Fuji Electric

AEROSOL ANALYZER

DATA SHEET ZSF

The aerosol analyzer (ZSF) uses MEMS technology to provide simultaneous and quantitative analysis of particle size, number of particles, and composition of aerosol including PM2.5. ZSF measures mass concentration of aerosol and its major components: black carbon, sulfate, and nitrate.

*MEMS=Micro Electro Mechanical Systems

FEATURES

1. Simultaneous measurement of 3 components
   A combination of light diffusion method, laser-induced incandescence method, and mass spectrometry enables simultaneous measurement of nitrate, sulfate, and black carbon.
2. Real-time monitoring
   Takes only 15 minutes for aerosol composition analysis, which used to take more than 8 hours by filter analysis.
3. Quantitative analysis
   The particle trap which uses MEMS (Micro Electro Mechanical Systems) technology is highly efficient in collecting PM2.5, enabling quantitative analysis which has been difficult.
4. User-friendliness
   From the front touch panel you can perform major operations such as indication of measured value and alarms, monitoring of operating status, and so on.

SPECIFICATIONS

1. Measurement

Measuring objects:
- Mass concentration of aerosol
- Mass concentration of black carbon in aerosol
- Mass concentration of sulfate in aerosol
- Mass concentration of nitrate in aerosol

Measuring principle:
- Light diffusion method:
  mass concentration of aerosol
- Laser-induced incandescence method:
  mass concentration of black carbon
- Quadrupole mass spectrometry:
  mass concentration of sulfate and nitrate

Measurement range:
- Aerosol: 0 to 100 μg/m^3
- Black carbon: 0 to 30 μg/m^3
- Sulfate: 0 to 30 μg/m^3
- Nitrate: 0 to 30 μg/m^3

Particle detectable range:
Light diffusion method: 0.12 to 2.5 μm (aerosol)

Sampling amount:
Approx. 2.0 L/min

2. Output signal

Analog output signal:
4 points: 4 to 20 mA DC (insulated by photocoupler),

Allowable load resistance: 600Ω or less
1) Mass concentration of aerosol
2) Mass concentration of black carbon
3) Mass concentration of sulfate in aerosol
4) Mass concentration of nitrate in aerosol

Ethernet communication:
- Number of channel: 1
- Interface: 10BASE-T/100BASE-TX
- Media control: IEEE802.3u
- Interface switching method: autonegotiation
- Connector: D-sub9P × 1
- AUTO MD1/MD1X: supported
- Transmission protocol: TCP/IP, ICPM, APP
- Data type:
  Measured value (mass concentration of aerosol, black carbon, sulfate, and nitrate)
  Error information

Alarm output:
- 1 point
- Contact output: open during error, close during normal
- Rated load and rated voltage current: 24 V DC, 2 A

3. Display function

Display type:
Touch panel type operation display

Display language: English

Operation screens:
- Operation screen:
  mode setting button, incandescent detector calibration button, start button, status indication
- Mass spectrometer status screen:
  flow rate monitor, backup pump pressure indication, vacuum chamber pressure indication, turbo molecular pump operation status, CO_2 laser status

- Incandescent detector status screen:
  Flow rate setting and monitor, diode laser status, temperature error
- Measurement result screen:
  Previous measured values (aerosol, black carbon, sulfate, and nitrate)
  Graph (transition of measured values of each component)
  Graph operation (changing time width, moving graph position, specifying mass concentration display range)

Error indication:
Incandescent detector:
flow rate error, temperature error, error of diode laser setpoint
Mass spectrometer:
flow rate error, CO_2 laser output setting error, mass spectrometer error, turbo molecular pump error, backup pump pressure error

Data export:
USB port: 1
Data format: CSV
Data type: measured values (mass concentration of aerosol, black carbon, sulfate, and nitrate)

4. General specifications

Power supply voltage:
100 V AC ±10%, 50/60 Hz ±5% or 220 V AC ±10% 50 Hz±5%

Power consumption:
Approx. 1 kVA (Max. 1.5 kVA)

