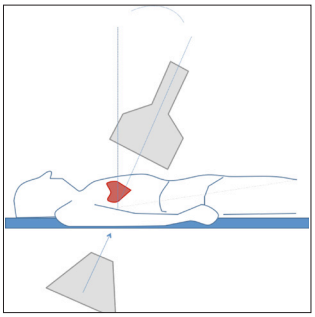
The LUCAS device allows for visualization of the coronary arteries in cranial views. The shadow of the LUCAS suction cup may be partially visible.

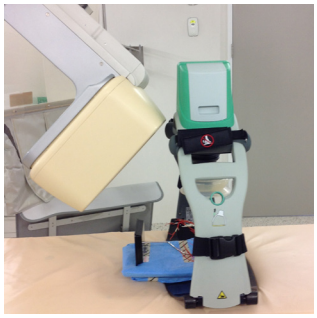




Caudal view

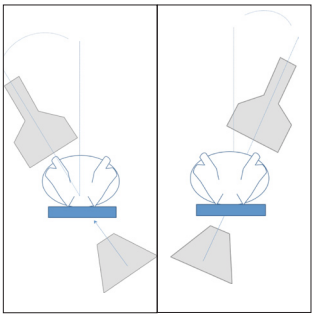
The LUCAS device allows for visualization of the coronary arteries caudal views.

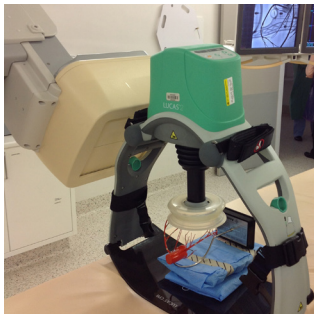




Lateral view

The LUCAS device support leg with screws causes minor artifact in lateral view.

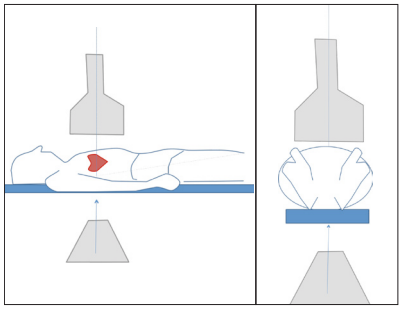




Straight posterior-anterior view

The straight posterior-anterior view cannot be used when the LUCAS device upper part is attached.

LUCAS PCI back plate (without upper part attached, in precautionary placement) allows for full visualization of arterial tree.



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24 Images courtesy of Dr. Sydney Lo, Director, Liverpool Hospital Cardiac Catheterization Lab, Sydney, Australia.

For further information, please contact Stryker at 800 442 1142 (U.S.), 800 668 8323 (Canada) or visit our website at strykeremergencycare.com

Emergency Care

This document is intended solely for the use of healthcare professionals. A healthcare professional must always rely on his or her own professional clinical judgment when deciding whether to use a particular product when treating a particular patient. Stryker does not dispense medical advice and recommends that healthcare professionals be trained in the use of any particular product before using it.

The information presented is intended to demonstrate Stryker's product offerings. A healthcare professional must always refer to operating instructions for complete directions for use indications, contraindications, warnings, cautions, and potential adverse events, before using any of Stryker's products. Products may not be available in all markets because product availability is subject to the regulatory and/or medical practices in individual markets. Please contact your representative if you have questions about the availability of Stryker's products in your area. Specifications subject to change without notice.

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!USA | Rx Only

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LUCAS® 3

CHEST COMPRESSION SYSTEM

SERVICE MANUAL

US

Table of Contents

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, PNs/CAT #: 3326785-0## / 26500-00#### Instructions for Use, LUCAS 3 Version 3.1, PNs/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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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

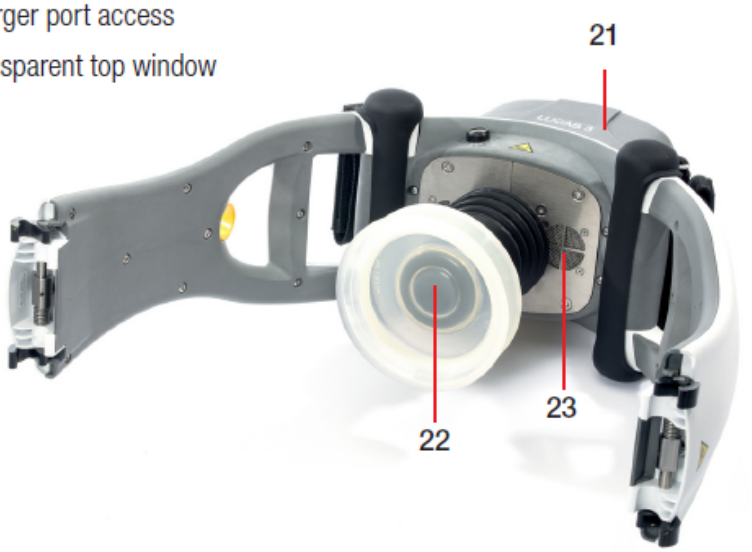
To obtain a detailed warranty statement, contact your local Physio-Control representative or go to www.physio-control.com

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

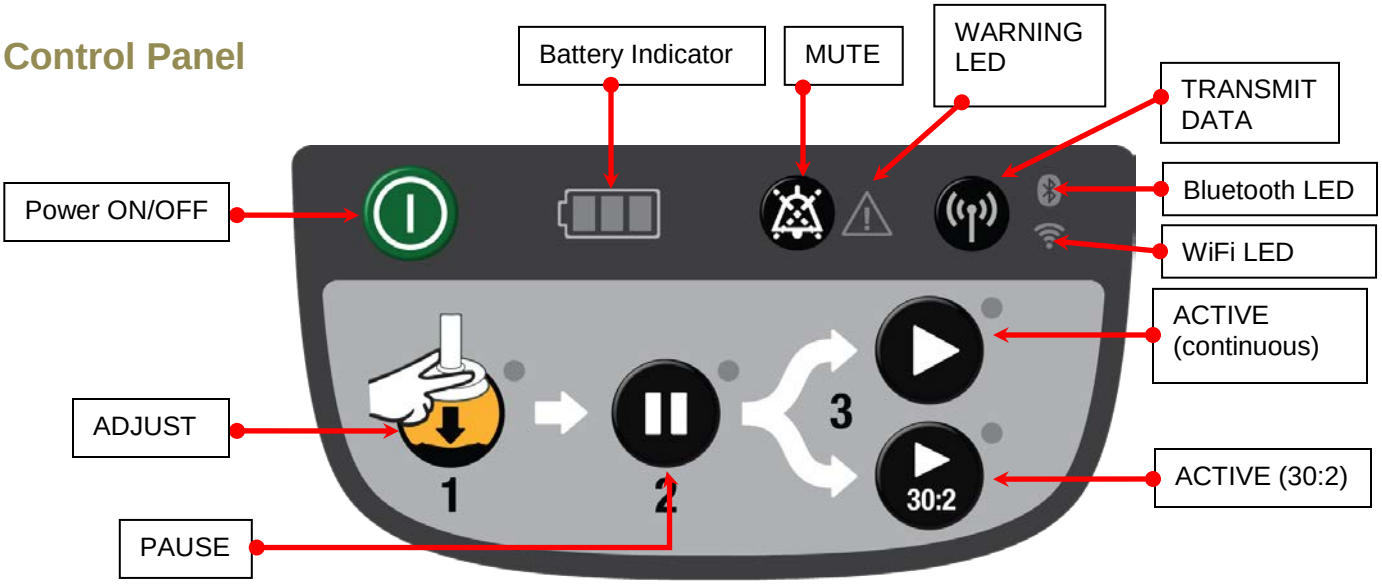
* Applied part
(according to IEC 60601-1)



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

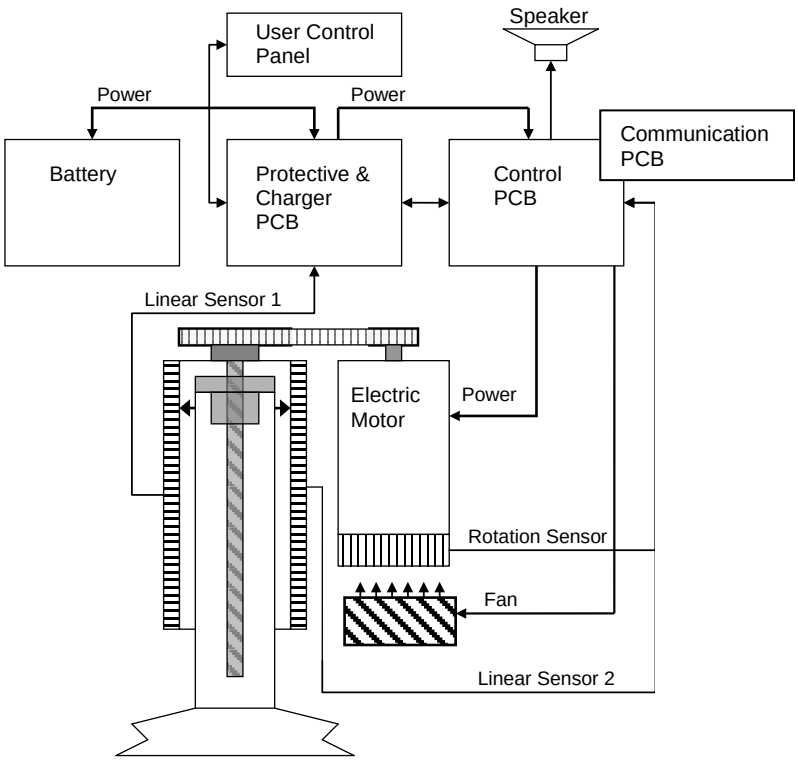
The Claw Locks automatically lock to the Back Plate when LUCAS is pressed on to it. To unlock the Claw Locks, pull the Release Rings

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

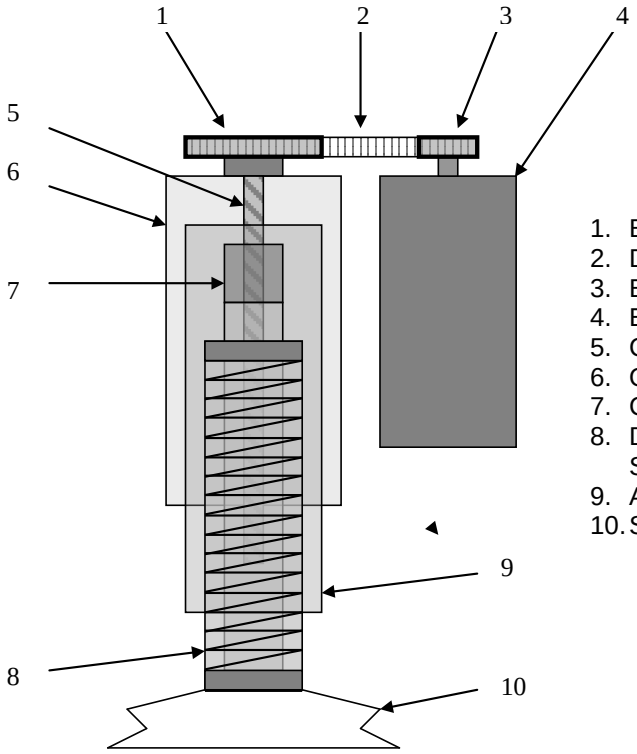
Compression Mechanism

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.

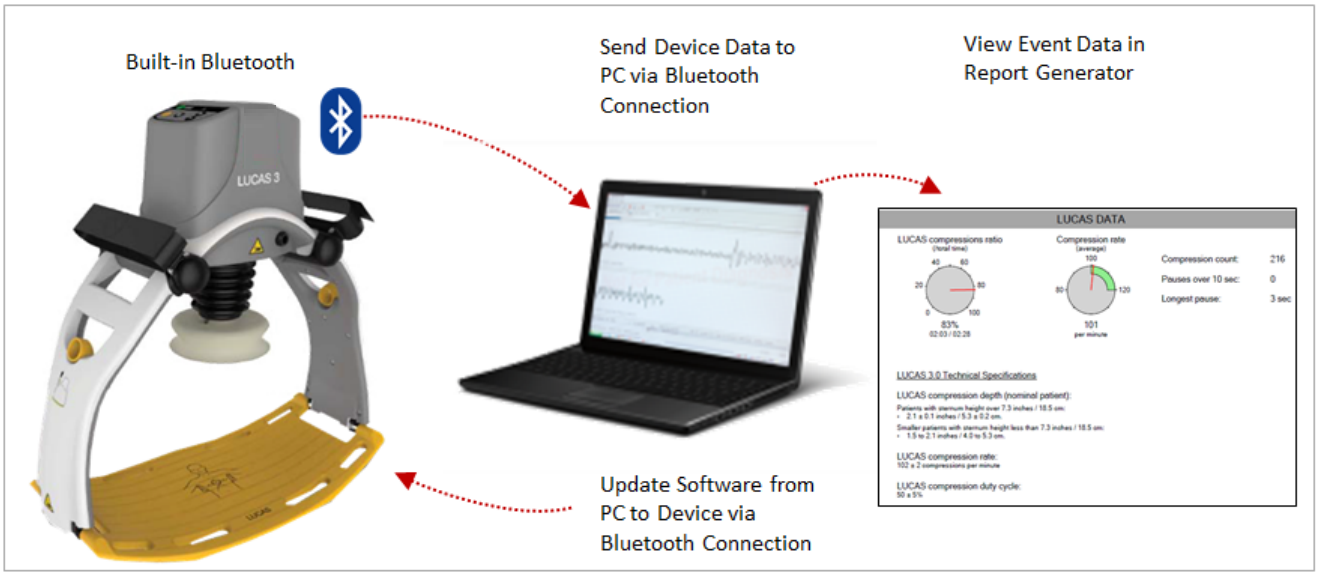
The **Decompression Spring** reduces the upstroke force.

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.



1. Belt Wheel Large
2. Drive Belt
3. Belt Wheel Small
4. Electric Motor
5. Carry Ball Screw
6. Outer Tube
7. Carry Ball Nut
8. Decompression Spring
9. Adjustment tube
10. Suction Cup

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.

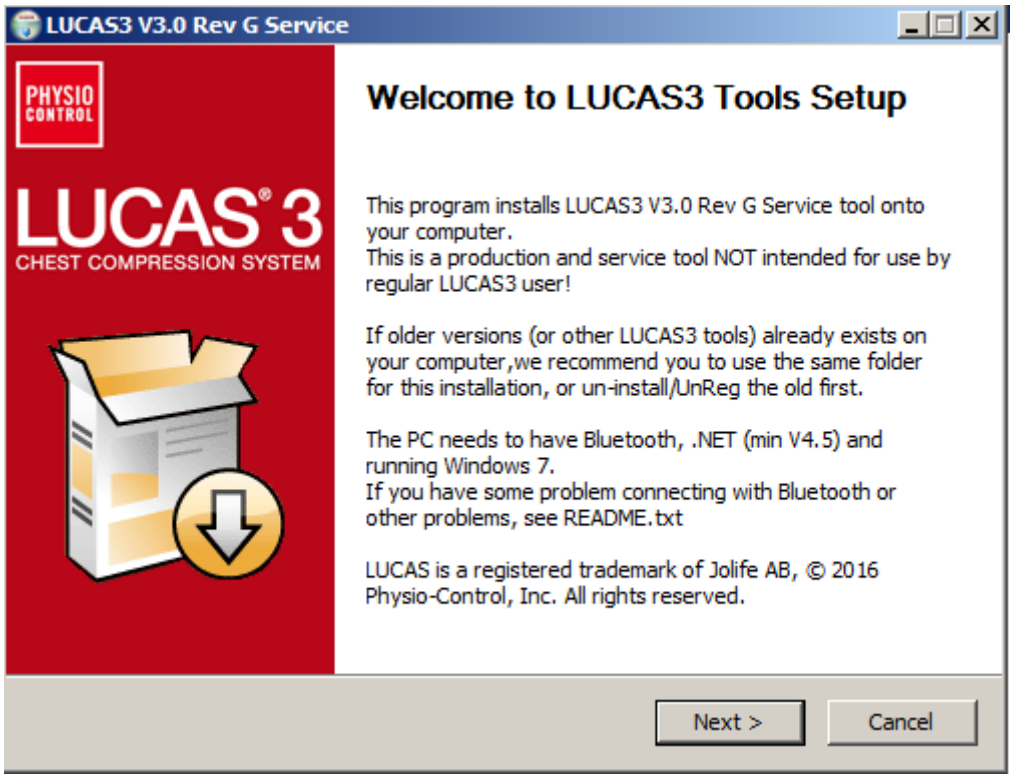
- LUCAS 3 Program Loader should only be used by trained personnel
- Antivirus protection and fire walls should be installed on the computer that have the LUCAS 3 Program Loader installed.
- All suspected cyber security threats shall be reported to Physio-Control.

