

# Dr. SPECKLE

## Speckle Contrast Measurement System



**Model: SM01VS09**



レーザー学会産業賞 貢献賞  
Laser Industry Contribution Award



13th New JSPMI Prize  
(The Director-General's Prize)

***Oxide Corporation***

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# Speckle evaluation tool for laser display development

Speckle is the laser interference pattern formed on human eye retina. Speckle noise markedly hazardous in resolving the image detail in laser displays. Precisely measuring speckle is the first step for speckle reduction devices development.

## Applications

Speckle noise evaluation of laser displays and laser lighting.

## Samples

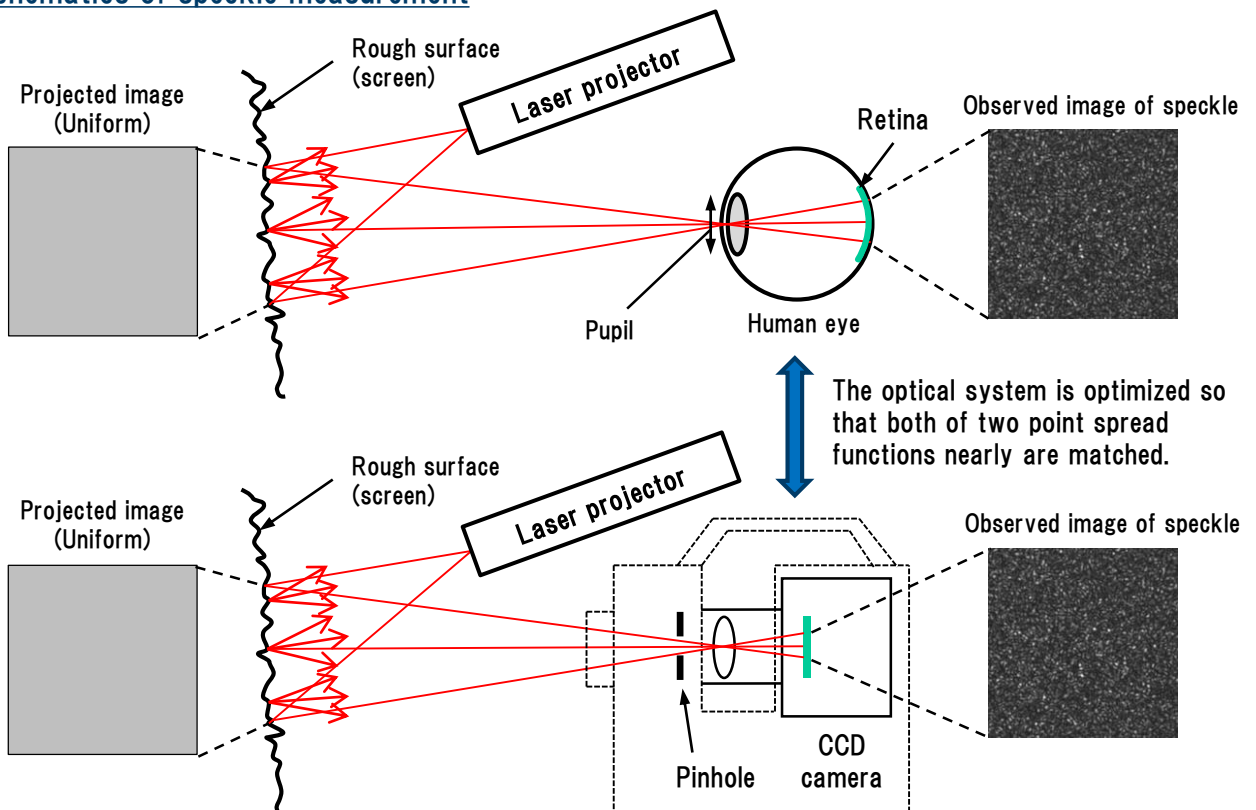
- Laser displays:  
Pico-projector, Large venue projector for cinema theater, Laser TV, Automotive head-up display (HUD), etc.
- Optical components of Laser display:  
Laser source, Spatial light modulator (SLM), Speckle diffuser, Screen, etc.
- Laser headlights, Laser lighting, etc.



