9.1 PERFORMANCE

Resolution (secondary electron image):	
	1.0 nm guaranteed (at accelerating voltage15 kV) 1.4 nm guaranteed (at accelerating voltage 1 kV, in GB mode) 2.0 nm guaranteed (at accelerating voltage 1 kV, in SEM mode)
Magnification	
LM (low magnification) mode:	×25 to ×19,000
SEM mode:	×100 (at WD 25 mm) to ×1,000,000 (at WD 8 mm)
Automatic magnification correction function:	
	Available
Switching from any magnification to a preset magnification:	
	Possible
Image rotation correction:	Provided, for WD in each EOS mode
Image modes:	Secondary electron image (SEI) Backscattered electron image (BEI) (option, composition image and topography image are obtained)
Accelerating voltage	
SEM mode:	0.5 to 30 kV (10 V steps from 0.5 to 2.9 kV) (100 V steps from 2.9 to 30 kV)
GB mode:	0.1 to 4.0 kV (100 V steps)
Probe current:	Order of 10^{-13} to 2×10^{-9} A

9.2 SPECIFICATIONS

9.2.1 Electron Optical System (EOS)

■ Electron gun

Type:	Field emission gun with cold cathode
Emitter:	Tungsten single crystal <310> cathode
Emission current:	Variable in 4 steps (2, 5, 10, and 20 μA)
Axis alignment:	Mechanical alignment and electromagnetic deflection

■ Lens system

EOS modes:	SEM, LM, GB
Condenser lens (CL):	Electromagnetic lens
Aperture-angle control lens (ACL):	Electromagnetic lens
Objective lens (OL):	Low aberration objective lens
Lens clear function:	Provided for hysteresis elimination (in CL and OL)
Automatic focusing:	Provided (function in SEM mode). Manual focusing is also available.
Focus link:	Provided. Linked with accelerating voltage
Automatic magnification correction:	Provided. Linked with accelerating voltage and WD
Image rotation correction:	Provided. Linked with WD in each EOS mode
OL aperture:	Installed. Fine adjustment in X and Y directions possible
Wobbler:	Provided for aligning axis of OL aperture and stigmator center. Linked with magnification
Automatic stigmator:	Provided. Manual adjustment is also available.
Dynamic focus:	Provided. Used for correcting specimen tilt, linked with accelerating voltage, magnification, and WD
Scanning coil:	Electromagnetic 2-stage deflection
Scan rotation:	Provided, with image rotation correction for WD in each EOS mode
Electromagnetic image shift:	±5 μm in X and Y directions (SEM mode, WD 15 mm)
Memory preset function:	Axis-alignment and stigmatic-correction parameters can be preset for accelerating voltage and WD
User login function:	Each user can set the following items. • Password for using personal files • File for saving observation conditions • File for saving image data • Directory for storing image files • Setting format for storing image files
Recipe function:	You can save and load the standard observation conditions, personal observation conditions, and observation conditions for specific specimens. A recipe may contain the following parameters.

Accelerating voltage, observation mode (SEM, LM, GB), probe current settings, focus settings, depth of focus, magnification, contrast/brightness settings, input signal (SEI, TOPO, COMP, AUX), image mode, automatic exposure (contrast/brightness), stage position (X, Y, Z, T, R), stage voltage (in GB mode), γ-filter, alignment values, display of image under stored observation conditions

9.2.2 Specimen Stage (Type 1A, SM-71480)

The computer controls the five axes of this specimen stage: X, Y, Z, T, and R.
The following functions are available by using the original graphical user interface and the operation panel.

- The stage automatically moves to center the point that you specified on the observation display using the mouse (point shoot function).
- A stored image (up to four images can be stored) can be moved in the same way (image shift function).
- You can switch the stage movement and image shift by using the mouse button. So, you can quickly search for the point of interest by switching the coarse movement (stage movement) and the fine movement (image shift).
- You can rotate the specimen about the image center irrespective of the location of the specimen stage center. So, you can easily observe the stereoscopic view by tilting the specimen (rotation eucentric function).
- The trackball rotates in the same direction as the image movement.