Software installation

To install LUCAS 3 Program Loader version 3.x:

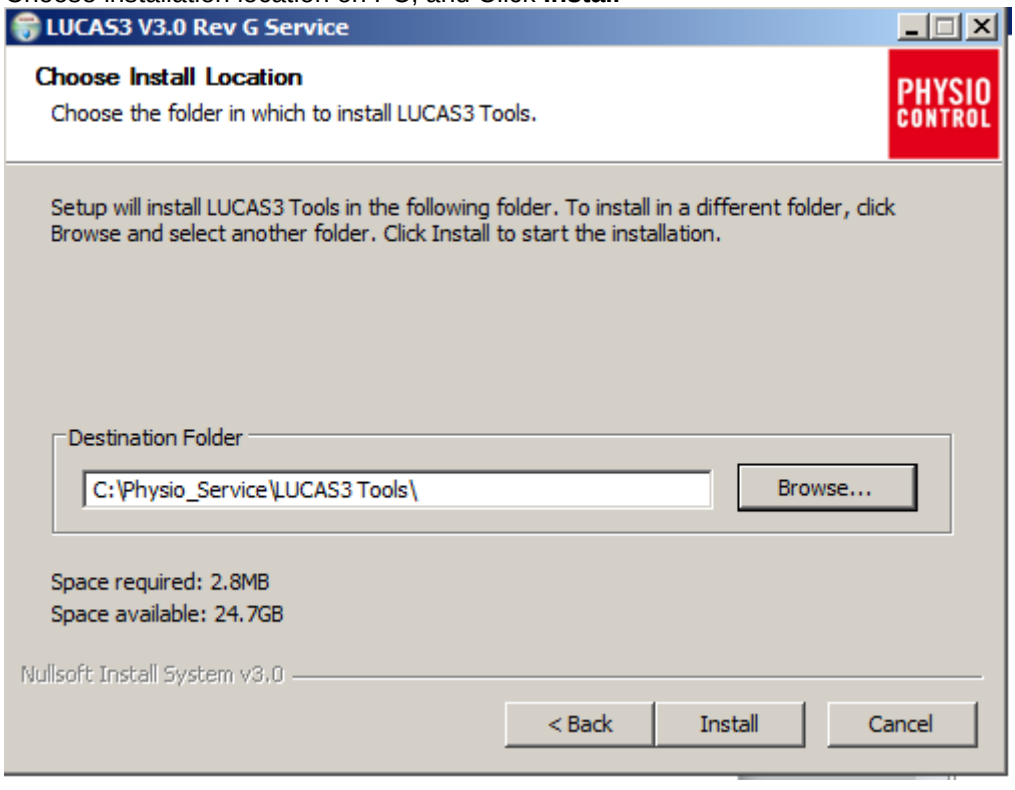
1. Right Click on LUCAS3_V3X_RevX_Service_Setup.exe, and Run as administrator

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

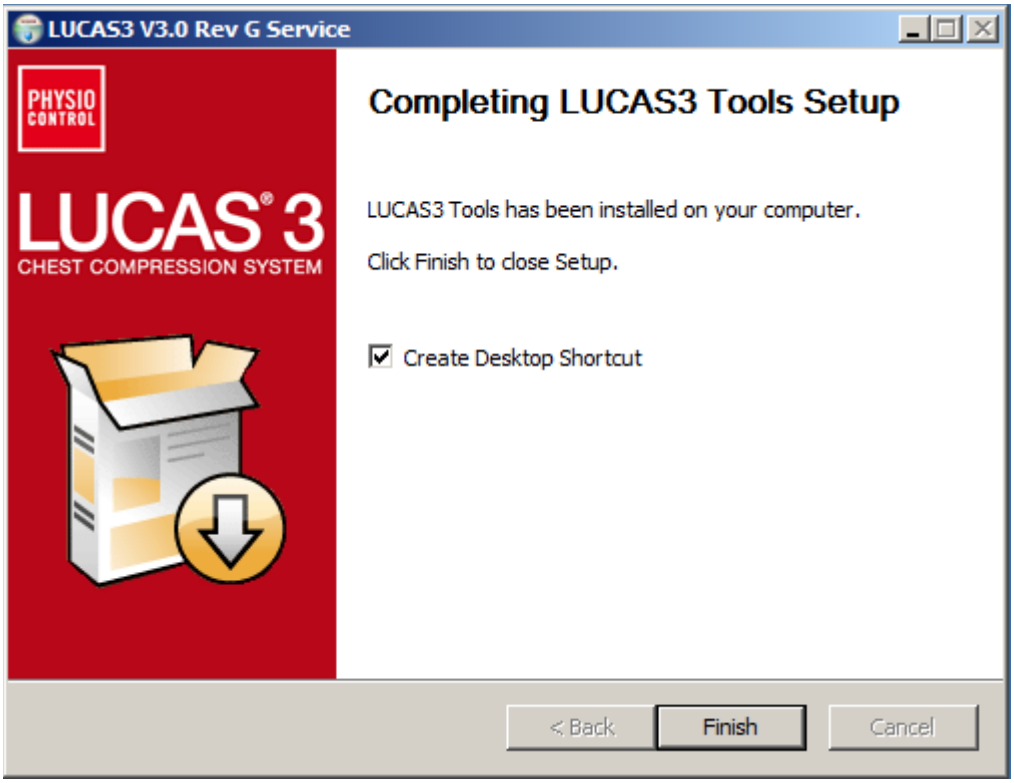


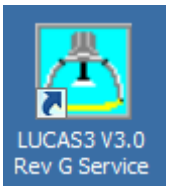
(Visual differences in screen interface may occur for different software versions.)

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



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



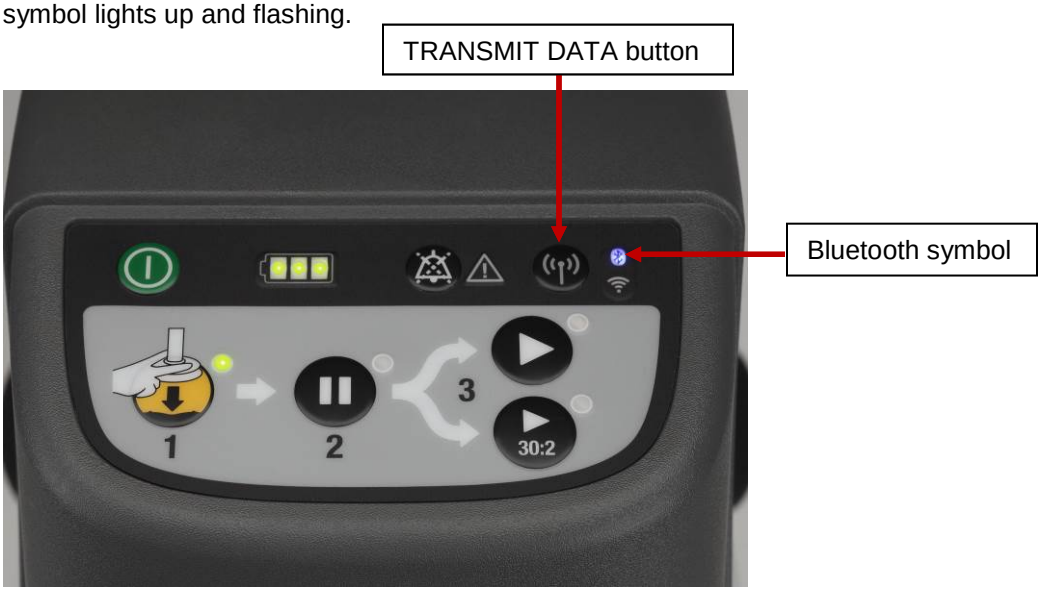
6. Test LUCAS 3 Program Loader by double click on desktop icon 

(Note. Different software versions can occur)

Connect the device via Bluetooth

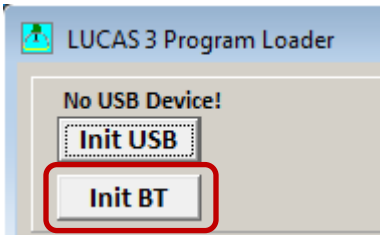
When updating the program in LUCAS using the Bluetooth connection, there is no need to open the hood.

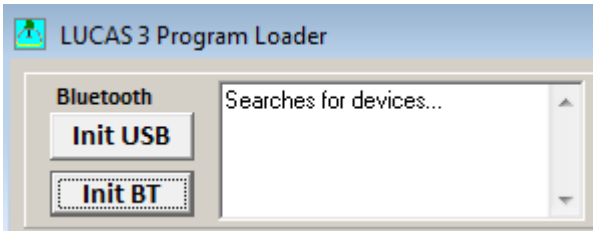
1. Ensure the LUCAS Device is powered OFF and no LEDs are on.
2. Press and hold **TRANSMIT DATA** button for one second to turn on Bluetooth mode, ensuring the Bluetooth symbol lights up and flashing.



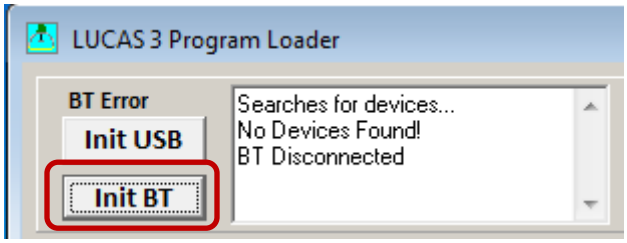
3. Start the LUCAS 3 Program Loader software by executing LUCAS3_V3_X_REV_X_Service.exe file,  . (Note. Different software versions can occur)

4. Click **Init BT** to connect PC to LUCAS 3 device via Bluetooth, and Wait for Program Loader to search for LUCAS 3 device…

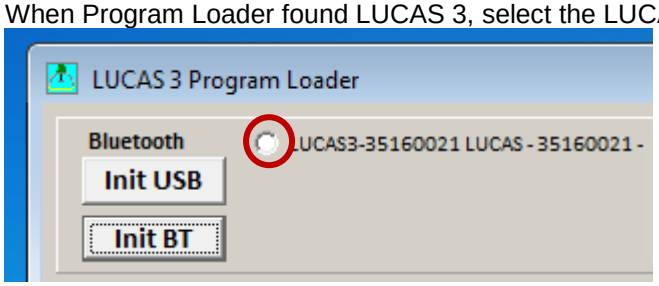




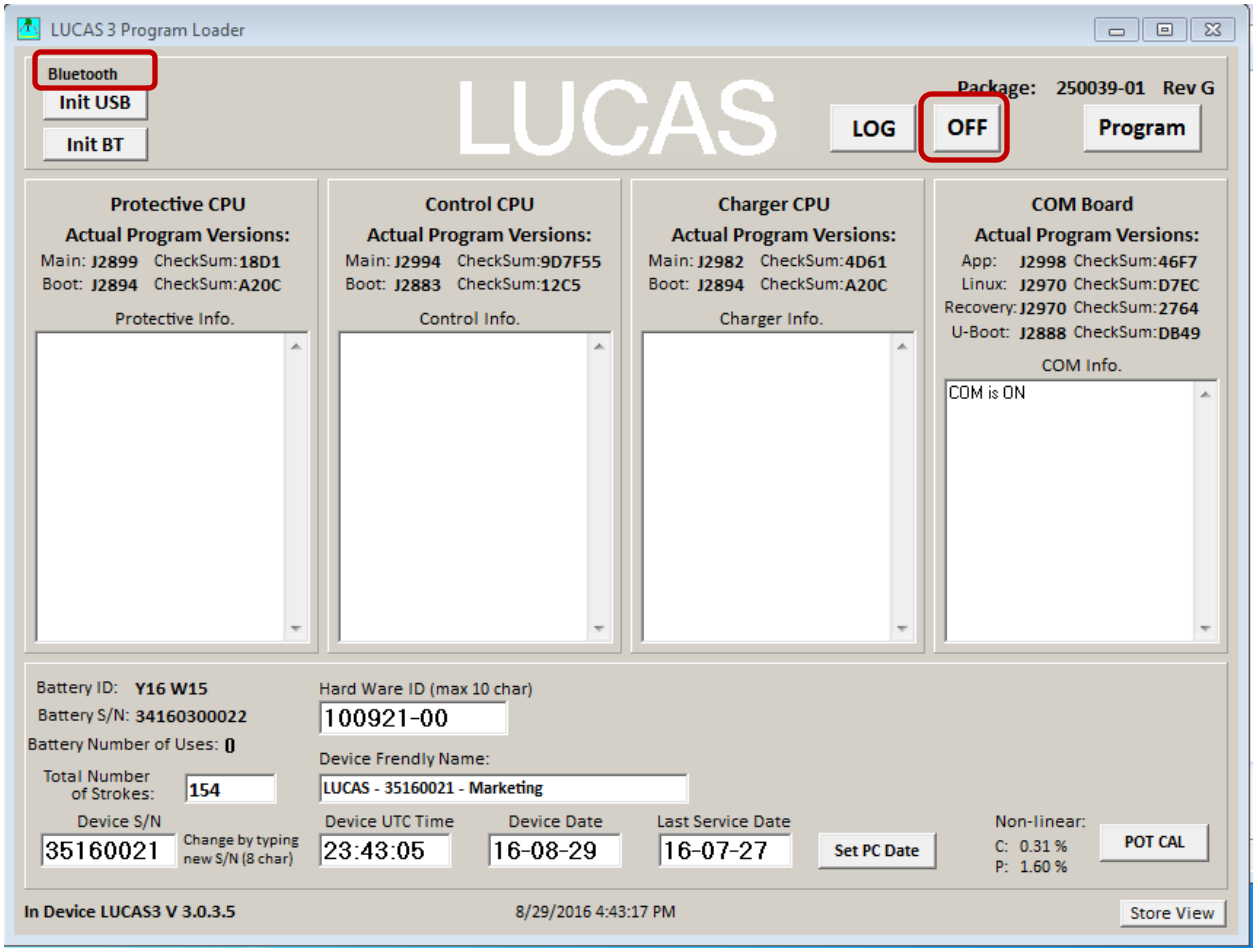
5. If **No Devices Found** message displayed, click **Init BT** and try again. **Note**: It may take up to 30 seconds for the LUCAS 3 communication app to boot up. You may have to click **Init BT** 2 ~ 3 times before LUCAS device shows up on the screen. If "**BT Error**" occurred repeatedly, refer to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



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



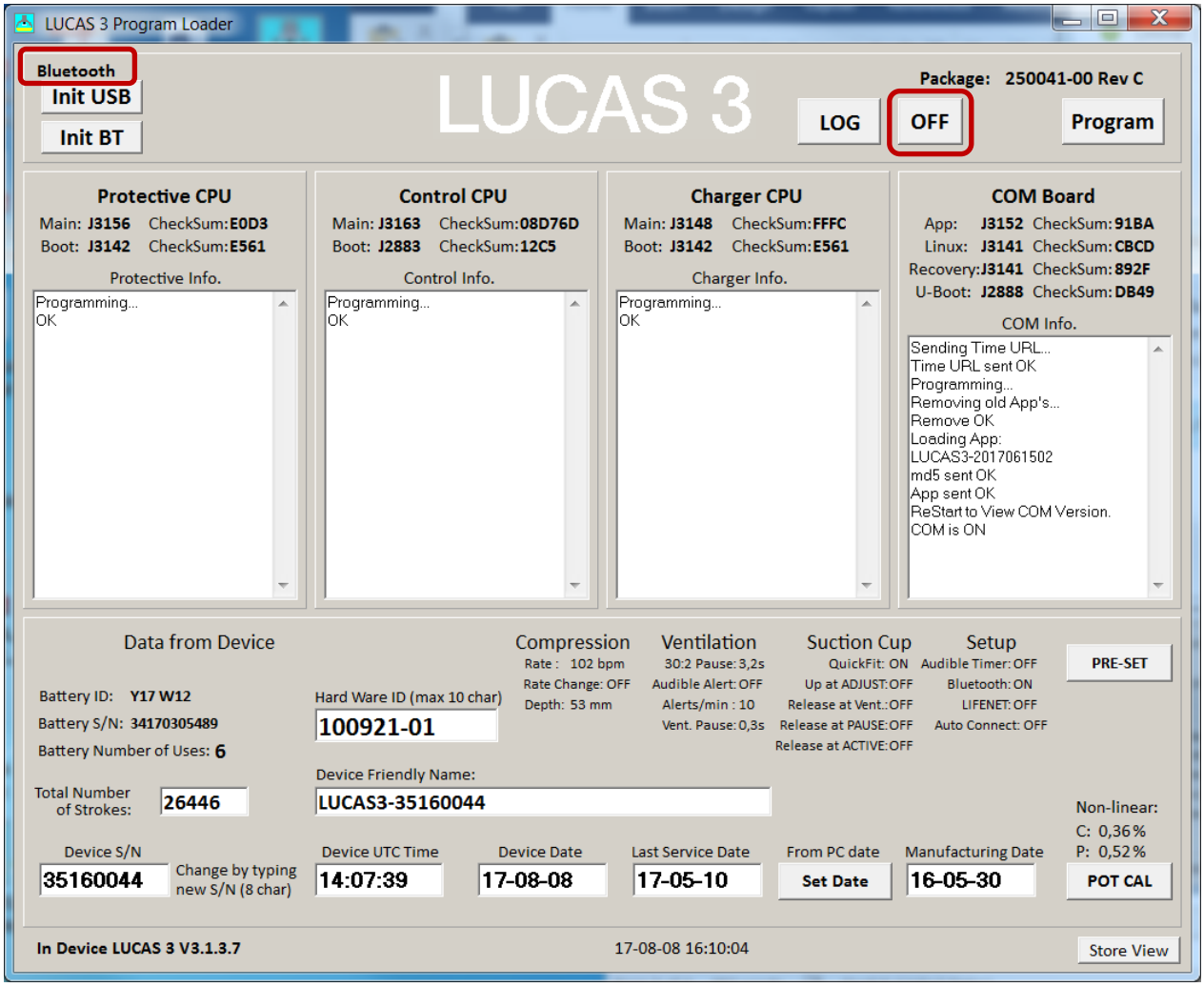
7. When Bluetooth connection is established, the Program Loader screen will show CPUs information shown as following pictures.



- 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)

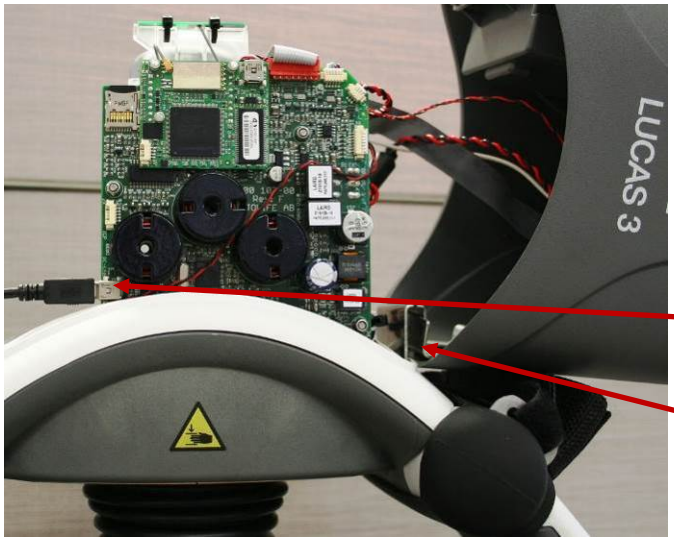
Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –

- 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.