## Features

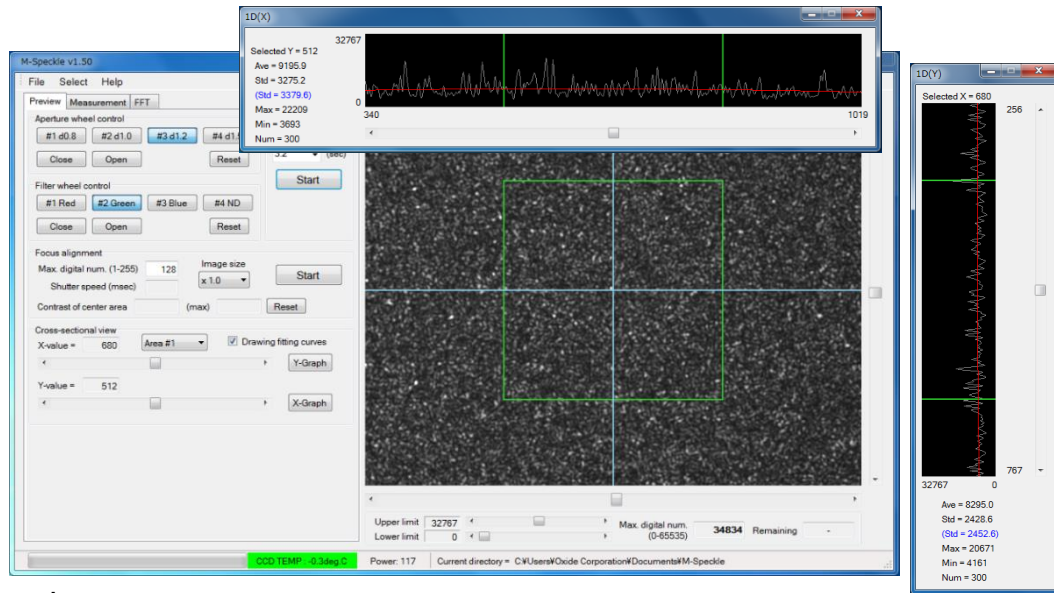
- The SM01VS09 simulates the point spread function of the human eye with a CCD camera.
- The speckle contrast calculable as a quantitative measurement index of speckle noise.
- The SM01VS09 meets the international standard, IEC 62906-5-2:2016.
- The SM01VS09 is equipped with a dedicated software developed in-house.
- High repeatability and dynamic range, thanks to a cooled CCD camera and an original algorithm.
- Two types of non-uniform background luminance distributions correctable.
- The speckle average grain size calculable.
- The SM01VS09 is conveniently portable using a camera tripod for 5kg load.

## Schematics of speckle measurement



# M-Speckle measurement software version 1.5 Running on Windows 10

- The M-Speckle is a dedicated software for the speckle contrast measurement system.
- Two editions of the M-Speckle are available, a standard edition and a premium edition.
- The premium has some functions shown in the table below in addition to the standard.
- The M-Speckle has three optional functions which can be added to the standard or the premium.



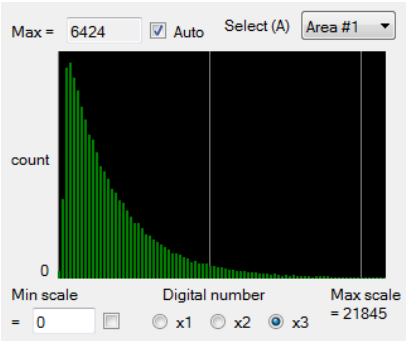
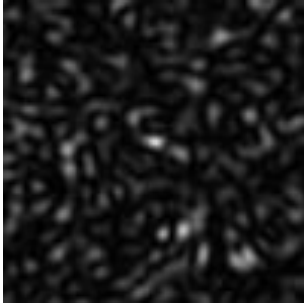
## Main functions

Items	Functions	Edition
Control system	Temperature control of a cooled CCD camera (0 °C fixed, automatic)	Standard
	Capturing in focus adjustment (shutter speed is automatically set, consecutive shooting)	
	Capturing in preview (shutter speed is selectable, single/consecutive shooting)	
	CCD camera's numerical aperture selection	
	Filter wheel control	Optional function
	Capture operation by external trigger input signal	
Capturing image	Histogram (horizontal axis: digital number, vertical axis: pixel counts)	Standard
	Cross-section views in the X-direction and Y-direction	
	Hot pixel reduction of defective pixels in a CCD imager	
	Calculating the Fourier transform image	Premium
	Displaying the image corrected by spatial-frequency filtering	
	Speckle average grain size calculation	
Calculating Speckle contrast	Speckle contrast measurement (one time/repeated)	Standard
	Correction-1: Quadratic functional averaging correction for quadric background distribution	
	Correction-2: Spatial-frequency filtering correction for periodic background patterns	Premium
	Correction-3: Zero point offset correction	
	Off-line analysis mode	
Multiple measurement areas for simultaneous measuring	Optional function	
Saving data files	Image data: TIFF/JPEG image file and pixel numerical data file in CSV format	Standard
	Histogram data: image file in BMP format and data file in CSV format	
	Speckle contrast measurement data: data file (one time/repeated) in CSV format	
	Complete raw data file in binary format	Premium