Stage type:	Fully eucentric goniometer stage Computer-controlled 5-axis (X, Y, Z, T, R) motor driven with backlash correction.
Specimen movements	
X-axis:	70 mm (motor driven, manual available)
Y-axis:	50 mm (motor driven, manual available)
Z-axis:	1.5 to 25 mm (continuous)
Tilt:	–5° to +70°
Rotation:	360° endless (motor driven)
Specimen-position indications (X, Y, Z, T, R):	On the observation display and beside each motor
Specimen-position file:	Storing and loading of specimen coordinates (X, Y, Z, T, R)
Coordinate specification:	You can specify the stage coordinates (X, Y, Z, T, R) in absolute or relative values.
Motor drive control:	Trackball operation (X, Y, Z, or R), or button operation (X, Y, Z, T, R)
Mouse operations on the observation display:	Point shoot (move to the center), step movement, holder map movement, image shift, with rotation eucentric function, with correction function for image moving direction

Specimen holders:	For 12.5 (ϕ) × 10 (H) mm specimen, and for 26 (ϕ) × 10 (H) mm specimen Mesh holder (12.5 (ϕ) × 10 (H) mm) Optional specimen holders for 32 (ϕ) × 20 (H) mm specimen and 152.4 (ϕ) × 10 (H) mm specimen are available
Selecting specimen holder:	Selectable from the standard holders and optional holders. Addition/deletion of the holders is possible
Movement range restriction:	Selecting a holder sets the range automatically (X, Y, Z, T, R). Locking/unlocking of axis is possible (X, Y, Z, T, R)
Specimen exchange chamber:	Specimen exchange chamber type 1 (SM-71010), air locking. Specimen holder of the size up to 150 (ϕ) × 10 mm (H) can be installed.
Specimen exchange:	Single touch chucking
Absorbed-current measure terminal:	Built-in
Specimen protection buzzer:	Built-in
Installing EDS in specimen chamber:	Exclusive-use EDS port (X-ray radiation angle is 35° with specimen stage of WD 8 mm. Probe current fluctuation detector is built-in)

9.2.3 Electron Detector System

■ Secondary Electron Image

- **Upper detector**

Consists of collector, scintillator, light guide and photomultiplier tube

Secondary-electron accelerating voltage:	10 kV
Video amplifier control:	Adjustable using the contrast and brightness knobs
r-filter:	Built-in

- **Lower detector**

Consists of collector, scintillator, light guide and photomultiplier tube

Secondary-electron accelerating voltage:	10 kV
Video amplifier control:	Adjustable using the contrast and brightness knobs

- **Low-angle backscattered electron detector (SM-74160LABE)**

Consists of silicon P-N junction and amplifier

Amplifier control:	Adjustable using the contrast and brightness knobs

■ Noise Canceller

Detector:	Fine adjustment in X and Y directions is possible from outside of vacuum. Preamplifier is built-in. Probe current fluctuation detector is built-in.
Image signal:	Digital signals selected by image selector
Amplifier gain:	Linked to accelerating voltage and extracting voltage

9.2.4 Scanning/Observation System

The system displays a high-quality image in real time with 1,280×960 pixels using the special-purpose graphical user interface. You can easily operate the instrument, from setting the observation conditions to observing the images, by operating the operation panel and keyboard.

Liquid crystal display for image observation (SM-75031)

Display size:	17 inch
Number of pixels:	1,280 × 1,024

SEM Control System

Computer:	IBM PC/AT compatible computer (SM-77220PC)
RAM:	512 MB or more
OS:	Windows XP professional

✍ Windows is a trademark of Microsoft Corporation.

Operation:	Graphical user interface under Windows XP. Operations using mouse and on the operation panel. Keyboard is used for entering characters and other operations.
Scan and display modes:	Full-frame scan, real magnification, selected-area scan, two-image display (with different magnifications, different image modes), two-image wide display, four-image display (four-signal live display), addition image (4 images + addition image), scale
Scan speed:	Four speeds can be selected from the following 12 speeds (speeds for 1,280 × 960 pixels scan).

	Scan speed at 50 Hz (60 Hz)	
No.	Horizontal (ms)	Vertical (s)
1	0.053	0.08
2	0.107	0.16
3	0.213	0.3
4	0.427	0.5
5	0.853	1.0
6	1.71	1.8
7	3.41	3.6
8	6.83	7.0
9	18.03 (15.54)	19 (16)
10	37.44 (32.04)	39 (32)
11	76.37 (65.59)	77 (64)
12	115.4 (114.8)	116 (112)

( ) shows the scan speed at 60 Hz

Pixels in image display area:	1,280 × 960, 800× 600
Image mode:	SEI, TOPO, COMP, LEI, AUX, ADD

Displayed contents:	Image, image observation on/off switch, accelerating voltage, accelerating-voltage selection switch, emission current, reset switch, main menu, observation-mode selection switch and palettes for selected mode, film photo number, dialog display
Entering characters:	Using keyboard
Data display:	Accelerating voltage, image signal, observation mode, magnification, WD, micron marker, label date and time
Data display position:	Horizontally displayed at bottom of image
Measuring distance:	Distance in X, Y, and diagonal directions using cursor. Angle is also displayed.
Reference image and comments:	Reference image can be selected and pasted. Comments can be entered using keyboard.