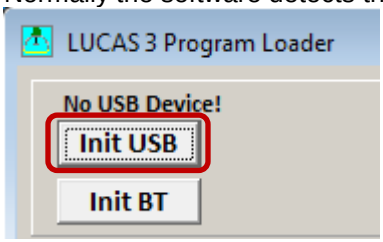


Hood Holder Bracket

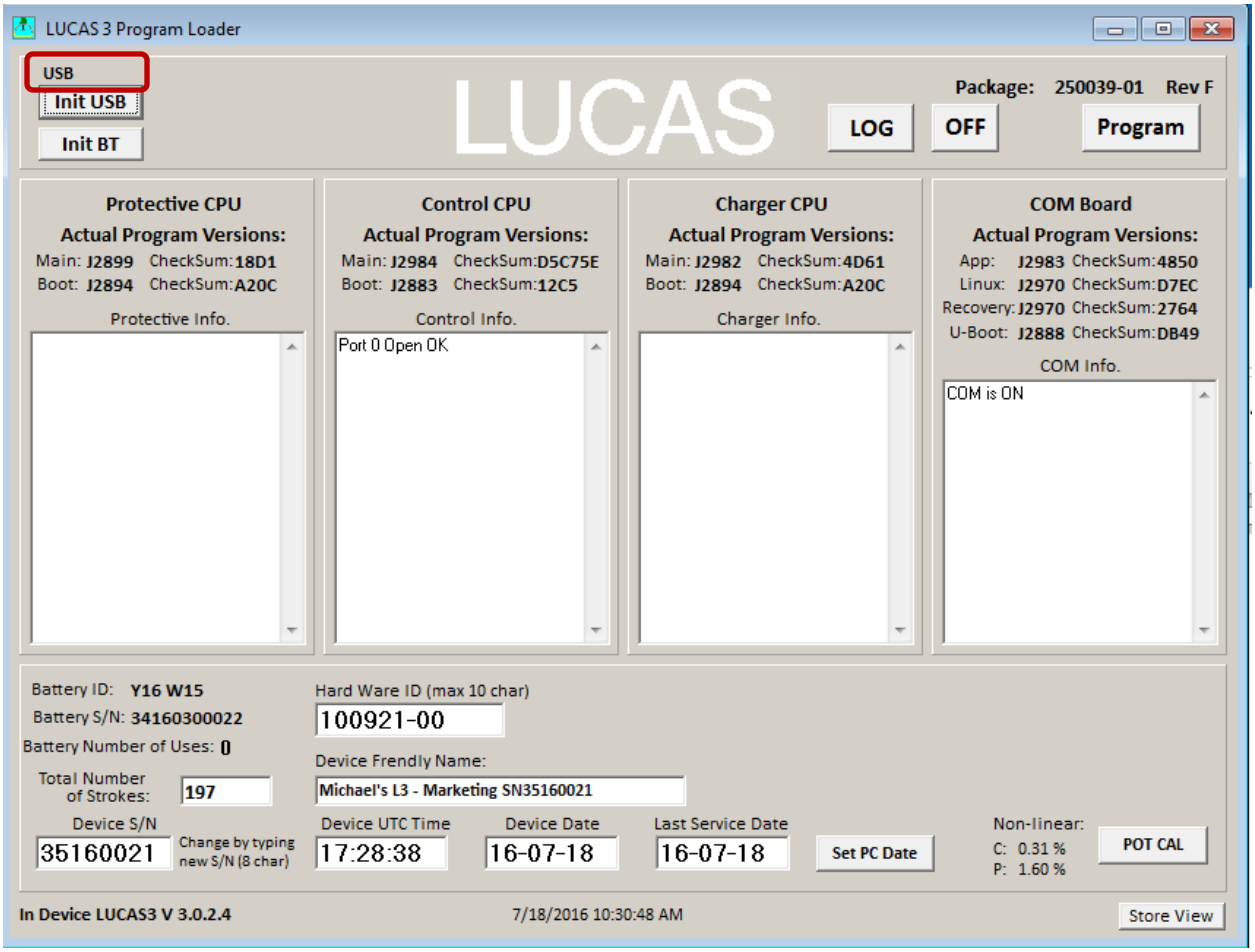
USB Port Location

Hood Holder Bracket Location

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**.

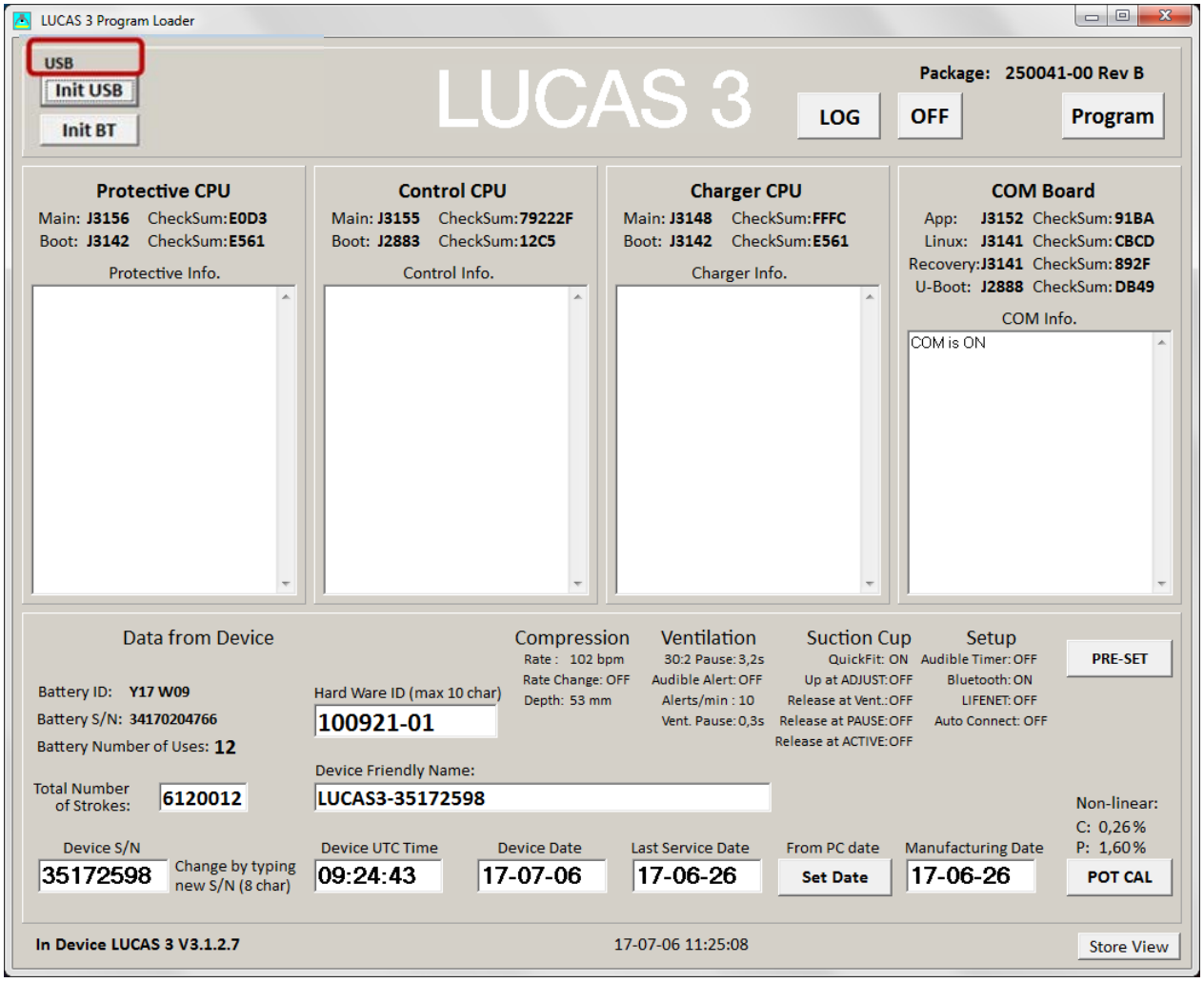


6. When USB connection is established, the Program Loader screen will show CPUs information



- 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, 

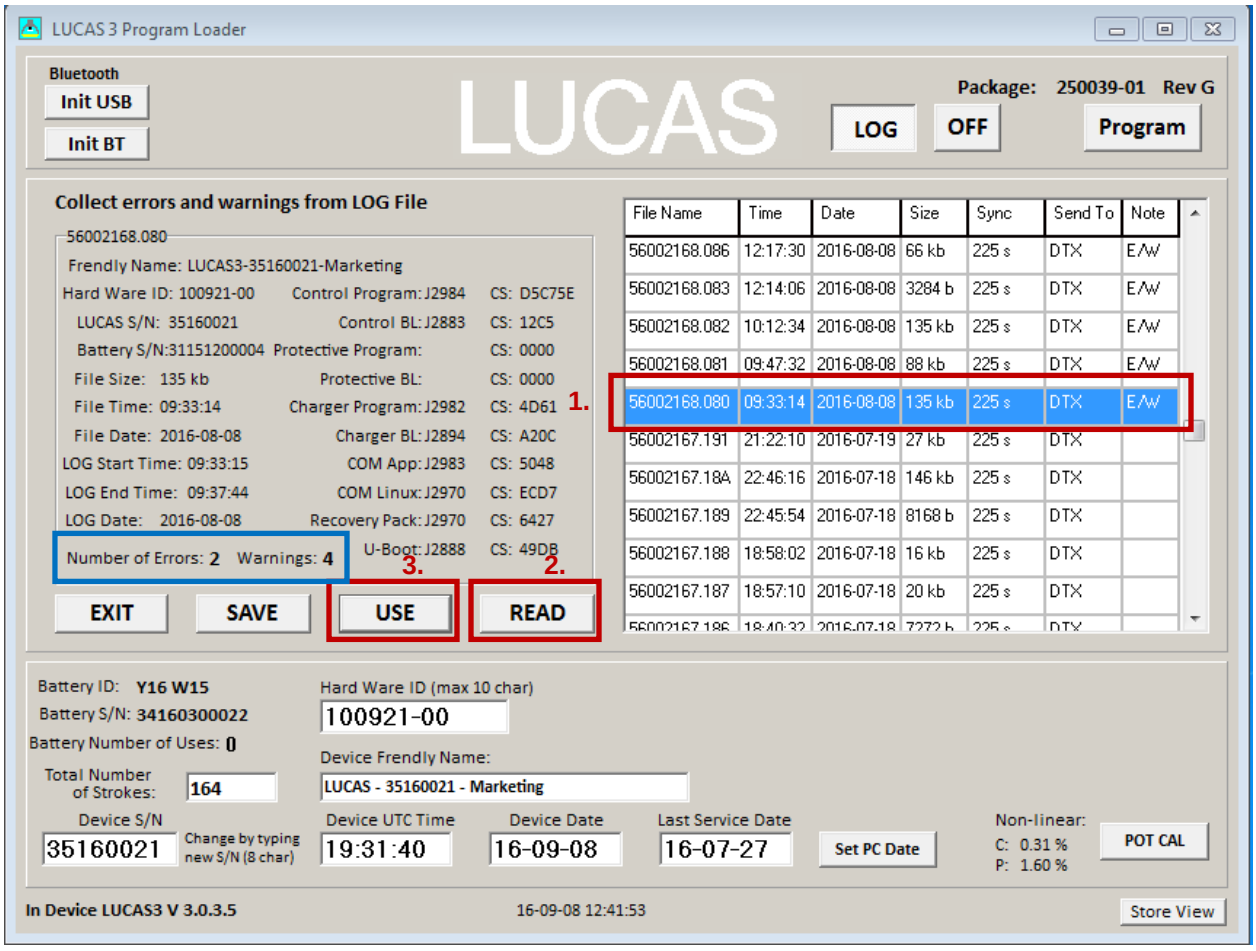
, Log view shows log data on screen.

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

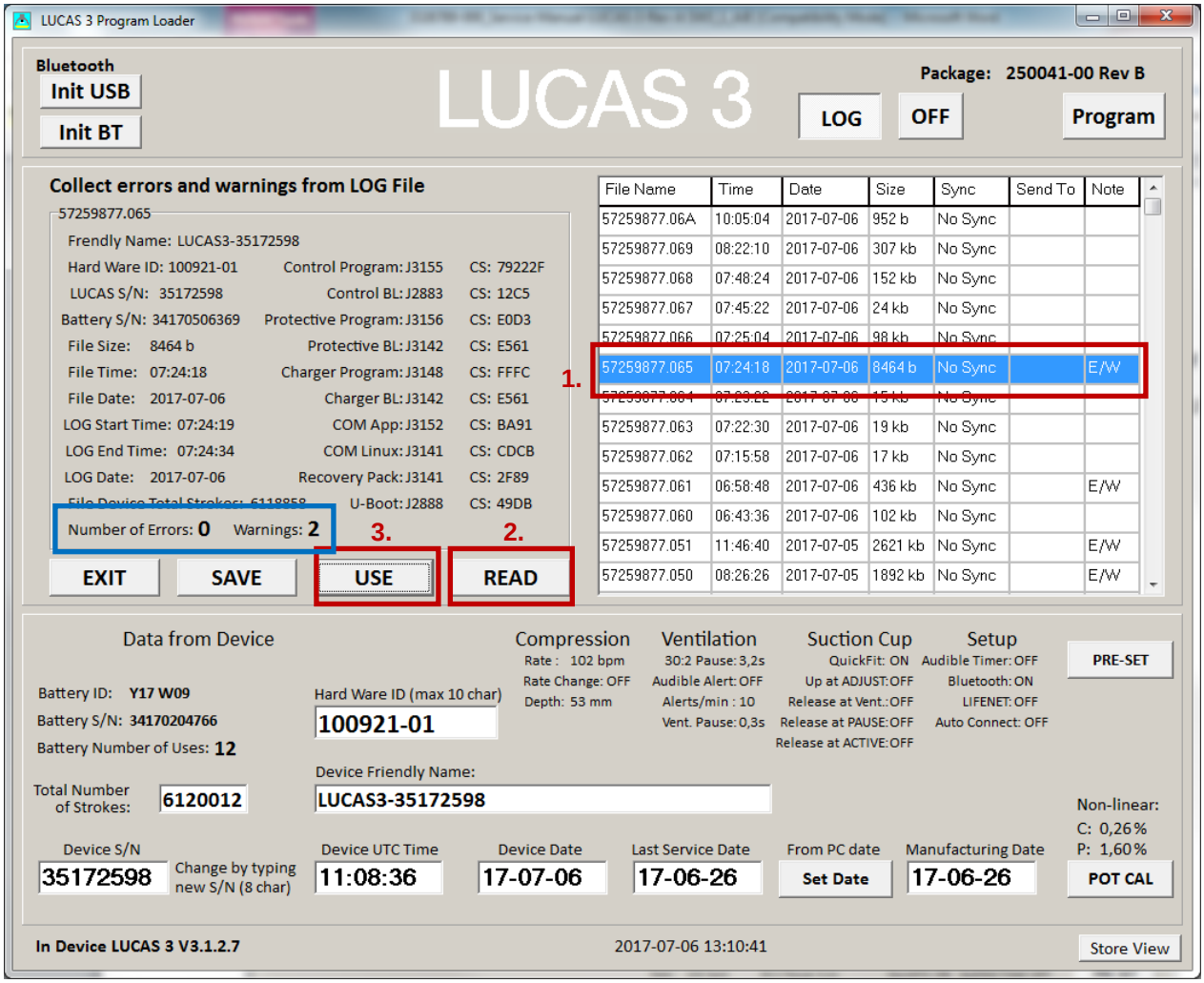
Example:

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).



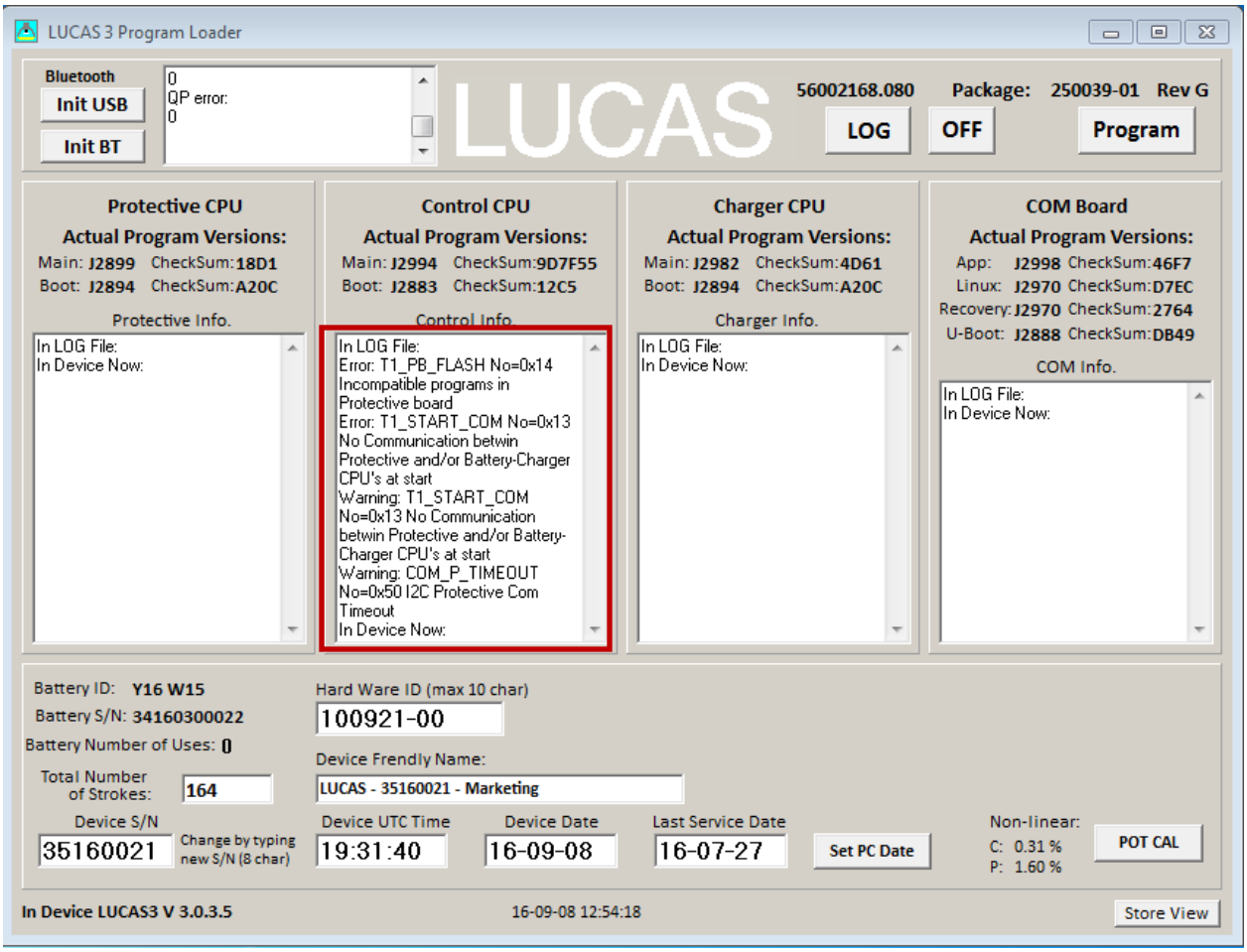
- Picture shows LOG File content on the left for LUCAS 3 Version 3.0 (Part No: 250039-00)