## Measuring examples (Speckle contrast/Speckle pattern/Histogram)

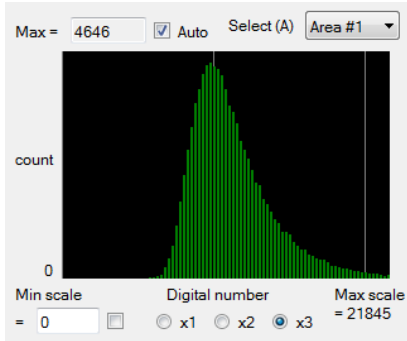
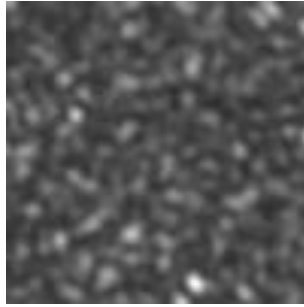
(a) He/Ne Laser

$$C_S = 0.97$$



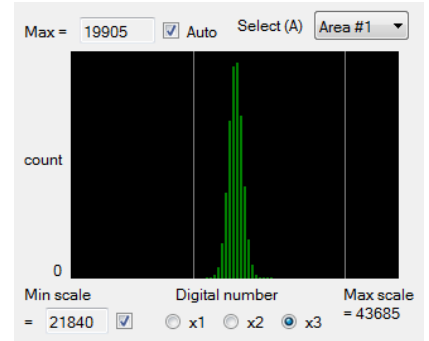
(b) Laser pico-projector

$$C_S = 0.24$$



(c) Red LED source

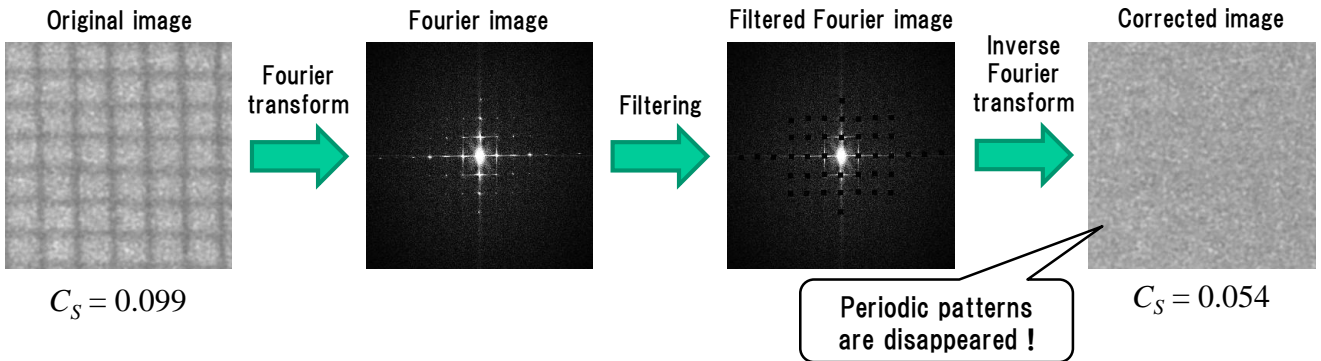
$$C_S = 0.01$$



## Spatial-frequency filtering correction (Premium edition)

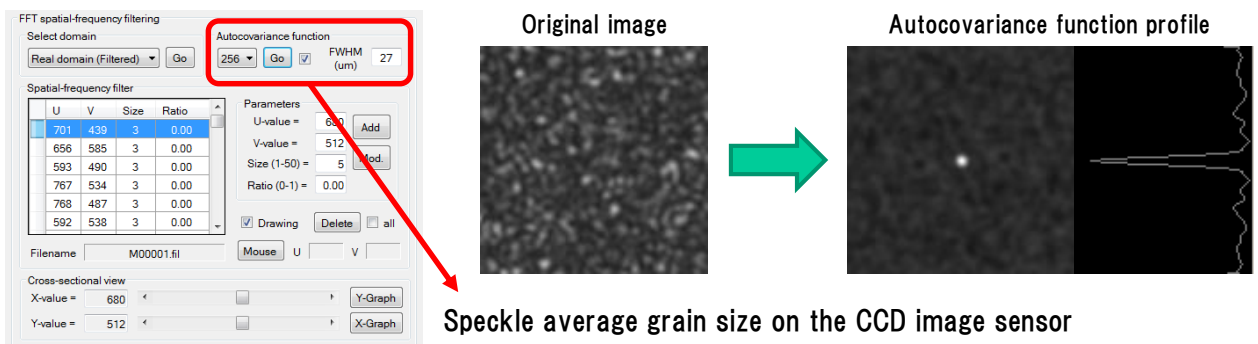
Periodic background patterns in the projection image (such as a projector black matrix or screen grid pattern) can be spatially filtered using two-dimensional FFT.

This capability allows you to measure speckle contrast close to the true value.



## Calculation of speckle average grain size (Premium edition)

The autocovariance function calculated from two-dimensional FFT provides with average grain size of speckle which is randomly distributed over the speckle images.



Speckle average grain size on the CCD image sensor

## Off-line analysis mode (Premium edition)

With the function mode, measurement and analysis are performed separately.

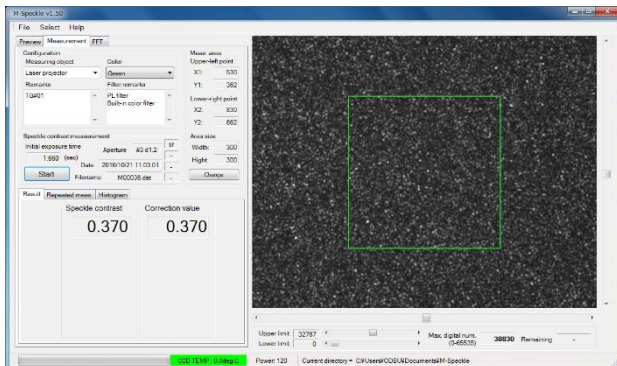
- A complete raw data file can be created in the speckle contrast measurement mode.
- The complete raw data file can be loaded in the off-line analysis mode.
