

ZEISS EVO[®]

EPSE User Guide

Operator



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2 Basic Information

2.1 About this Handbook

This Handbook is intended to serve as both an installation manual for the Carl Zeiss EPSE and a user manual. It is divided into 3 main areas.

- Important Safety Information – Please ensure you are familiar with all the information in this section before installing or using the Carl Zeiss EPSE.
- Operating Instructions
- Installation Instructions

2.1.1 Explanation of symbols

The safety instructions in this service-handbook follow a system of three risk levels, that are defined as follows:



DANGER

This symbol and signal word calls your attention to the threat of a life-endangering situation.

*Disregarding this warning **WILL** lead to serious injury or death.*



WARNING

This symbol and signal word calls your attention to the threat of a danger to health or life

*Disregarding this warning **CAN** lead to serious injury or death.*

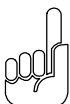


CAUTION

This symbol and signal word calls your attention to possible danger to health or equipment.

Disregarding this warning can lead to injuries or damage to the instrument or equipment.

Moreover you will find the following type of information:



NOTICE

This symbol and signal word call your attention to important and useful additional information

2.1.2 Typographical conventions

For the description of software, the following typographical conventions are used:

Typography	Meaning
Type <Ctrl + Alt + Del>.	Jointly type Ctrl key, Alt key and Del key on the keyboard
Type <key1, key2>.	First type key 1, then type key 2 on the keyboard
Push <ENTER>	Push the ENTER key on the keyboard
Click on the High Voltage icon. Select Aperture size from the drop down list.	Icons, buttons and drop-down menus are printed in bold.
Select Aperture size <i>30µm</i> from the drop down list. Set EHT Target to <i>zero</i>	Values to be selected are printed in italics.

2.2 Fundamental safety information

2.2.1 Safety Instructions

Follow the safety instructions given in this handbook. This is essential to prevent damage and to protect yourself and other persons against accidents and unsafe practises. Do not deviate from the instructions provided in this service-handbook.

This section summarises possible hazards and recommended safety procedures.

DANGER

Danger of life: High-Voltage electrical currents occurring in the electron microscope can be fatal. Only NTS field service engineers specially trained and certified by NTS are allowed to service the electron microscope. Safety interlocks are built into the system to protect the operator and to safeguard the equipment. Do not override the interlocks.

Mains Voltage:

When the SEM is shut down, mains voltage will still be present both within the plinth and on some of the external cables.



***ALWAYS SWITCH OFF THE SEM SWITCH AT THE REAR OF THE PLINTH TO ISOLATE THE INSTRUMENT FROM THE ELECTRICITY SUPPLY, BEFORE STARTING ANY MAINTENANCE WORK.
IN AN EMERGENCY, PRESS THE RED ILLUMINATED STOP BUTTON.***

The emergency stop button is located on the right hand side of the console at the front. Pressing it will interrupt the distribution of the mains supply within the console.

Do NOT use this switch as a means of isolating the SEM from the electricity supply, because some parts of the instrument will still be live. To isolate the SEM use the switch at the rear of the plinth or disconnect the mains input

cable.

**DO NOT REMOVE THE EARTH BRAID FROM THE EHT SET, OR THE CHASSIS WILL FLOAT AT HALF THE MAINS SUPPLY VOLTAGE.
DO NOT REMOVE THE EARTH BRAID FROM THE CHAMBER, OR THE COLUMN, CHAMBER AND THE EHT SET WILL FLOAT AT HALF THE MAINS SUPPLY VOLTAGE.**



WARNING

**Suffocation hazard when chamber door is opened due to lack of oxygen, since nitrogen may be used to ventilate the chamber. Inhaling nitrogen may cause unconsciousness.
Maintain a safe distance from the chamber door while it is open.
Ventilate the workspace well.**



CAUTION

**PCBs can be damaged due to electrostatic discharge (ESD).
When working on PCBs, take precautions to prevent electrostatic charge; wear wristbands and cotton clothes. Use grounding pad and special instruments to discharge.**



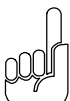
CAUTION

Panels and covers: For safety reasons and to comply with EMC regulations, do not operate the SEM with any panel or cover removed.