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



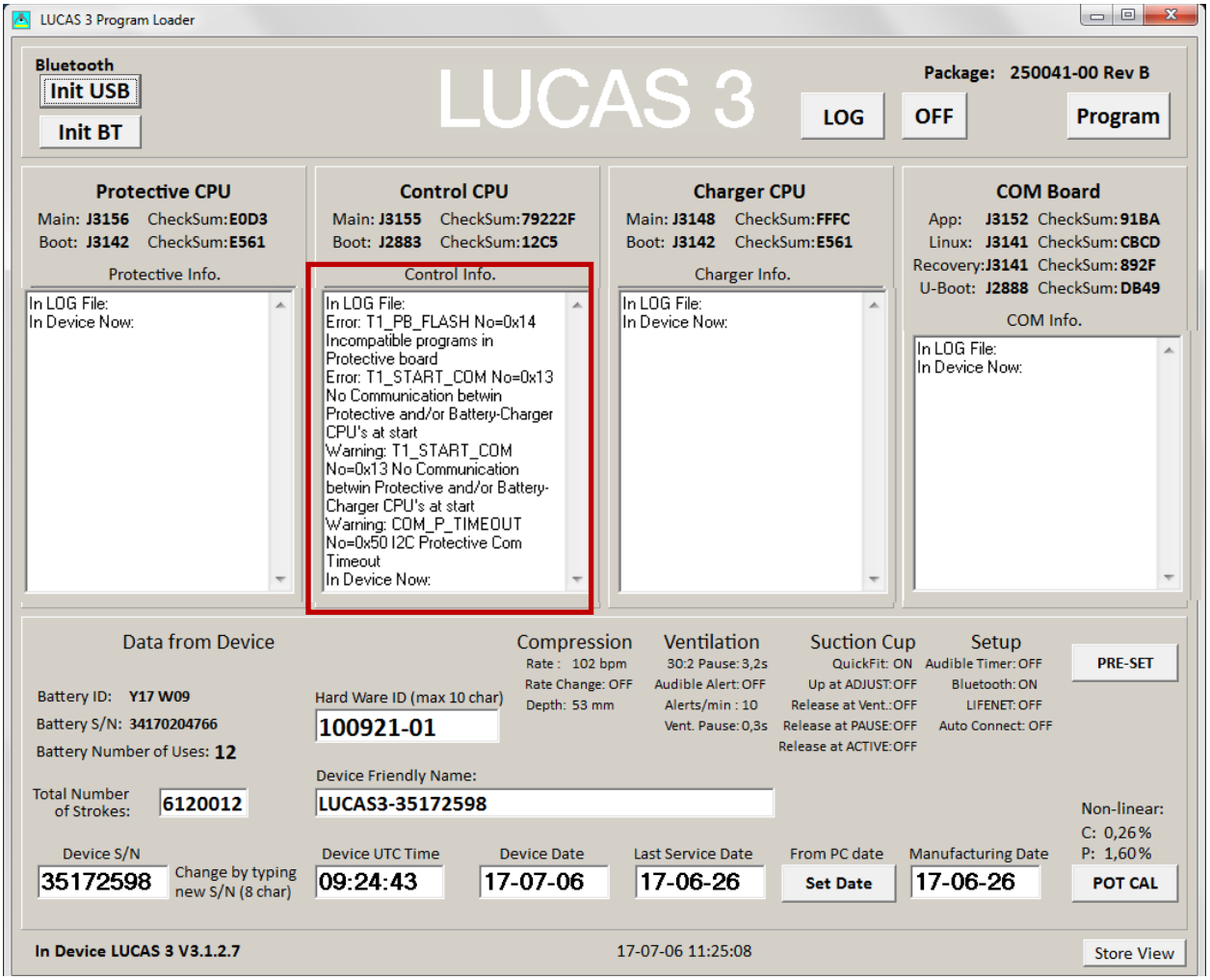
- Picture shows LOG File content on the left for LUCAS 3 Version 3.1 (Part No: 250041-00)

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 –

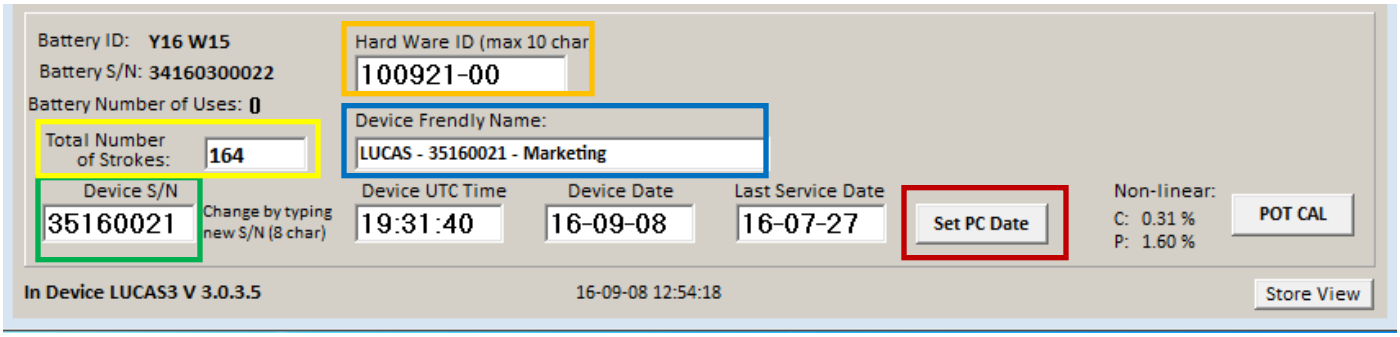


- Picture shows Error Codes in CPU window for LUCAS 3 Version 3.1 (Part No: 250041-00)

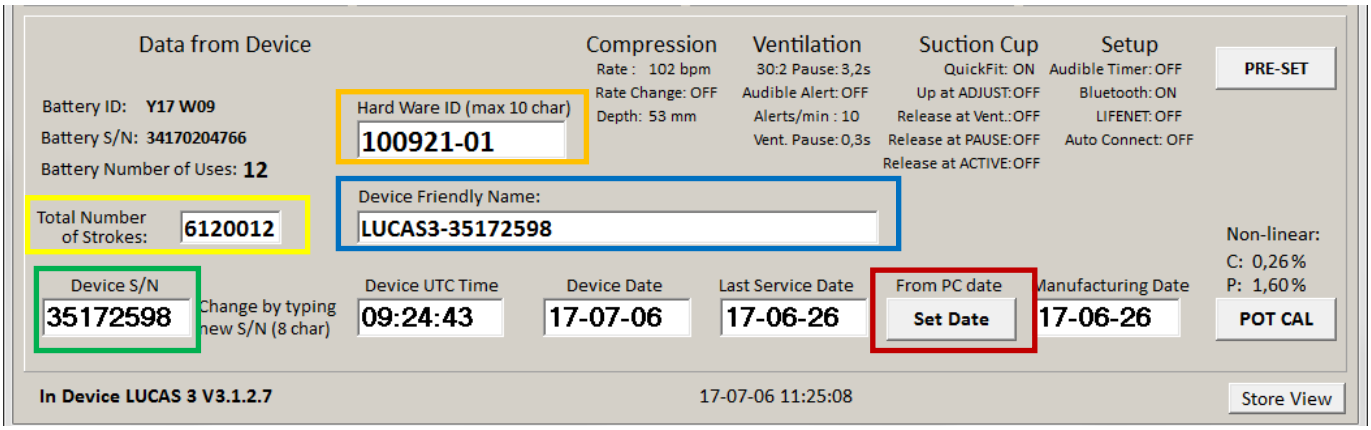
Note, differences in J-numbers and CheckSum Numbers may occur due to different program versions –

4. Then refer to Error Codes Tables for more information about how to handle the errors.

Set Device S/N, Date, and Data



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



- 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 name[1]. 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.

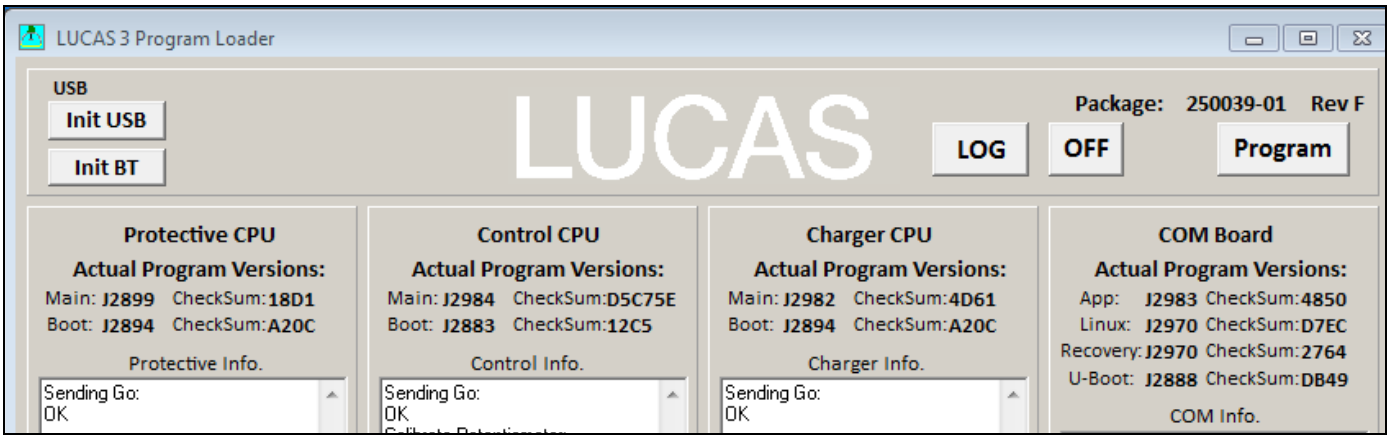
[1] An administrative right to the "LUCAS3 Tools" folder is necessary to save the screenshot. This can either be done by right-clicking the LUCAS® 3 program loader.exe file and chose "Run as administrator" every time you want a screenshot saved to the "Pictures" subfolder or by locating the "LUCAS3 Tools" 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

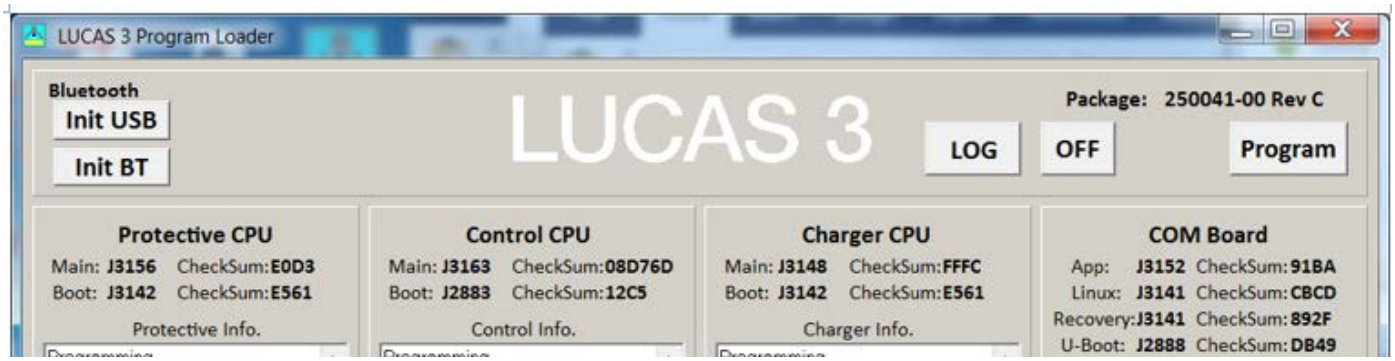
To identify the installed program version you can check the **CheckSum** values to match table below:

	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.



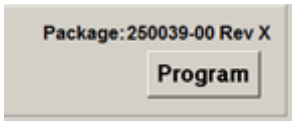
- **LUCAS 3 Version 3.0 (Part No: 250039-00) –**



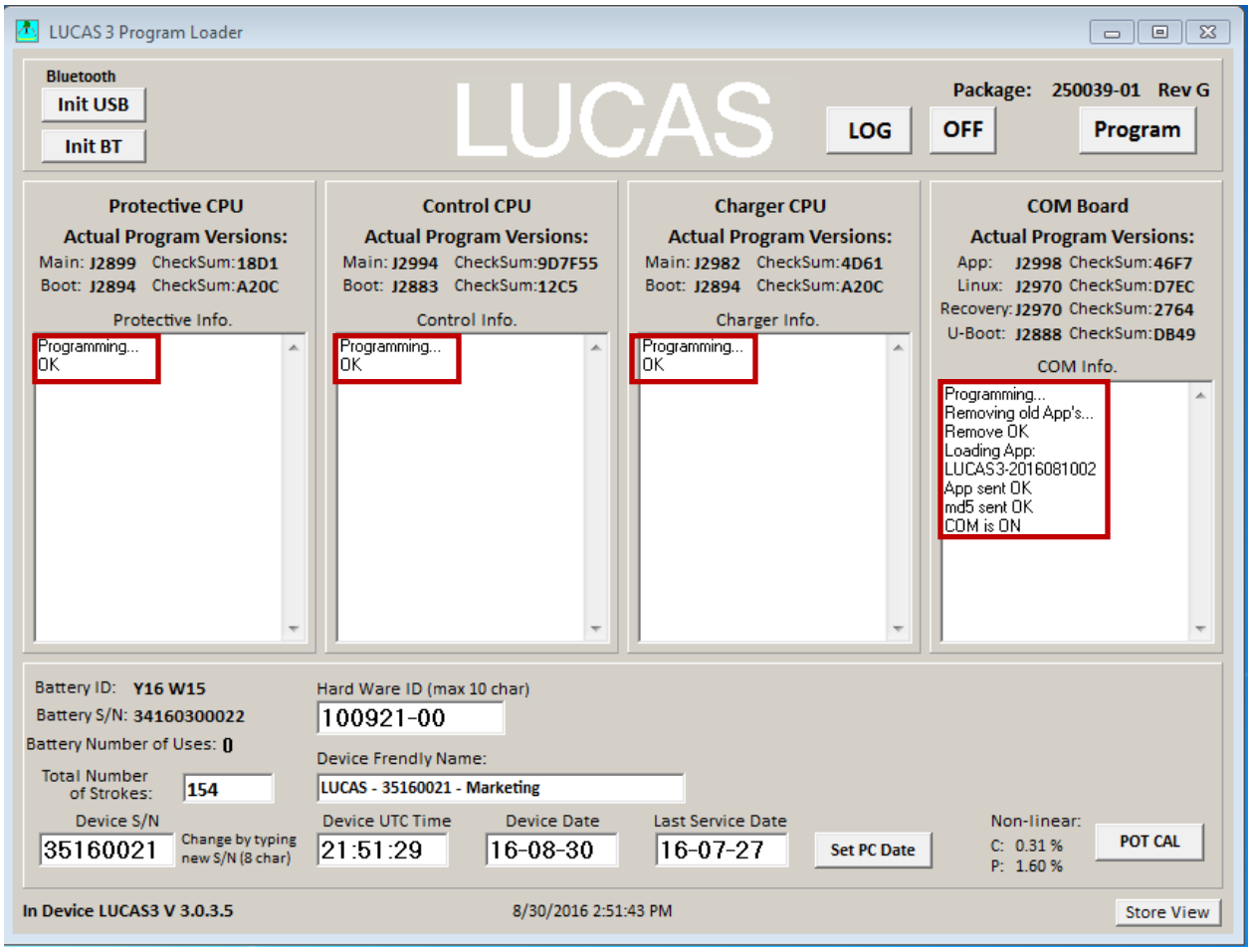
- **LUCAS 3 Version 3.1 (Part No: 250041-00) –**

Update LUCAS Software

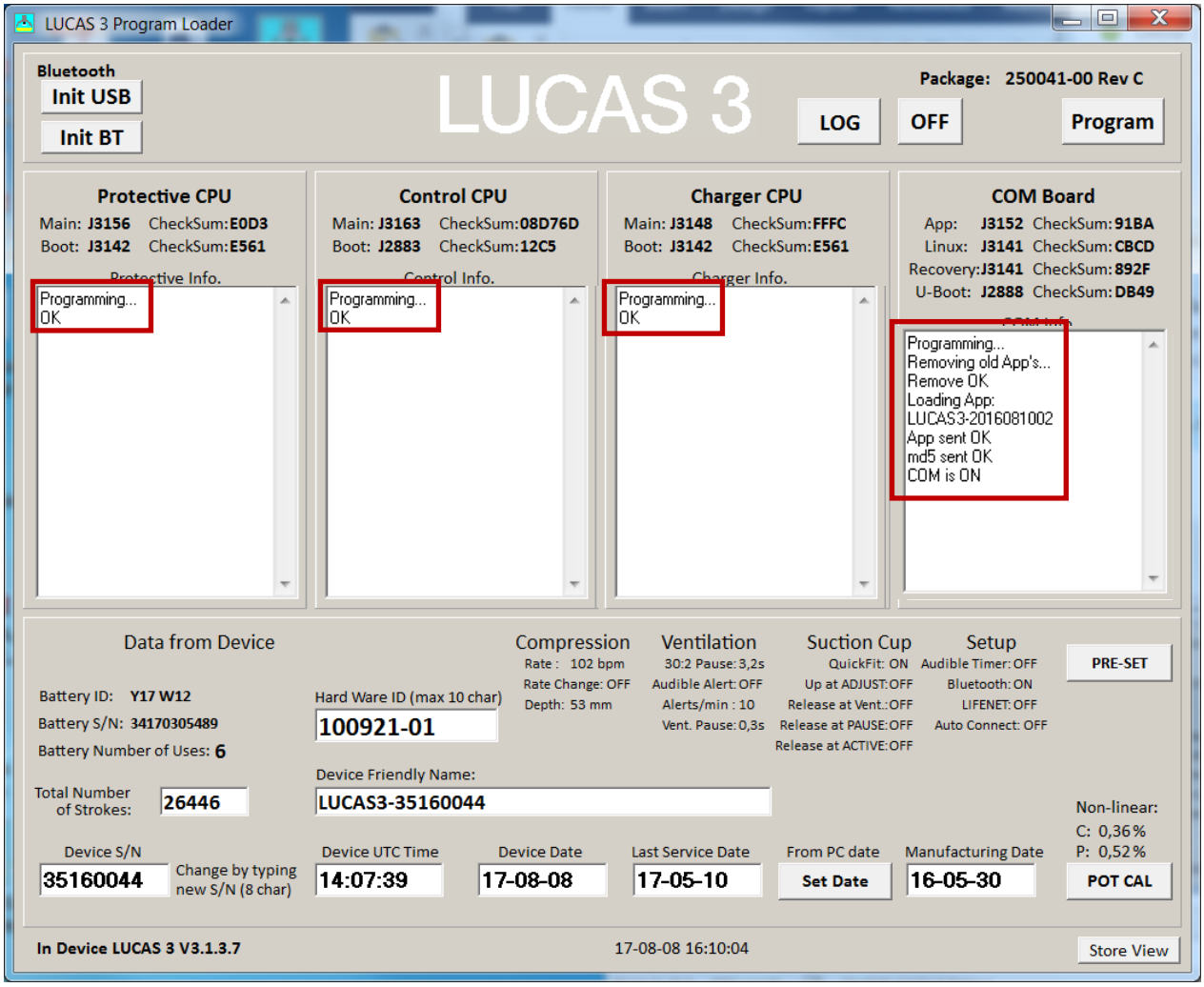
1. Click **Program** in the upper right corner to update LUCAS software.



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.