- Recalculation of speckle by changing the measurement area and the correction conditions in the off-line mode.
- The measuring information can be displayed when loading speckle contrast measurement data.

## Multiple measurement areas for simultaneous measurement (Optional function)

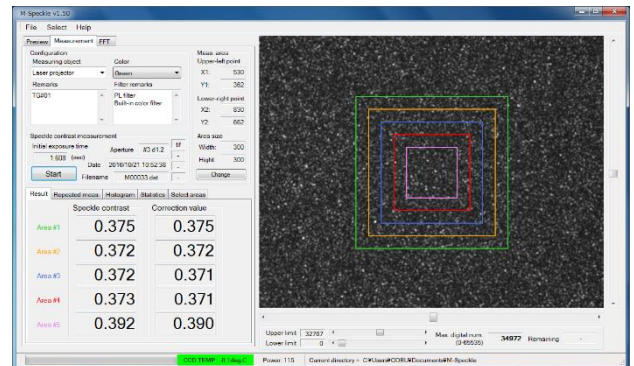
The function is used to measure the speckle contrast in multiple areas at the same time.

- The measurement area can be defined up to five. (only one place if the function is not enabled.)
- The multiple areas can be set on the “Select areas” tab as in the conventional method.

When the function is disabled



When the function is enabled



## Filter wheel control (Optional function)

The function is used to select the filters from the computer.

- The filter wheel is built into the speckle measurement unit.
- The built-in filters are:
  - Red filter
  - Green filter
  - Blue filter
  - ND filter (for the focus adjustment)

\* The speckle measurement unit has to be modified.

Speckle measurement unit without its front panel



## Capture operation by external trigger input signal (Optional function)

The function is used to capture the image when the external signal is triggered.

- The detectable signal form is TTL CMOS 5V falling edge.
- The accessory is a cable with connector.