CAUTION

When in use, the Backscattered Detector occupies a thickness of between 3 to 7 mm directly below the final lens. The EPSE diode will be irreversibly damaged by a collision with a sample.



NOTICE

**Fingerprints can cause virtual vacuum leaks. NEVER handle components and mechanisms that are subject to vacuum with bare hands.
Always wear lint-free gloves when handling inner parts of the vacuum system.**

3 Operation

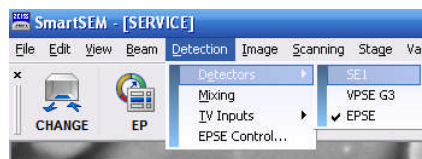
3.1 Introduction

This chapter contains information about the day-to-day operation of the EPSE system. It is split into the following sections:

- Quick Start – a guide on how to get the EPSE up and running and obtaining an image;
- Maximising Performance – advice for the conditions for getting the best image quality out of the EPSE system;
- Further Information – advanced information about the operation of the EPSE system.

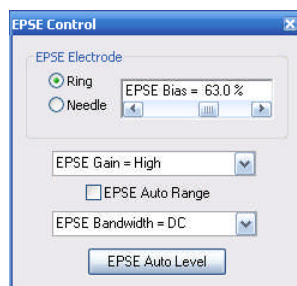
3.2 Quick Start

- 1 Obtain and focus an image using the **SE1** detector using 30 kV and 1.5 nA.
- 2 Select **EPSE** from the **Detection** ► **Detectors** submenu of SmartSEM™.



Selection of the EPSE detector.

- 3 Open the **EPSE Control** dialog by selecting **EPSE Control** from the **Tools->Goto Panel** dialog.
- 4 Select **EPSE Gain = High** from the **EPSE Control** dialog



The EPSE Control dialog.

- 5 Set **Contrast = 20%**.
- 6 Set **Brightness = 50%** and click **EPSE Auto Level**.
- 7 Adjust **Contrast** to get the desired image.

- 8 If the Contrast is very high or low it may be necessary to change **EPSE Gain** to a different range. Go down a gain range if the contrast is very low or up a gain range if the contrast is very high.

3.3 Maximising Performance

The EPSE is measuring the current generated at the sample by the primary electron beam.

Factors to maximise the signal include:

- Working in VP/XVP/EP increases Signal to Noise ratio (compared to high vacuum mode).
- Reducing the microscope scan speed.
- Increasing the microscope Probe Current, i.e., increase **I Probe**
- Obtain a **WD** = 4 to 6 mm and 0° sample tilt.
- Increasing the accelerating voltage of the SEM, i.e., increase **EHT**

3.3.1 Probe Current

The signal to noise ratio is also a function of the probe current. The higher the probe current, the better the signal to noise ratio at the expense of resolution. The balance between probe current and resolution needs to be considered:

- The probe current should be set so it is high enough for the required image (high signal to noise ratio),
- The probe current should also be set that it is small enough to give the minimum electron probe spot size for the resolution required.

NOTICE

The following should only be performed by Carl Zeiss Electron Microscopy Engineers or an authorised agent:-

- *Should finger marking occur, they may be removed by very careful wiping with a soft tissue.*
- *Stubborn contamination can usually be removed by cautious use of solvents such as alcohol.*



3.4 Further Information

The Zeiss EPSE is controlled by the SmartSEM[®] software. This section details the operation of the relevant parts of the user interface.

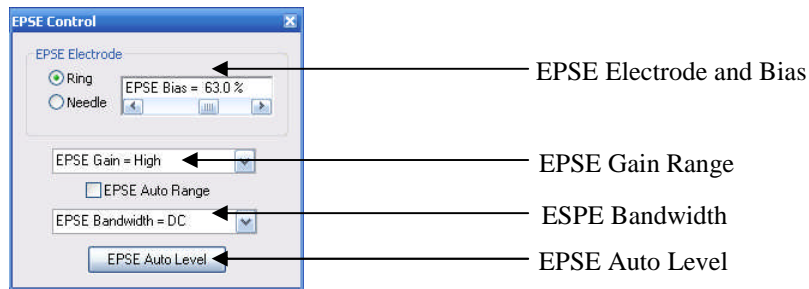


Image of the EPSE Control dialog

3.4.1 Electrode and Bias

To be written.