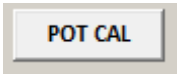
- LUCAS 3 Version 3.0 (Part No: 250039-00) –

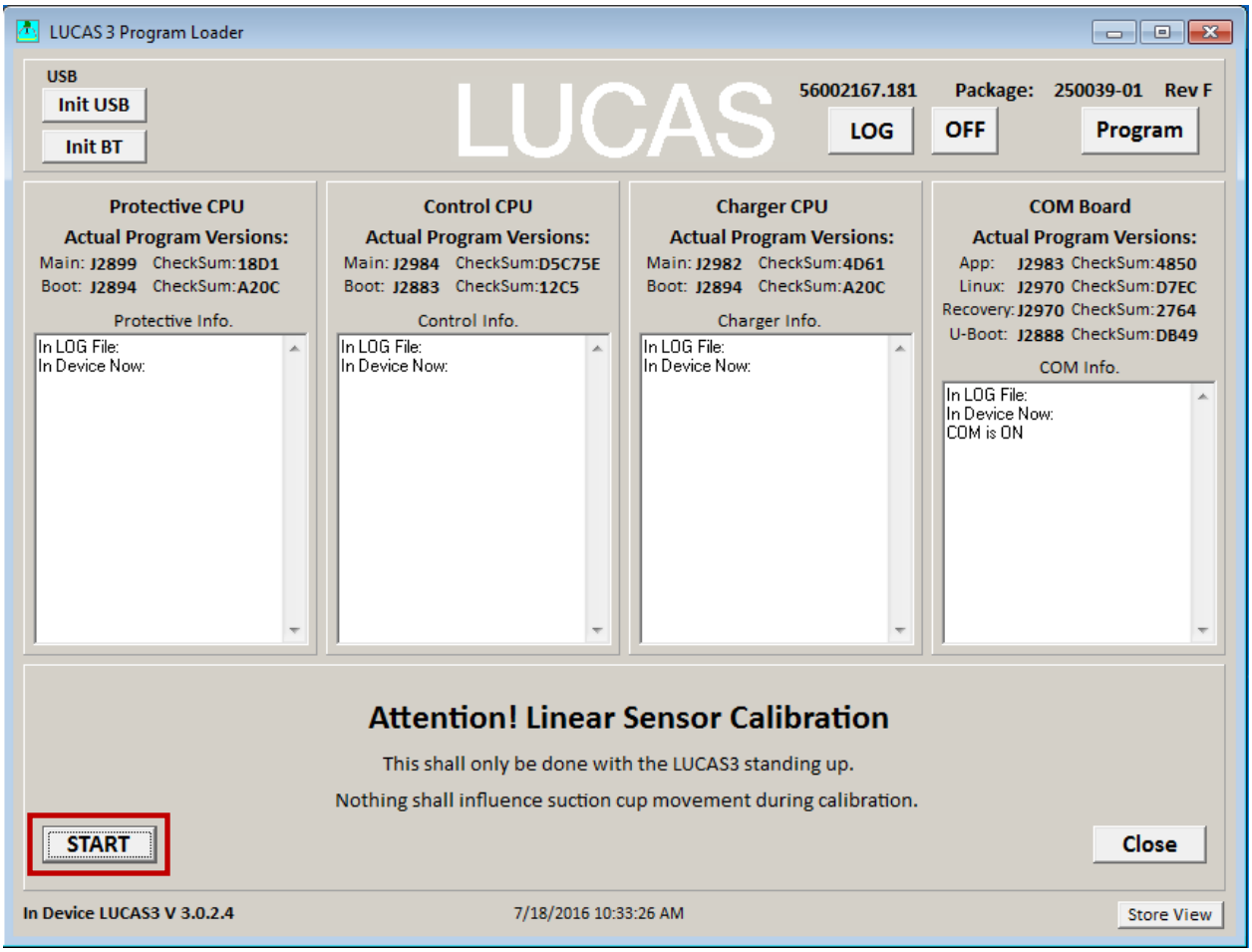


- LUCAS 3 Version 3.1 (Part No: 250041-00) –

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.



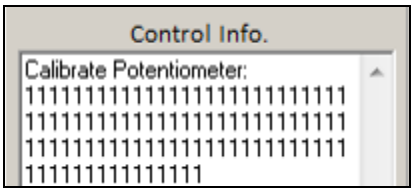


- Example LUCAS 3 Version 3.0 (Part No: 250039-00) –

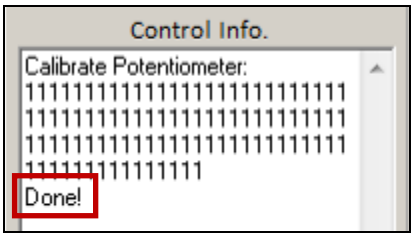
- LUCAS 3 Version 3.1 (Part No: 250041-00) –

1. Click **START** to calibrate Linear Sensor.

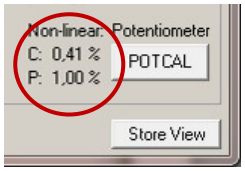
2. When the Calibration process starts, the progress will be shown in the Control CPU's window. When the calibration is done, the result is shown in the lower right corner.



- POT CAL In Progress -



- POT CAL Done -



- 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:

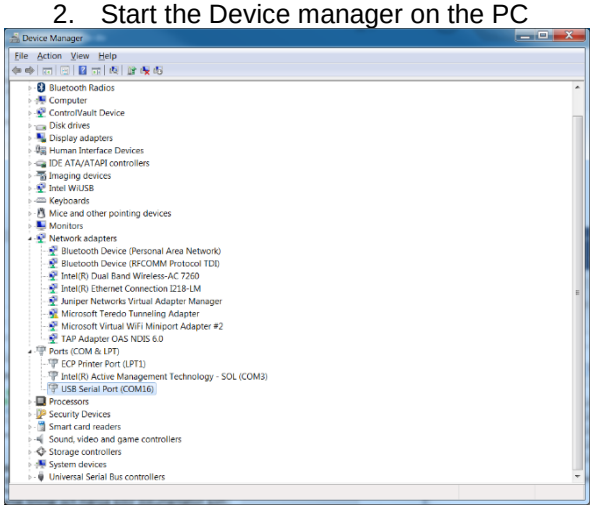
If this error "**Cup not moved to top**" showed in Control CPU window, manually move the suction cup down an inch and then click **POT CAL** again to recalibrate.

Update LUCAS 3 sw 3.0 to LUCAS 3 sw 3.1

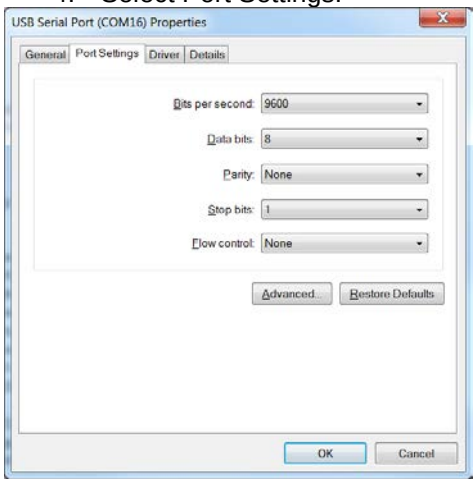
Setup

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

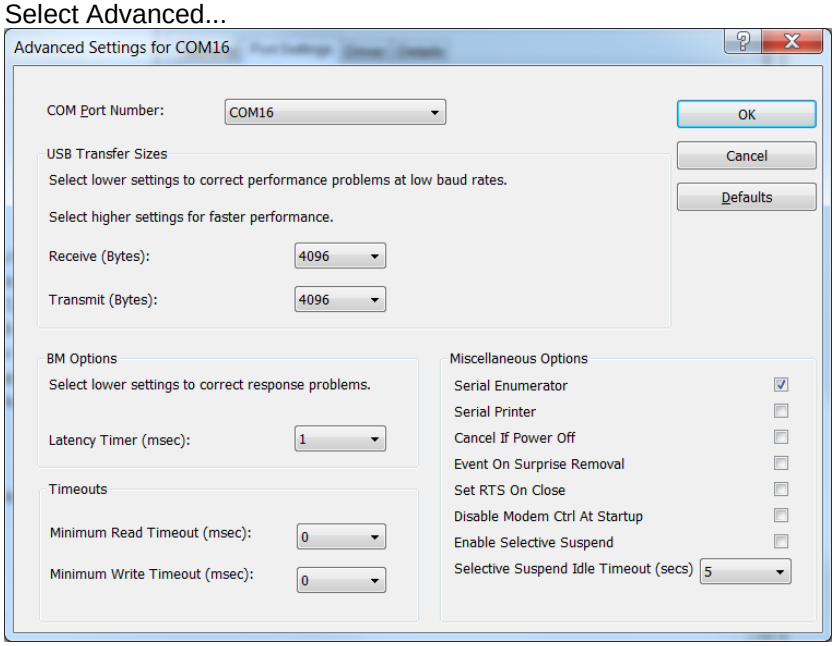
1. Connect the USB connector to the PC and let the PC install the driver for the USB programming cable
2. Start the Device manager on the PC



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



5. Select Advanced...



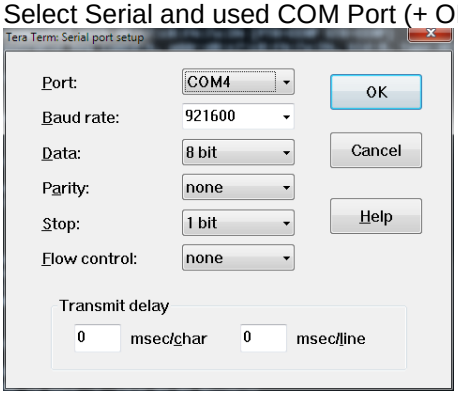
6. Change Latency Timer to 1 ms.
7. Press OK.

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.

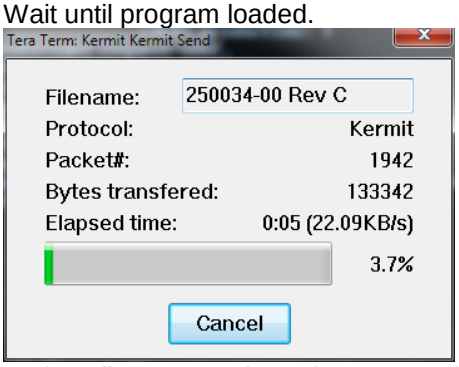
Update and Test procedure

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

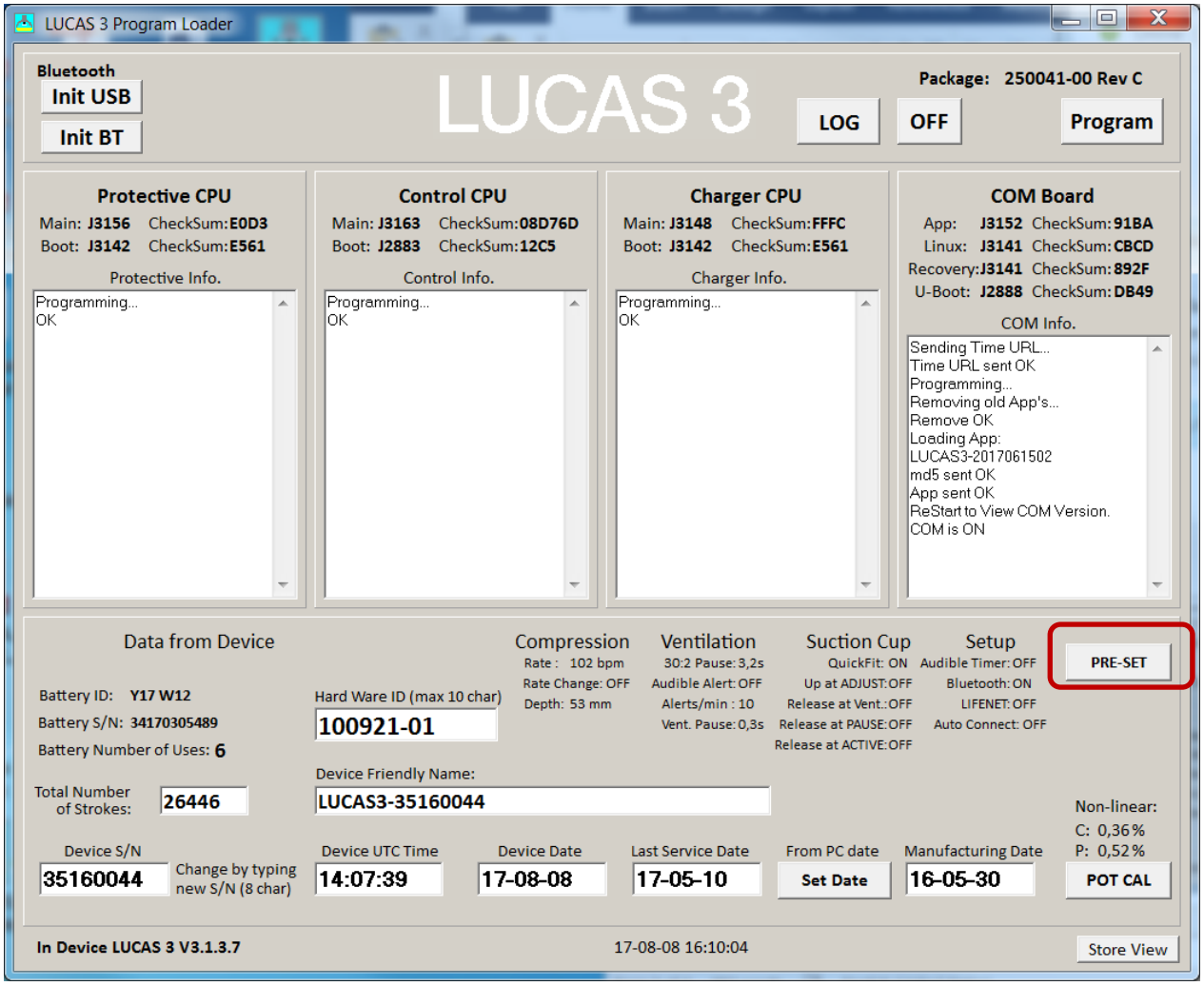
9. Wait until program loaded.



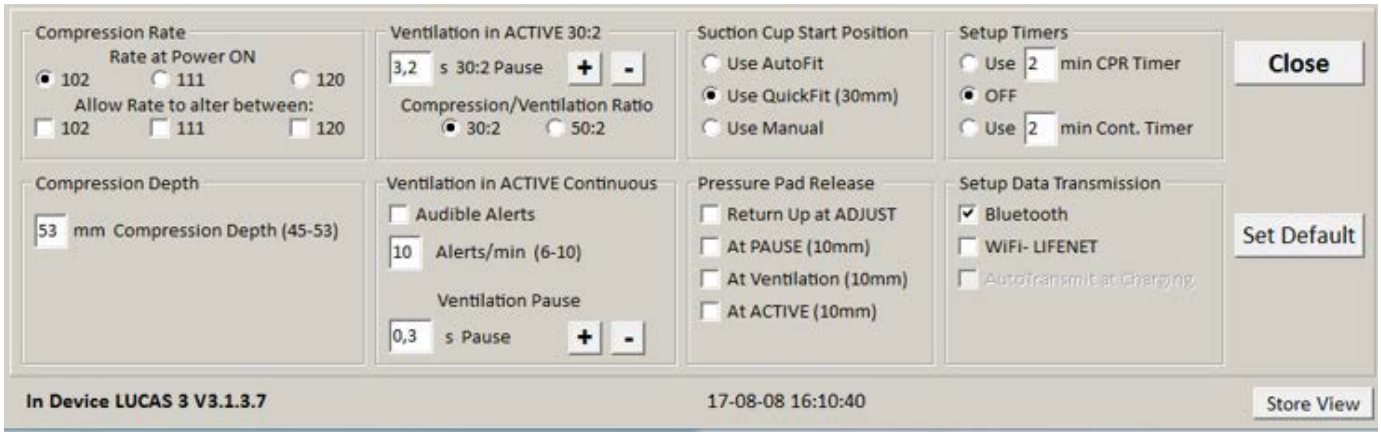
10. Wait until LINUX and App have started, Wait until "....." is started to be written.
11. Turn Off the LUCAS3 device by pressing ON/OFF key two times.
12. Disconnect the USB cable.
13. Assemble the LUCAS3 device.
14. Press the Transmit key on the LUCAS3 device and confirm that the blue LED is flashing.
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 “Progam”-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 bet set according to IFU 3326785-1##, section 9.2 Compression parameters, refer to below.

Category	Specifications
Compression depth (nominal patient)	Factory default setting 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
	Setup options 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
Compression frequency	Factory default setting 102 ±2 compressions per minute
	Setup options 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.
Compression duty cycle	50 ±5%
Compression mode ACTIVE continuous	Factory default setting Continuous compressions with ventilation LED alert 10 times per minute
	Setup options 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.
Compression mode ACTIVE 30:2	Factory default setting 30:2 (30 compressions followed by a 3-second ventilation pause)
	Setup options 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

	ongoing compressions.
Category (continued)	**Specifications (continued)**
Suction Cup Start Position	Factory default setting 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.
	Setup options The device can be setup for QuickFit, AutoFit or Manual. 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. 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.
Suction Cup in ADJUST mode	Factory default setting Manual: The Suction Cup has to be pulled up manually
	Setup options 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.
Pressure pad in PAUSE mode	Factory default setting The device stops compressions and locks the pressure pad in its Start Position.
	Setup options 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.
Pressure pad during ventilation pauses in ACTIVE modes	Factory default setting The device temporarily stops compressions and locks the pressure pad in its Start Position.
	Setup options 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.
Pressure pad in ACTIVE modes	Factory default setting The pressure pad returns to Start Position between each compression
	Setup options 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.

Category (continued)	Specifications (continued)
Audible timers	Factory default setting No timer (OFF)
	Setup options 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.

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 PNs/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 un-influenced 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_POTHALL 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	Reel 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 N0=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 In Active: Compressions out of range
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.	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/N xxxxxxxx)
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/N xxxxxxxx)
BATT 10 MIN ALARM	Battery continues below 25.3V	Uncharged battery.	Battery	Medium priority Alarm. Flashing orange battery LED (B1)	Battery low charge (S/N xxxxxxxx)
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)

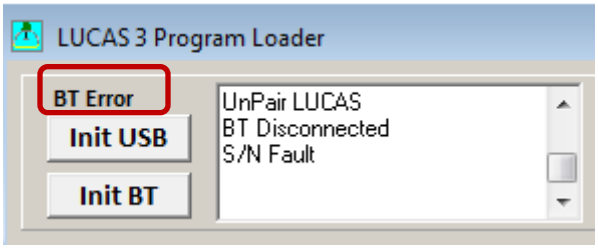
T1 BATT CS ALARM	Battery communication check- sum fault	Connector fault.	Check connections. Unplug and insert battery, check for fault. Or replace battery.	None. Shall be shown at LOG file read.	Battery not recognized as Physio-Control proprietary (no S/N)
T1 BATT COPYRIGHT ALARM	Incorrect copyright 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

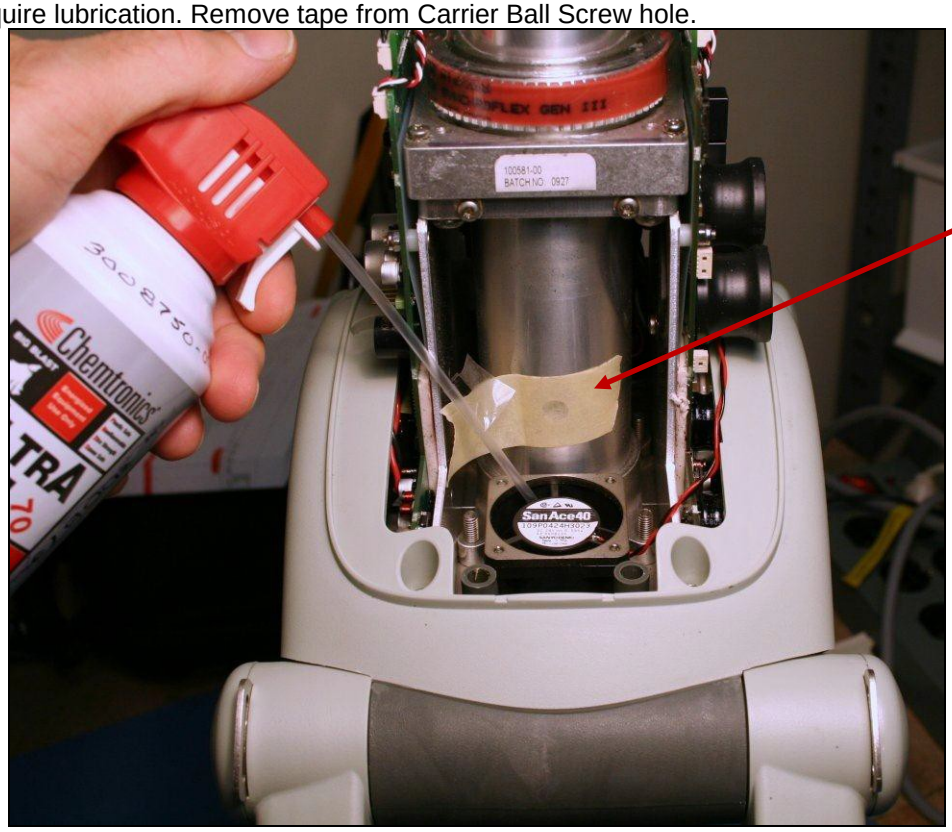
NOTE: Use PIP checklist 3326789 Rev C to record PIP results during the maintenance procedure.