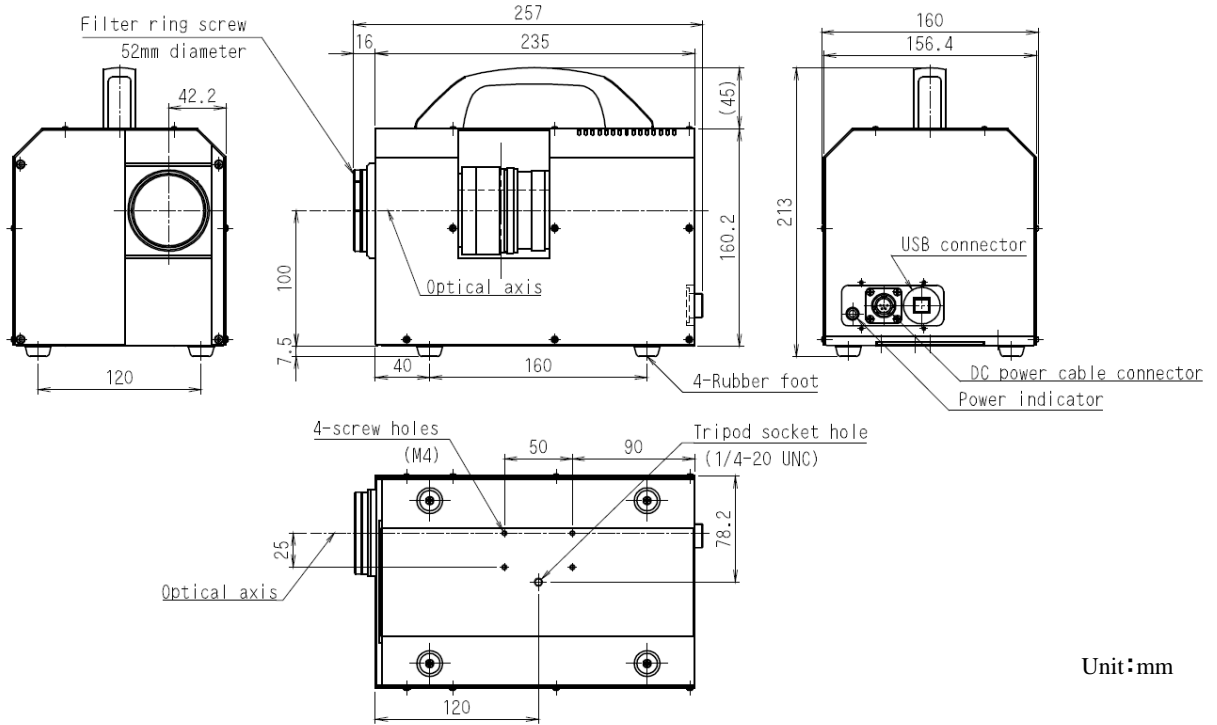
\* The speckle measurement unit has to be modified.