9.2.5 Image Processing

Functions	
Averaging:	1 to 1,024 times
Integration:	1 to 256 times in powers of two
Color mode:	Black and white Pseudo color (2-color composite image)
Look-up table (LUT):	γ correction, binary coding, multiple-value coding, histogram
Gray scale:	Can be displayed
Image processing functions:	Sharpening, smoothing, median, Gaussian, edge enhancement

9.2.6 Automatic Functions

Automatic focusing:	Possible. Combination with ACB is also possible.
Automatic correction of stigmatic aberration:	Possible. Combination with ACB is also possible.
Automatic exposure:	Possible. Automatic memorizing of observation image contrast and brightness settings possible.

9.2.7 Image Filing

Displayed items:	Directory and name of the image file, list of images in the file, observation conditions of the selected image
Image data in a file:	Image data (in 8-bit or 16-bit gradation) and text data (observation conditions)
File formats:	BMP, JPEG, TIFF
Number of files:	Depends on the disk capacity (1.28 MB/image for the BMP format)
Simple report:	Pasting an image on a formatted-report frame and printing it possible

9.2.8 Evacuation System

Gun chamber, first and second intermediate chambers:
Ultra high-vacuum dry evacuation system using ion pumps

Specimen chamber:	Dry evacuation system using a turbo-molecular pump (TMP)
Nitrogen gas connector:	Built-in (with automatic stopper for nitrogen-gas venting) ✍ The customer must provide a coupler ISO 7/1 Rc 1/4.
Ultimate pressure	
Gun chamber:	Order of 10^{-7} Pa (for standard configuration)
Specimen chamber:	Order of 10^{-4} Pa (for standard configuration)
Evacuating time required	
Specimen exchange chamber:	Approx. 1 min. (vacuum control using Pirani gauge)
Gun-chamber isolation valve:	Built-in (pneumatic drive. Linked to accelerating voltage on/off switch and specimen-exchange chamber isolation valve. If an optional RBEI is installed, the valve is linked to in/out of RBEI)

Specimen-exchange chamber isolation valve:
Built-in, automatic pneumatic drive

Vacuum gauges:		
Pirani gauge	×3 for monitoring ion-pump currents (for gun chamber, and first and second intermediate chambers)	
Ion pumps:	60 L/s	×1
	20 L/s	×2
Turbo-molecular pump:	270 L/s	×1
Oil rotary pumps	100 L/min (with line trap)	×1

9.2.9 Safety Devices

Safety devices are provided to protect against an increase in pressure, water stop, power failure, insufficient nitrogen-gas pressure, and leakage of current.

9.3 INSTALLATION REQUIREMENTS

Power and grounding

Power:	Single-phase, 200 V AC, 50/60 Hz, 4 kVA maximum, 1.4 kVA in normal use
Grounding terminal:	100 Ω or less × 1

Cooling water

Faucet:	14mm outside diameter or ISO 7/1 Rc 1/4 ×1
Flow rate:	0.3 to 0.5 L/min
Water pressure:	0.05 to 0.25 MPa (gauge pressure)
Water temperature:	20 ± 5 °C
Drain:	25 mm inside diameter or ISO 7/1 Rc 1/4 ×1

Dry Nitrogen Gas

Pressure:	0.4 to 0.5 MPa (gauge pressure)
Coupler:	ISO 7/1 Rc 1/4

✍ Dry nitrogen gas must be provided by the customer.

Installation room

Temperature:	20 ±5 °C
Humidity:	60% or less
Stray varying magnetic field:	0.3 μT (p-p) or less (50/60 Hz sine wave, WD 15 mm, accelerating voltage 30 kV)*
Floor vibration:	3 μm (p-p) or less at sine waves of 5Hz or higher frequency*
Acoustic noise:	75 dB or less with flat characteristics*
Floor space:	3,000 × 2,800 mm or more
Door size:	1,000 (W) × 2,000 (H) mm or more

✍ Consult your local JEOL service office if a door size is 900mm.

* These items are the minimum requirements for this specification. The stray varying magnetic field, floor vibration and acoustic noise in the installation room should be measured before installation by JEOL personnel to determine the maximum observable magnification.

Dimensions and masses

	Width (mm)	Depth (mm)	Height (mm)	Mass (kg)
Main unit	790	1,125	1,800	750
Operation and display unit	1,200	1,000	700	250
Oil rotary pump (RP)	465	180	270	25

INSTRUCTIONS

JSM-7500F
JSM-7500FA

FIELD EMISSION SCANNING ELECTRON MICROSCOPE

OPERATION GUIDE

This document is for common use with:

SM-77430SCS3

For the proper use of the instrument, be sure to read this instruction manual. Even after you read it, please keep the manual on hand so that you can consult it whenever necessary.

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