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 6.4 in the IFU
5	Check/Replacement Stabilization Strap		
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.

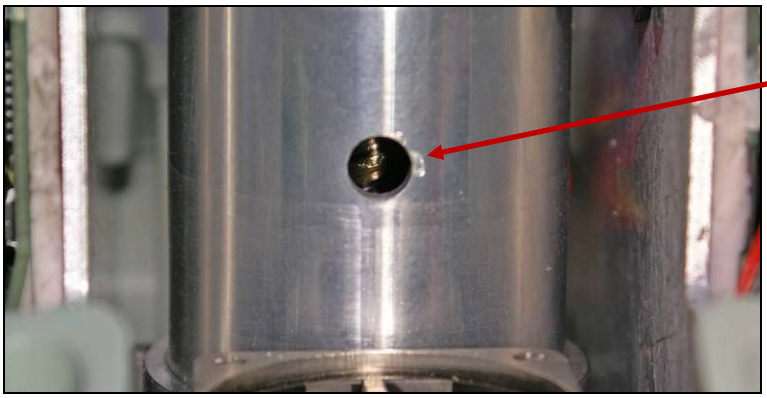
From the inside of the device, clean the Fan and Mesh Grill with compressed air. Clean dust from areas on the device that require lubrication. Remove tape from Carrier Ball Screw hole.



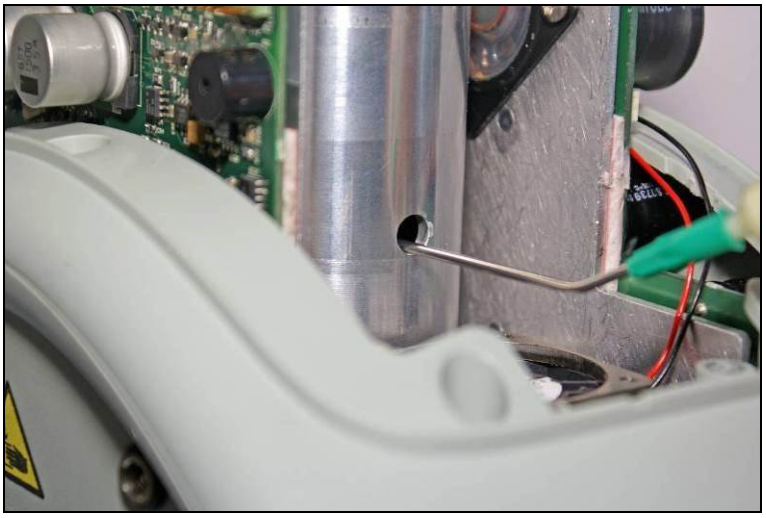
Compression Module Lubrication

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.

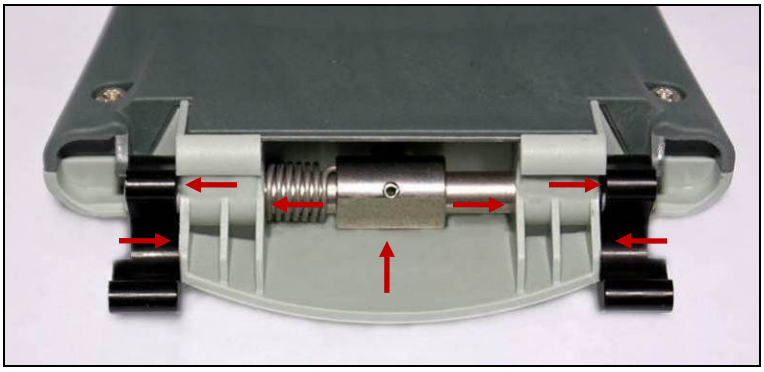


Claw Lock Lubrication

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

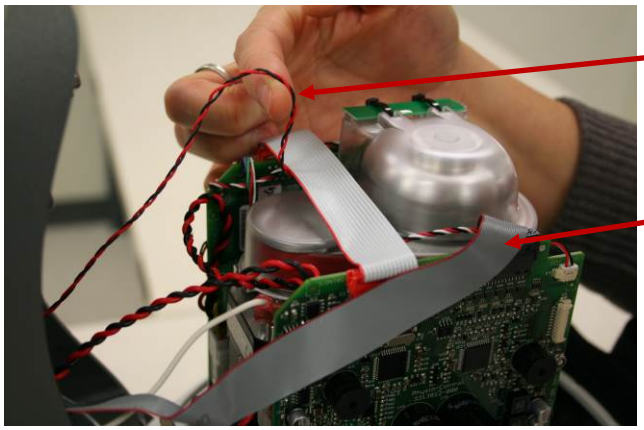
WARNING: Take Off The Battery Before Opening The Device!

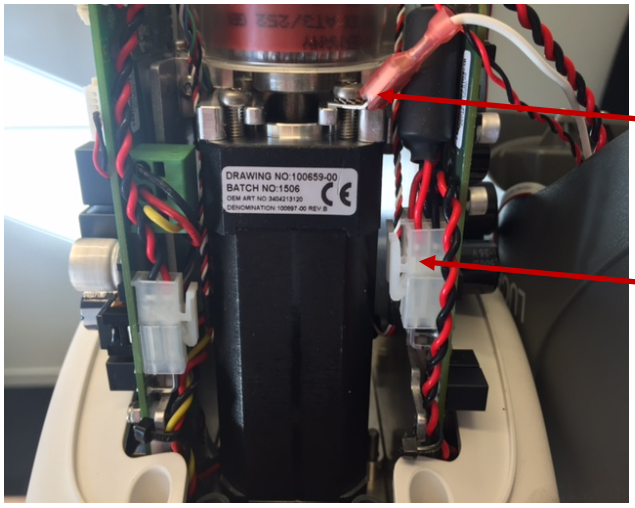
NOTE: Do not connect the battery to hood cover unless the Hood Holder Bracket Service Tool is installed. The weight of the battery in a hood cover can damage the wires or connections.

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.

Correct hood installation

- 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.

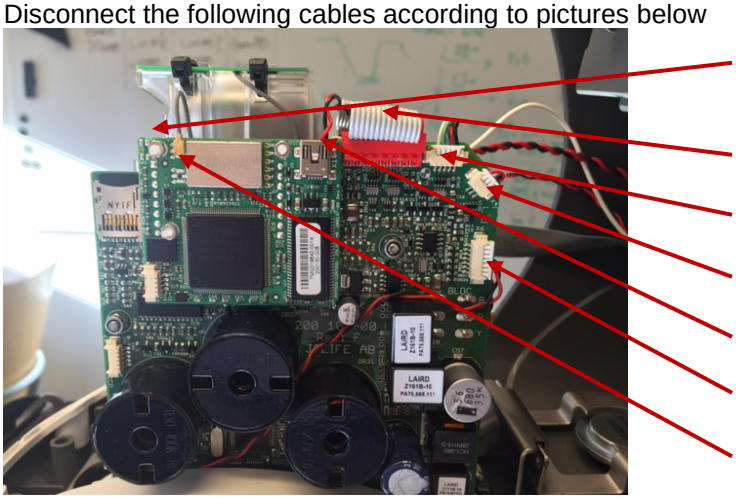
- Place the Bellows ring above the retaining ring.
- Thread the edge of the Bellows over the Bellows ring.

- Put back the Suction Cup.

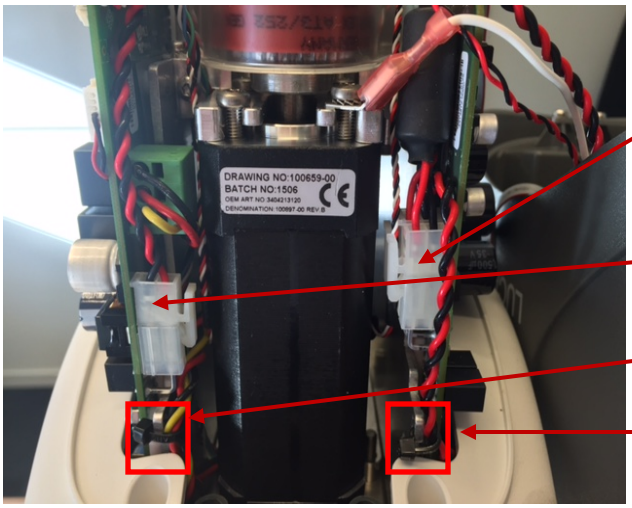
3. **Test**
   Perform a Function Check according to Function Check.

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

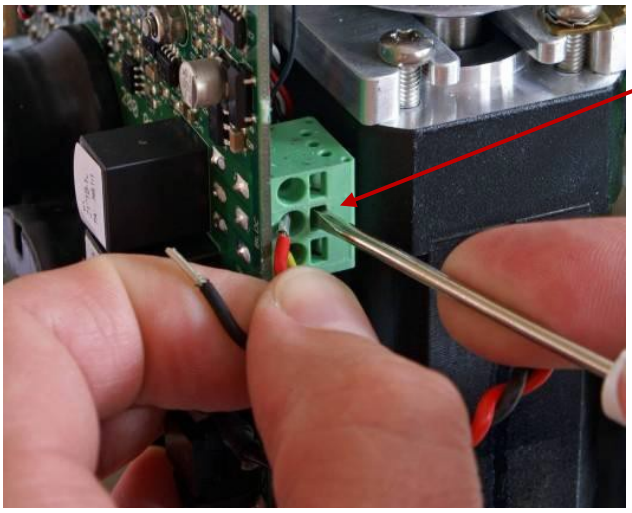


8. Protective Power Cable

9. Control Power Cable

Remove if taking out Compression Module

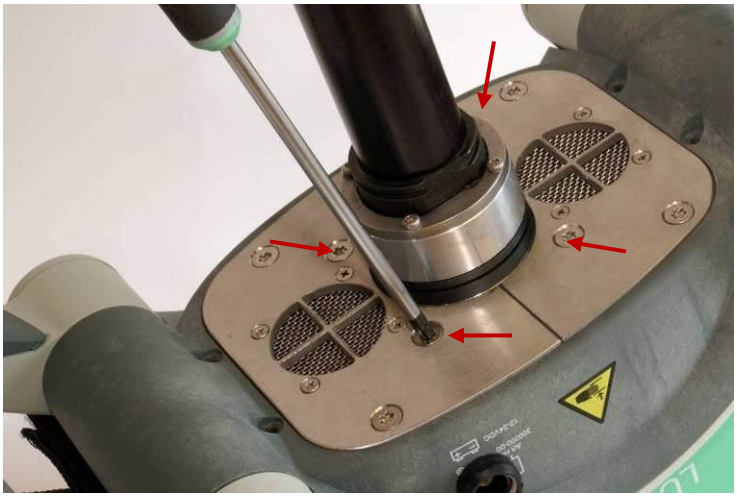
Remove if taking out Protective PCB



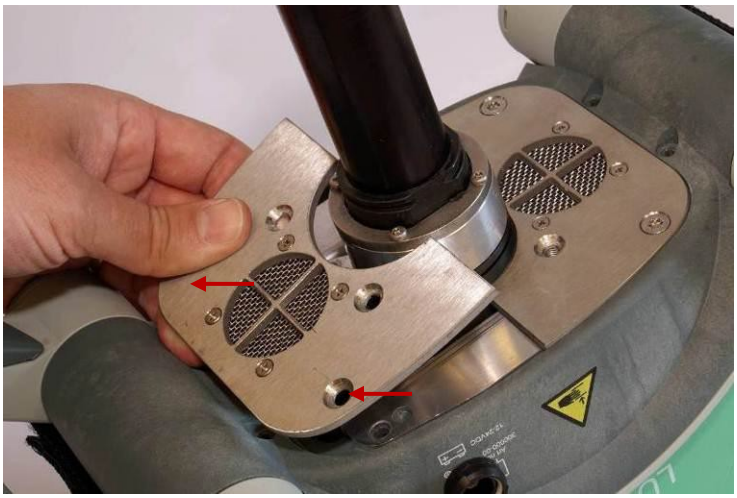
10. Motor Power Cable; use a small flat screwdriver to remove the cables, three wires:

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

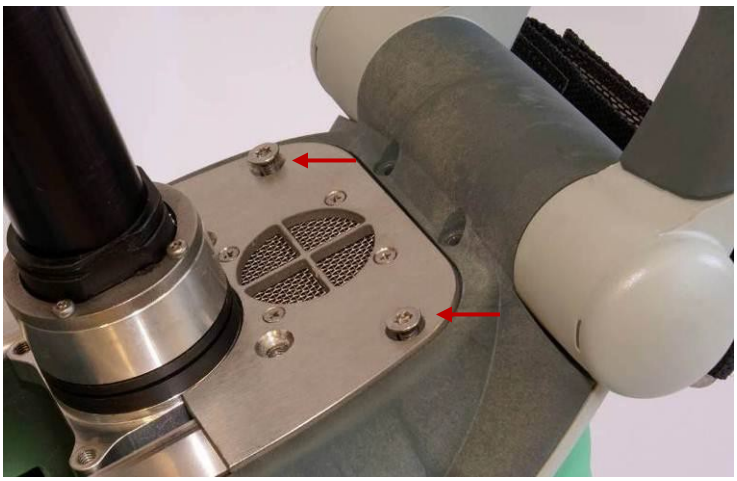
- From beneath, remove the four screws that hold the Compression Module with a *Torx 25 (T25)* Screwdriver.



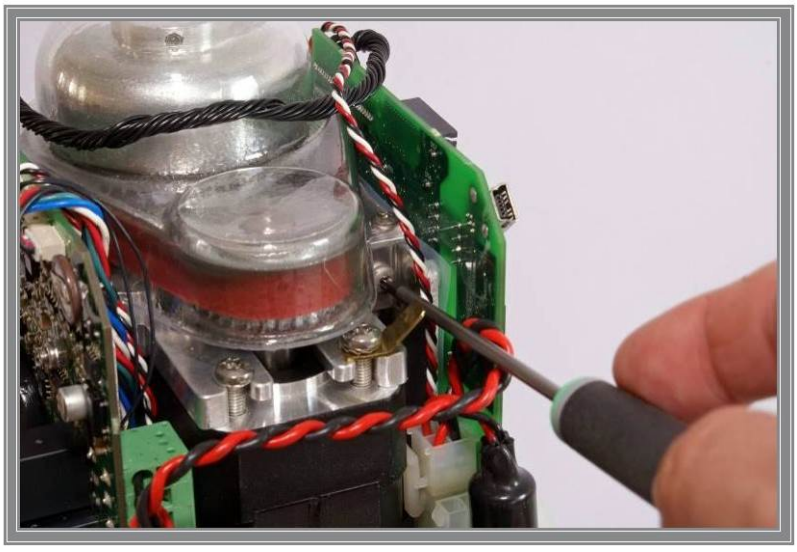
- Remove the two screws that hold the Fan Bracket with a *Torx 25 (T25)* Screwdriver, and remove the bracket.

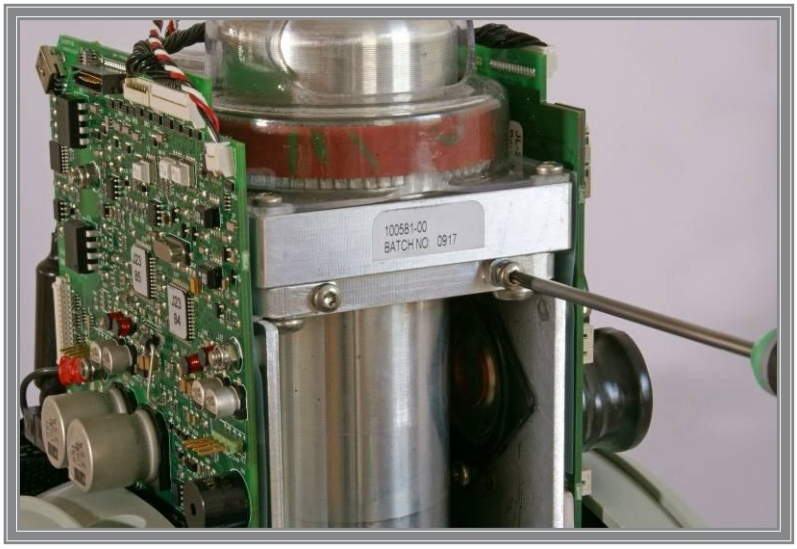


- Loosen the two remaining screws on the other bracket without removing them.



- 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 Copression Module, make sure that no cables get stuck or harmed especially the Linear sensor Cables.