Rear panel of speckle measurement unit

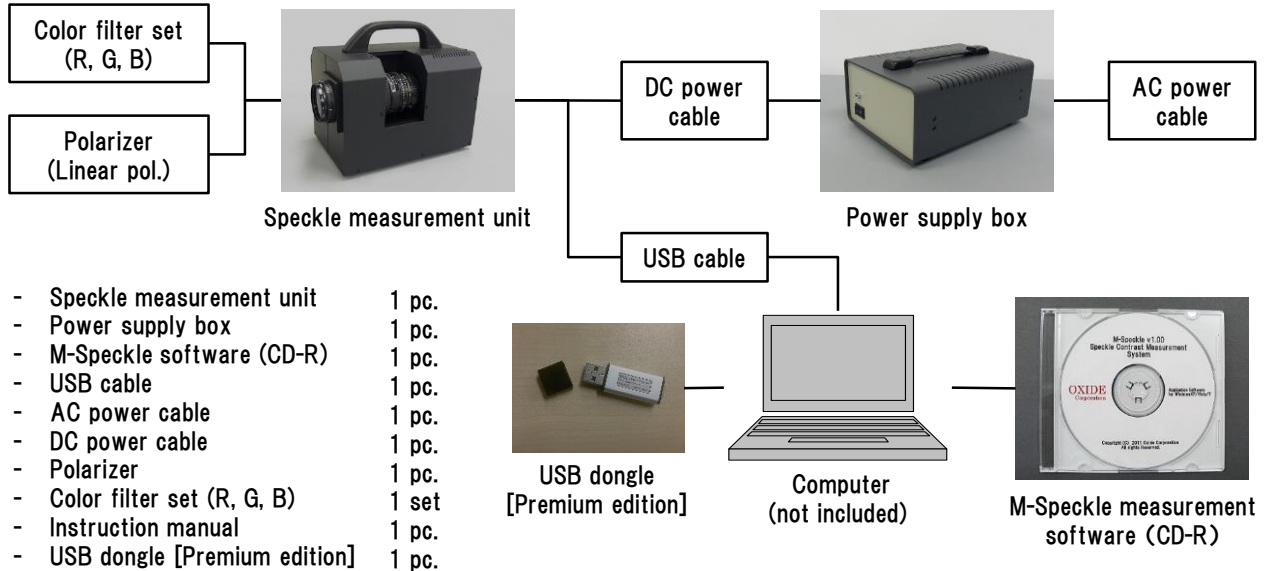


External trigger cable connector

## Dimensions of speckle measurement unit



## Products contents



## Optional accessories



Aluminum carrying case

### Others

- Upgrade for the M-Speckle software  
The M-Speckle can be upgraded from the standard edition to the premium.
- Rental service  
We provides a rental service of the speckle contrast measurement system.
- Customization  
We can tailor to your optical measurement systems, jigs, stages, software, etc.

# Specifications

Speckle measurement	Measurement value	Speckle contrast $C_S = \sigma / I_{bar}$ ( $\sigma$ is standard deviation and $I_{bar}$ is average intensity of captured image)
	Range	0.01 ~ 1.00 (Measurement resolution: Significant to two decimal places)
Measurement conditions	Luminous Flux	10 lm (lumens) or over (monochromatic) *Assuming a scanning type laser projector
	Observation distance $L$	300 mm to 1000mm (TBD)
	Observed area on screen	13 mm square ( $L = 300$ mm) ~ 40 mm square ( $L = 1000$ mm) *Imaging area is $300 \times 300$ pixels.
	Wavelength	Visual light region
	Projection image	Light beam with spatial uniform and temporally static image
Camera	CCD device	Sony image sensor with external cooling system, 1.4 million pixels ( $1360 \times 1024$ )
	Imager size	$8.8$ mm $\times$ $6.45$ mm (pixel size $6.45$ $\mu$ m $\times$ $6.45$ $\mu$ m)
	Shutter	Electronic shutter
	Cooling method	Peltier cooling (Air cooling, 0 degrees C)
	A/D Conversion	16-bit (65,536 gradation)
	Color	Black & White
	Lens	Nikon Single focal length lens f 50mm/F1.4
	External trigger (Optional)	Synchronous photography by a TTL CMOS 5V falling edge signal
Aperture size		Pinhole diameter: $\phi 0.8$ mm, $\phi 1.0$ mm, $\phi 1.2$ mm, $\phi 1.5$ mm (selectable)
Filter wheel (Optional)		Filter type: Red, Green, Blue, ND (OD: 2.0) (selectable)
Electrical specifications		AC single phase 85 ~ 264 V (47 ~ 63 Hz) / Flat 2 pole plug with ground (TYPE B)
Consumption		100W (without computer)
Operation conditions		Temperature: 15 ~ 30 degrees C, humidity: 10 ~ 70 % (No dew condition)
Storage conditions		Temperature: 10 ~ 40 degrees C, humidity: 10 ~ 70 % (No dew condition)
Install condition	Location	The system should be installed stable. (Tripod can be adopted.)
	Environment	Dark room (The recommended environment is specified by JIS L-1055-1987)
Outer dimensions and weight	Speckle meas. unit	257 (L) $\times$ 160 (W) $\times$ 213 (H) mm, 4.8 kg (5.2kg with the filter wheel control)
	Power supply box	248 (L) $\times$ 180 (W) $\times$ 118 (H) mm, 2.3kg

# System requirements

OS	Microsoft® Windows® XP, Vista, 7, 8, 8.1, 10 (32bit/64bit) *The English or Japanese version recommended
CPU	Intel® Core™ 2 Duo T8100 (2.10GHz) or higher recommended
Memory	1 GB minimum (2 GB minimum recommended)
Display resolution	1280 $\times$ 800 or higher (1600 $\times$ 900 recommended)
Interface	USB 2.0 (at least two ports)
other	CD-ROM Drive (for measurement software installation)

# OXIDE

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\* The contents are subject to change without notice.

\* The contents are things of 30-November-2016.