3.4.2 Gain Ranges

The gain range of the EPSE is adjusted by either using the **EPSE Gain** drop down in the **EPSE Control** dialog or the **Gain Control** in the **Status Bar**.

The EPSE electronics can operate at 4 different gain ranges labelled:

- **EPSE Gain = Low**
- **EPSE Gain = Medium**
- **EPSE Gain = High**
- **EPSE Gain = Very High**

The **Contrast** control adjusts the gain within these ranges.

If an image is obtained at a low contrast, i.e., **Contrast** <15%, a superior image may be obtained by changing to a lower gain range. Changing to a higher gain range may also be advantageous if **Contrast** > 85%.

3.4.3 EPSE Auto Range

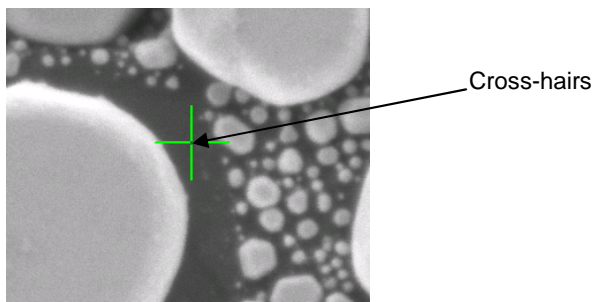
Selecting **EPSE Auto Range** will compress the four **EPSE Gain** ranges above into one 0-100% scale. At 25%, 50% and 75% there will be a short disturbance to the image as the electronics changes gain ranges.

3.4.4 EPSE Auto Level

The **EPSE Auto Level** button is used to automatically trim the EPSE electronics to the sample image. To get the best out of this function, set **Brightness = 53%** before selecting **EPSE Auto Level**. An image should appear. Adjust the **Contrast** then **Brightness** and to get the desired image.

The **EPSE Auto Level** function analyses the current EPSE video signal and attempts to set a mid grey pixel level in the image to coincide with a brightness of 50%. A manual selection of pixel intensity can be achieved with the following procedure:

- 9 Select **Scanning** from the main menu bar and navigate and select **Spot**. This will put the scanning system into spot mode.
- 10 A set of green cross-hairs will appear as show below



- 11 Set the position of the cross hairs to the point of interest
- 12 Select the **EPSE Auto Level** function
- 13 Set the scan mode back to normal (Select **Normal** from the **Scanning** option on the main menu).

3.4.5 EPSE Bandwidth

The EPSE Bandwidth is adjusted by using the **EPSE Bandwidth** drop down in the **EPSE Control** dialog at the bottom of the **EPSE Control Panel**. In normal usage the EPSE Bandwidth should be left in the default **EPSE Bandwidth = DC** mode.

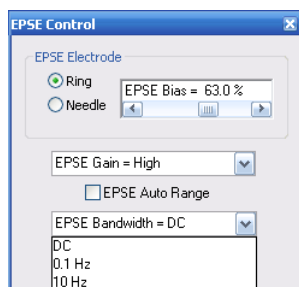


Image of the EPSE Bandwidth drop down.

However, in some circumstances low frequency noise from the electronics may impair image quality. This will appear banding at low scan speeds, i.e., **Scan Speed = 10** or slower. The amount of disturbance may be reduced, or eliminated, by using **frame averaging or frame integration at scan speeds 6 or 7**.

In the cases of **EPSE Bandwidth = 0.1 Hz** and **EPSE Bandwidth = 10 Hz** the EPSE electronics is instructed to operate in an AC coupled mode. In this mode the DC component of the video signal is rejected and only the AC component is presented to the user. The 0.1 and 10 Hz values correspond to the time constant of the high pass filter.