2. Reassembling

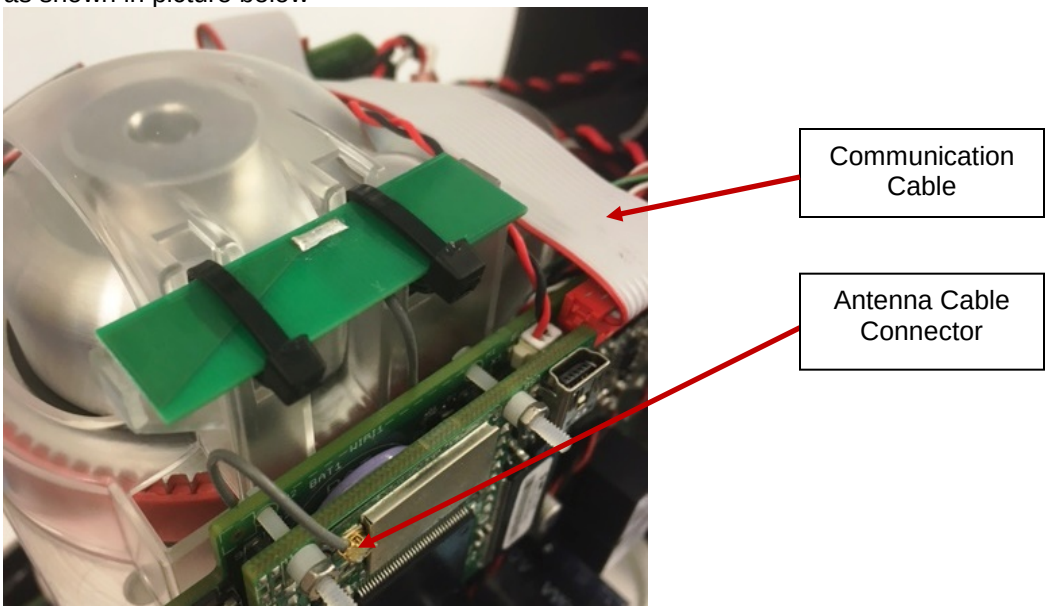
- Carefully lower the Compression Module down between the PCB's.
- Position the PCB boards and fasten the Compression Module in the PCB brackets, use thread lock fluid and tighten to 9.0 in-lbs / 1.0 Nm with a Torque Screwdriver *Torx 10 (T10).*
- Put back the Fan Bracket, use thread lock fluid and tighten 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

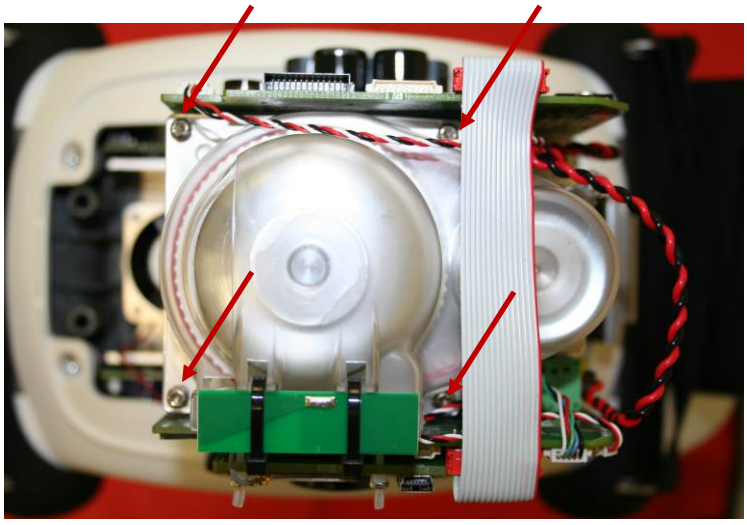
Perform a Function Check according to Function Check.

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.

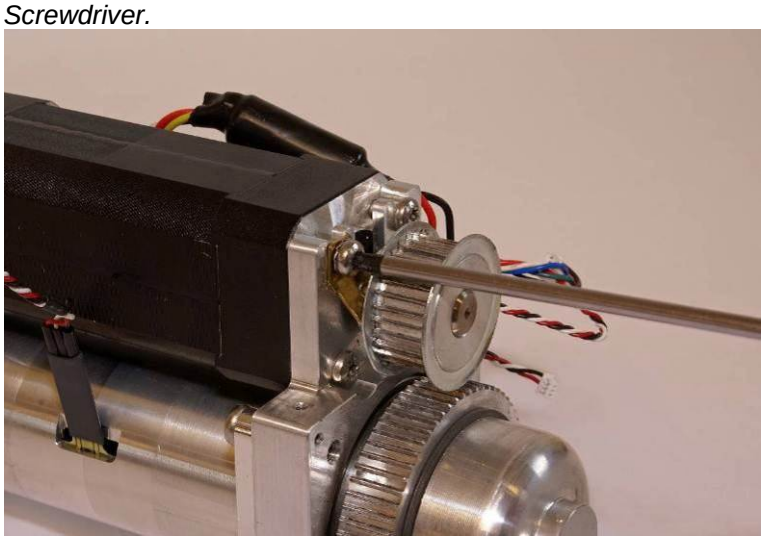
2. **Reassembling**
   - Thread the new Belt over the small Belt Wheel first.
   - Continue to Thread it over the Large Belt Wheel and turn the wheel at the same time to get the belt in place.

- 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.

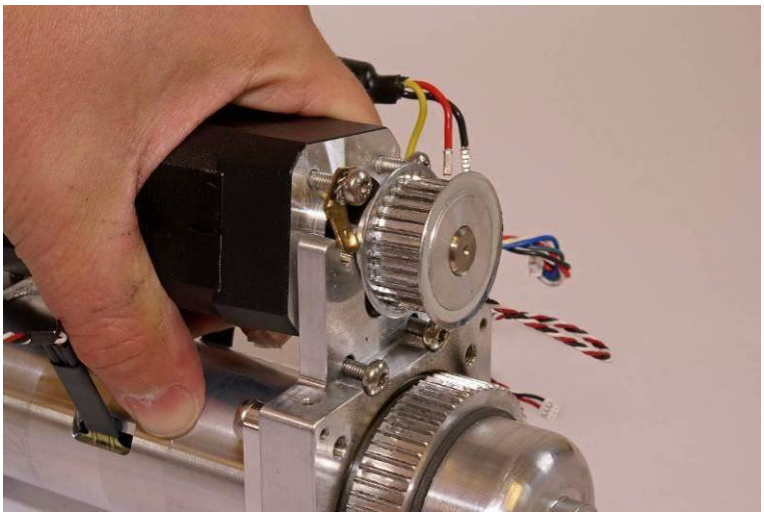
3. **Test**
   Perform a Function Check according to Function Check.

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.

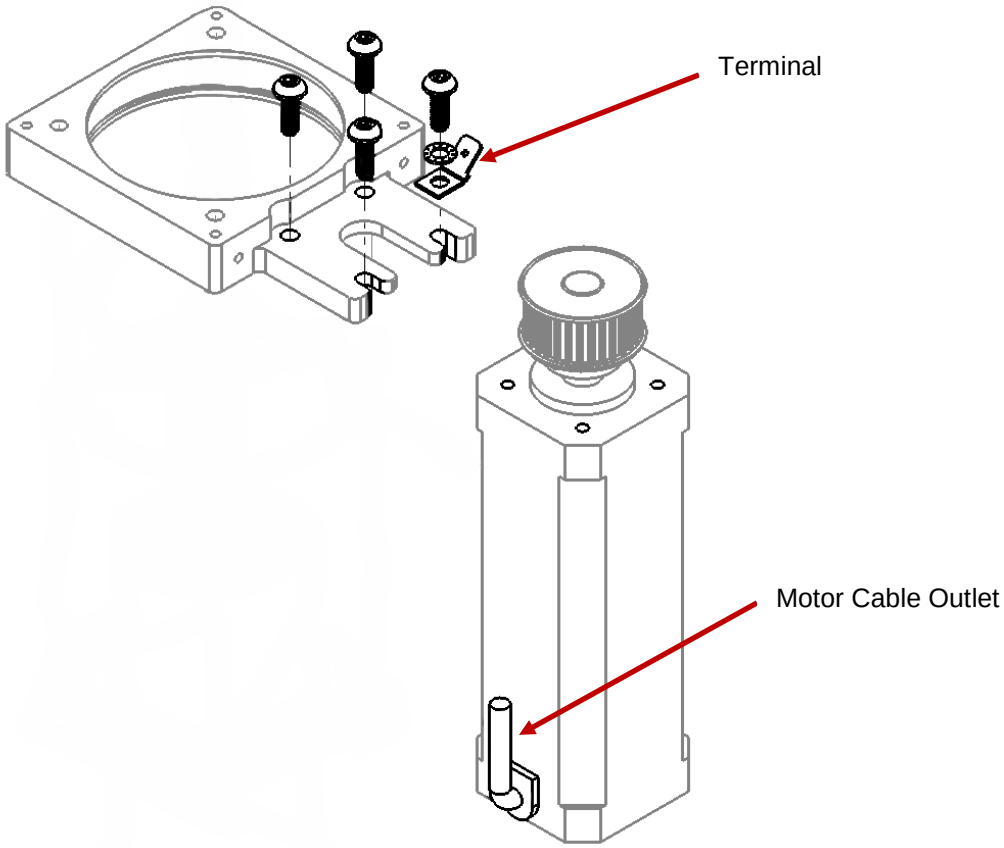


2. Reassembling

- 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.

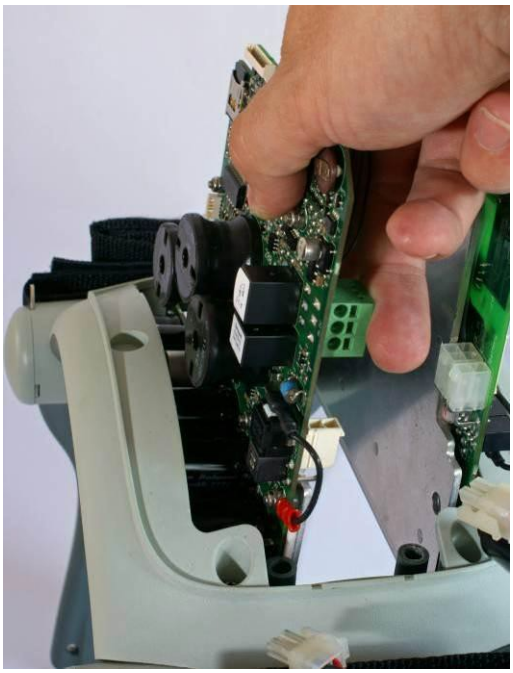


- Put back the Drive Belt according to **Reassembling** instruction in How to Replace the Drive Belt.
- Put back the Compression Module according to **Reassembling** instruction in How to Replace the Compression Module.
- Put back the Hood according to **Reassembling** instruction in How to Replace the 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.

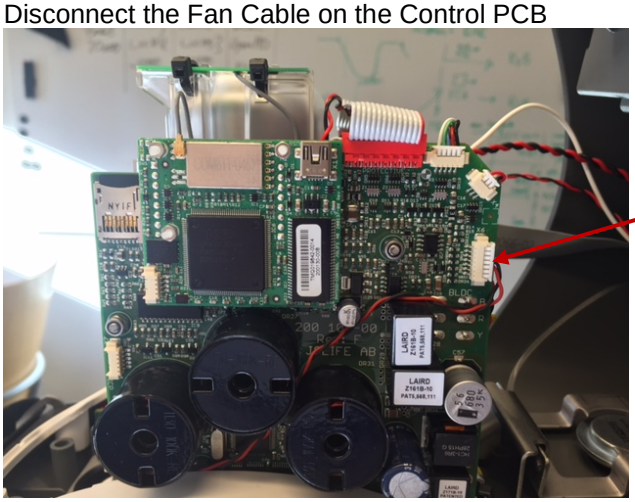
2. **Reassembling**
   - Put the new PCBA in place and fasten loosely with two screws together with the Bottom Plate with a *Torx 25 (T25)* Screwdriver.
   - Put back the Compression Module according to **Reassembling** instruction in How to Replace the Compression Module

- 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.

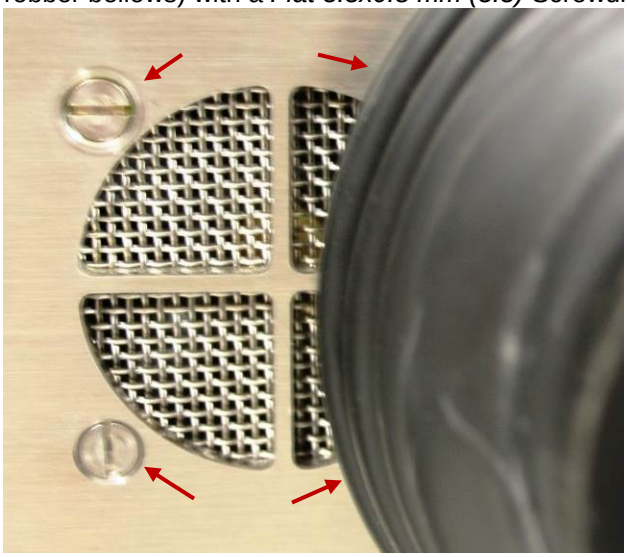
3. **Programming**
   - Connect a laptop and program the Protective PCB according to LUCAS® 3 Program Loader.
   - Check that “Device S/N”, Time and Date, “Total Number of Strokes”, “Hardware ID” and “Device Friendly Name” are correct (if possible check against “Store View” performed in Disassembling 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



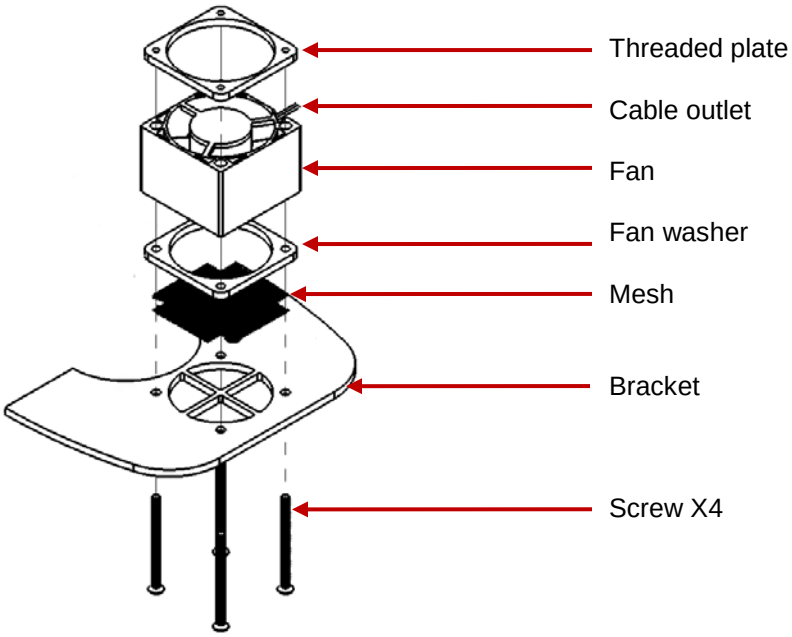
   - Remove the four screws that hold the Fan (under the battery side, two more screws are hidden under the robber bellows) with a *Flat 5.5x0.8 mm (5.5)* Screwdriver.



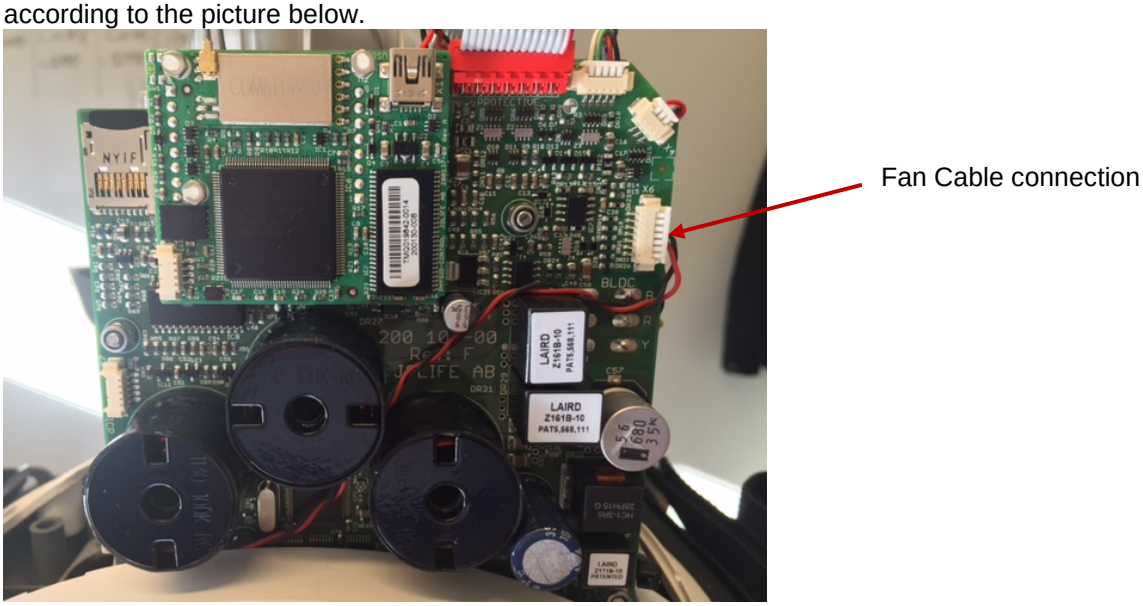
   - Take off the Threaded plate and lift out the Fan.

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.

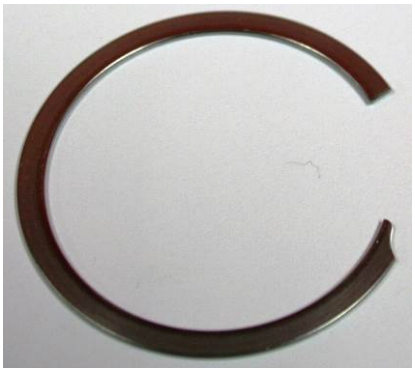
How to Replace the Support Leg

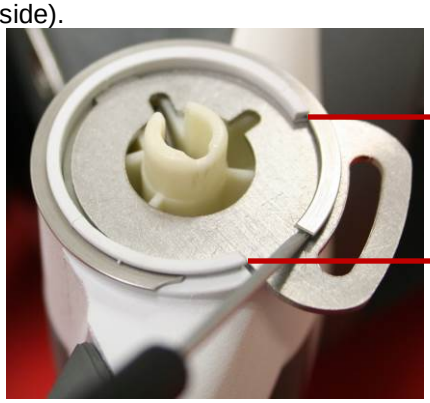
This procedure can be used for replacing the Support Leg or replacing the Axel-Angle Shaft.

1. **Disassembling**
   - Remove the Patient Strap.

   - Remove the Bumper.

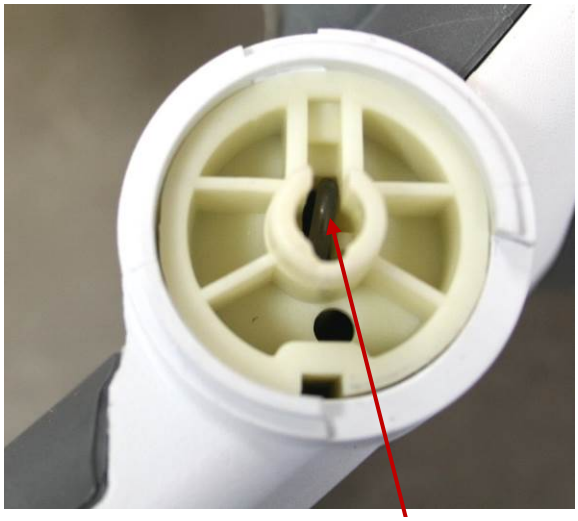
   - Remove Snap Ring by turning the open end of ring to the open edges of the leg, shown in the picture; and take it out (two rings, one on each side).



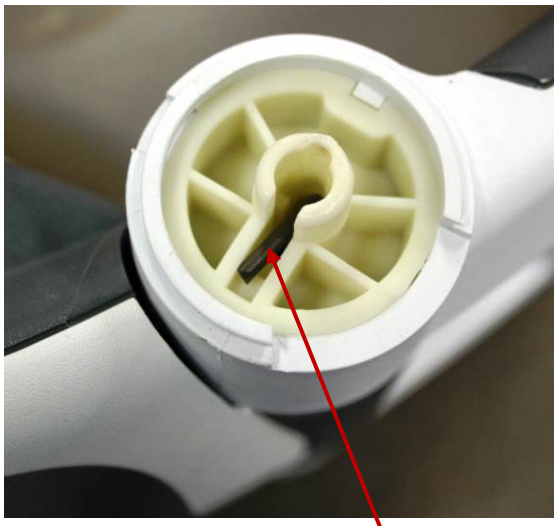


   - Remove the Patient Strap Holders (two, one on each side).

   - 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.

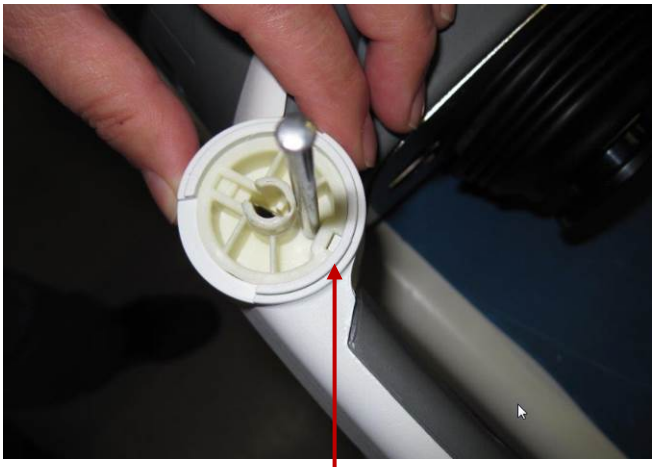
Knock the **Spring** from round end out of shafts.

Spring

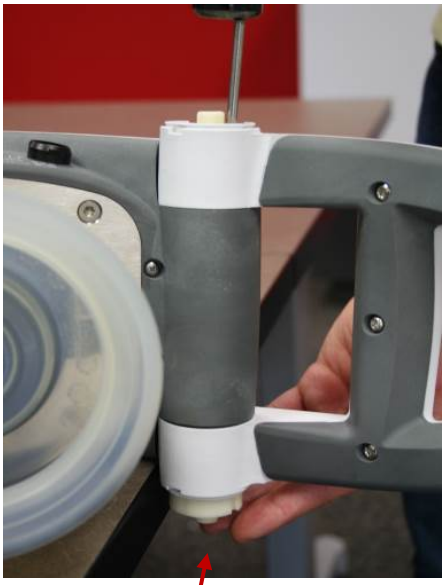
- When the **Spring** is removed from the Angle Shaft, turn the device over so the press fitted side is facing up. Using the metal Pin or similar tool and Hammer, push the bottom, non press-fitted Angel Shaft out of Support Leg. Always knock out the non press fitted Angle Shaft first.

Metal Pin

Angel Shaft



Press Fitted Side with Key



The bottom, non-press fitted Angel Shaft

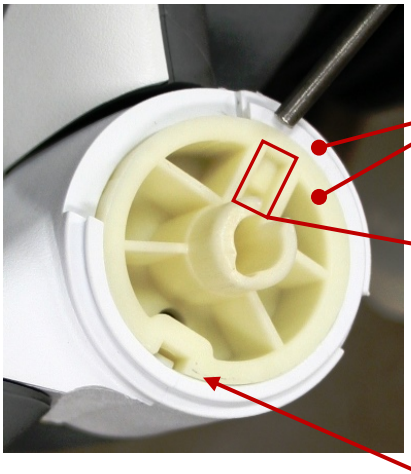
- Turn the leg on the other side; and use the Angel Shaft Tool (optional tool) or similar tool with a Hammer to knock out the press fitted Angle Shaft, which is fitted into the Main Body.

- 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

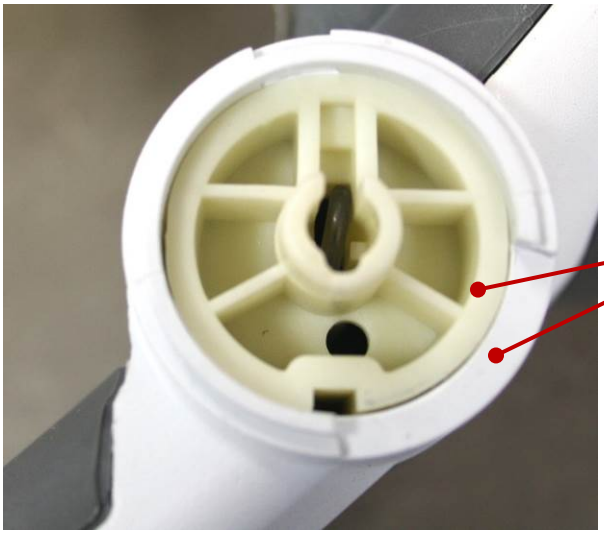
During this reassembling step, the keyways for the **Spring** should always be pointing towards the Compression Module on both shafts.
Note: Notch of the Angle Shaft pointing toward the claws.

- 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.

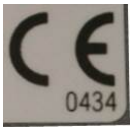
Skirt edge on the bottom

Type Label

- 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

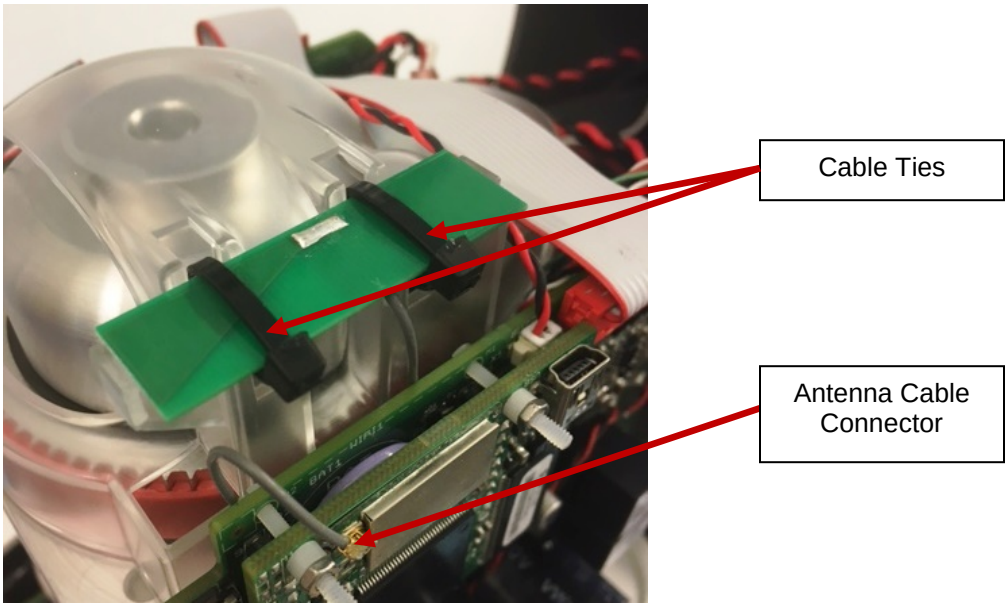
Do the following tests to verify that the repair/replacement has been performed correctly:

- 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

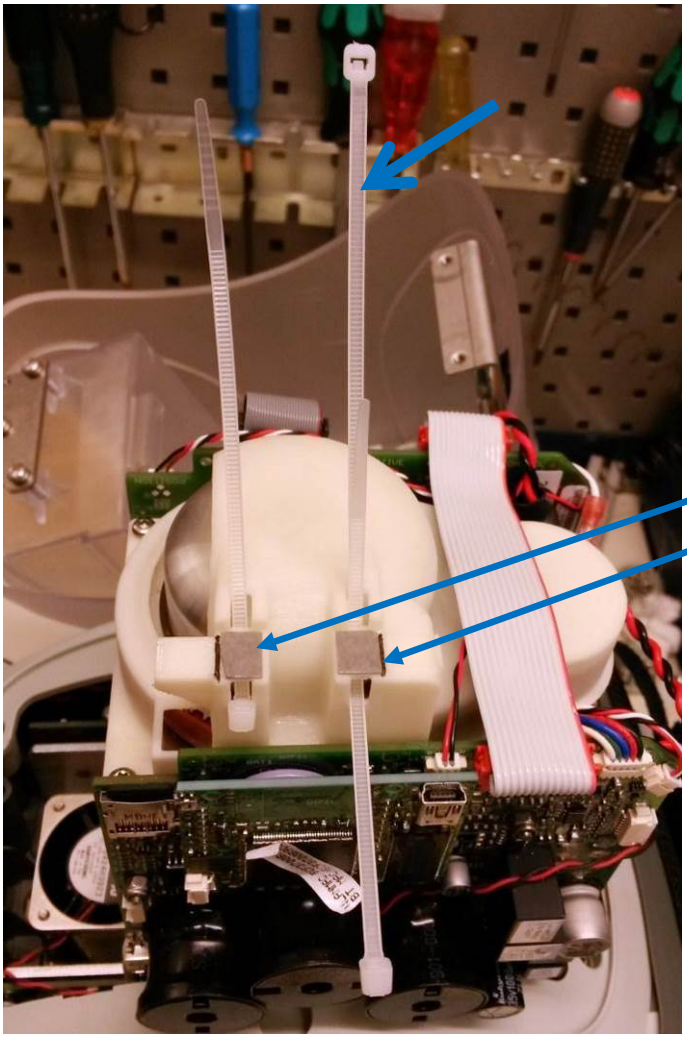
1. **Disassembling**
   - Remove the Hood according to instructions in How to Replace the Hood.
   - Cut out two cable ties



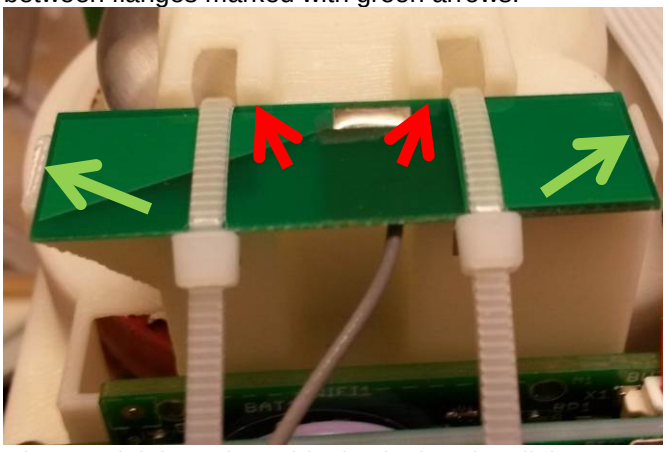
   - Disconnect the antenna cable connector from Communication Board
   - Remove the antenna board from the belt cover

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

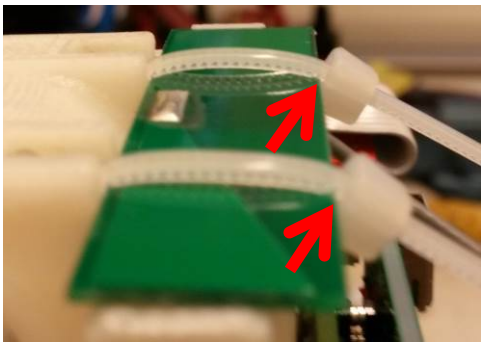
   - Use a third cable tie (marked with blue arrow in the picture) to guide the cable tie through the holes

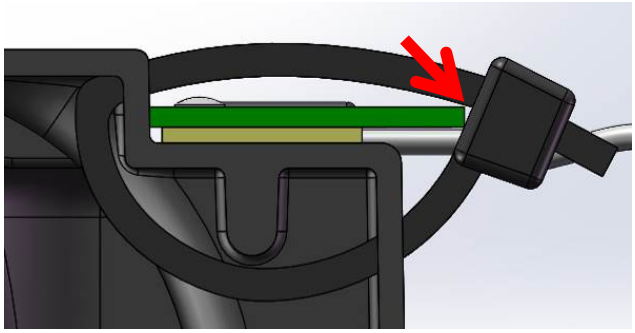


- Apply transfer tapes (approximate 7x8mm, 2x) to the belt cover, and remove the tapes protective top layer.
- Place the antenna on top of the transfer tapes and against the surfaces marked with red arrows and in between flanges marked with green arrows.

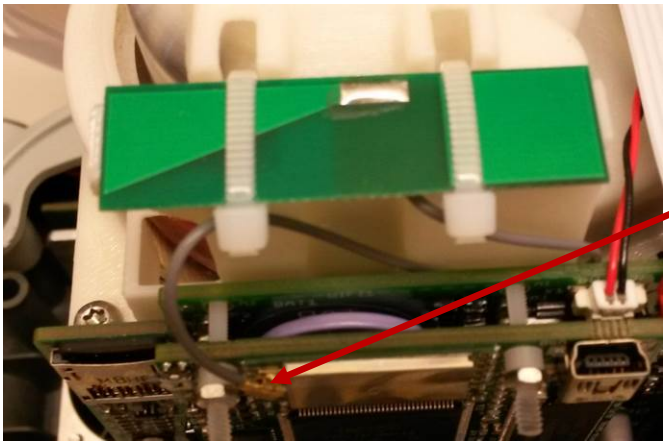


- Close and tighten the cable ties by hand until the antenna is secured as shown in the pictures below, with the cable tie closing position against the edge of the antenna board.





- 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.

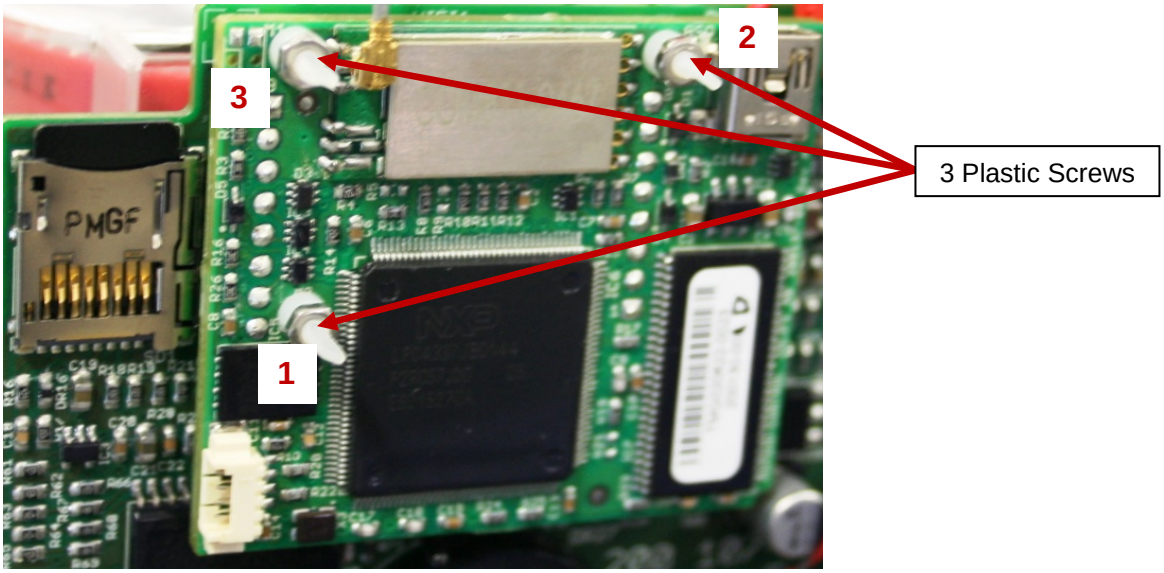


- Put back the Hood according to **Reassembling** instruction in How to Replace the Hood.

3. **Test**
   - Perform a Function Check according to Function Check

How to Replace the Communication PCB

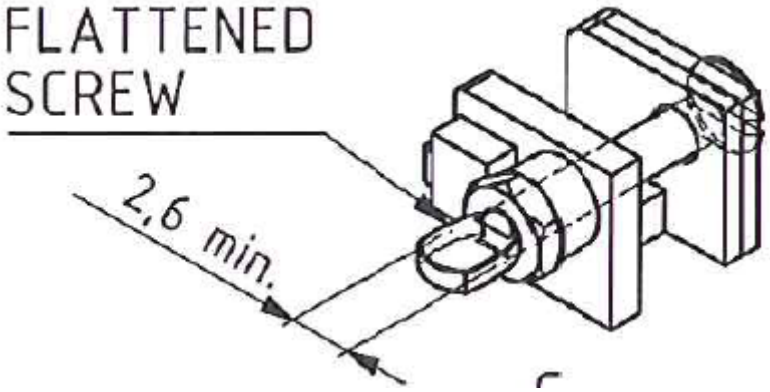
1. **Disassembling**
   - Before disassembling and changing any PCB and if possible; connect a laptop and perform “Store View” using LUCAS® 3 Program Loader.
   - Follow **Disassembling** instructions in How to Replace the Controller PCB to take out the Controller PCB.
   - Use a plier carefully cut 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 ¾ 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!

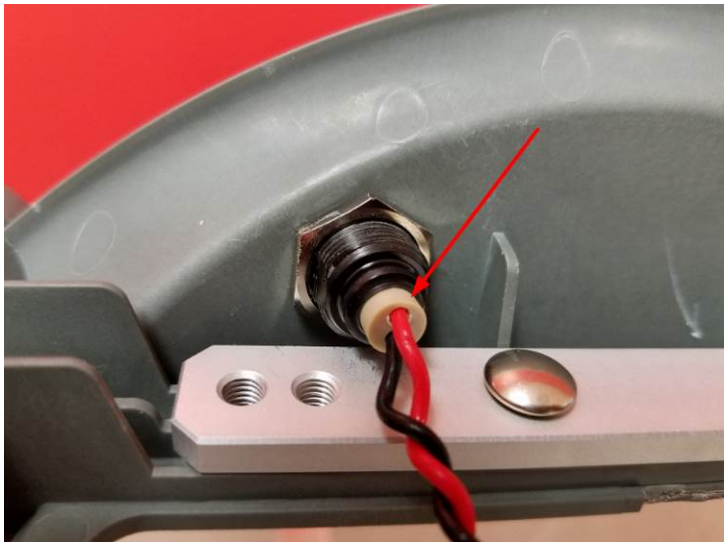
- Remove the four Torx 20 screws to remove the Main Body Lid.

- 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.

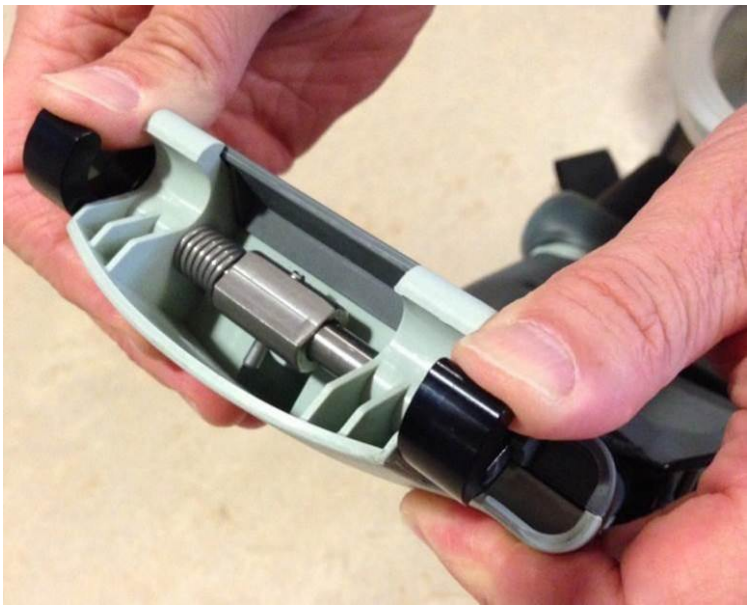
Mechanics Test

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 to 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)