Ambient temperature:
15 to 30°C

Ambient humidity:
30 to 75% RH

Outer dimensions (W × H × D):
640 × 1740 × 828 mm (not inched I bolt)

Weight:
Approx. 350 kg

Cubicle structure:
Indoor installation (with casters), single-swing front/rear door
Plate thickness 1.6 mm SECC

Cubicle finish color:
Front cover: silver (dark), Mansell N6.7 equivalent
Rear cover and side panels: black, Mansell N1.5 equivalent

Sampling port:
Port connector SS-401-PC (Swagelok), on the top surface of the main body

Exhaust port:
KF16 flange (scroll pump DIS-90)

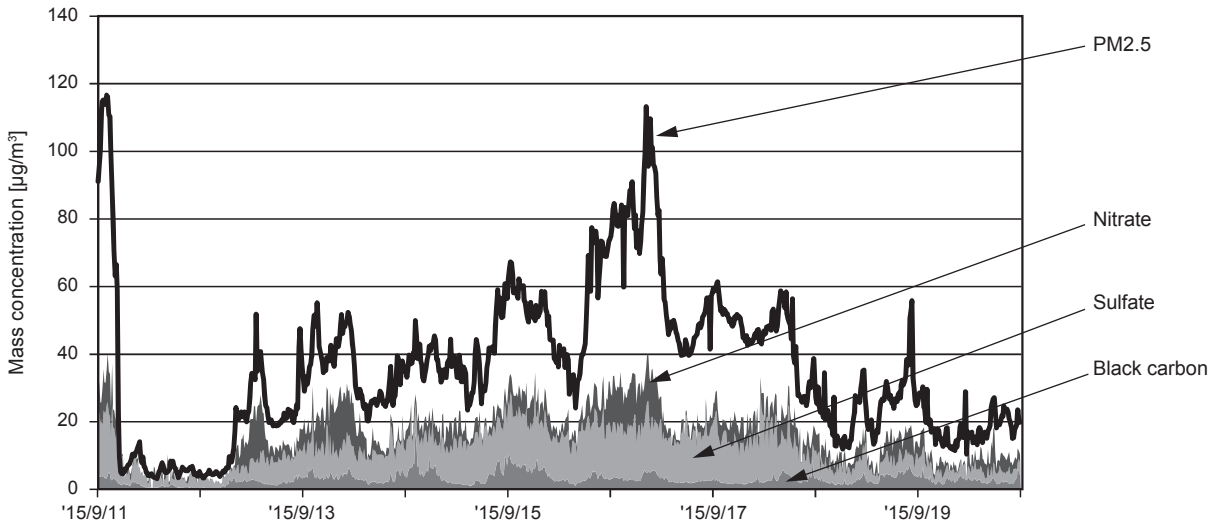
Calibration cycle: monthly
As the cycle may change according to the operating duration, it is recommended ordering our maintenance service.

5. Installation conditions

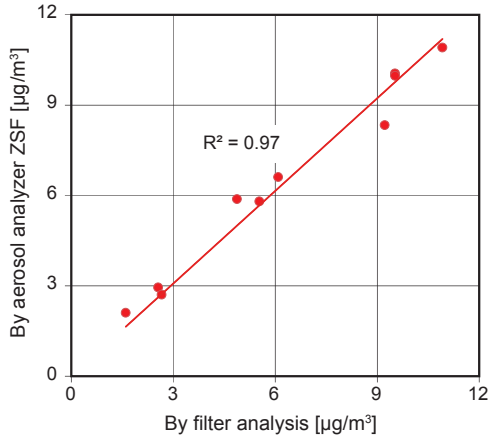
Air-conditioned room where:
- No radiation heat from high-temperature matter
- Sampling port can be provided
- Receives no heavy vibration
- With clean atmosphere

Real-time analysis of aerosol composition*1

*1 Stacked bar chart

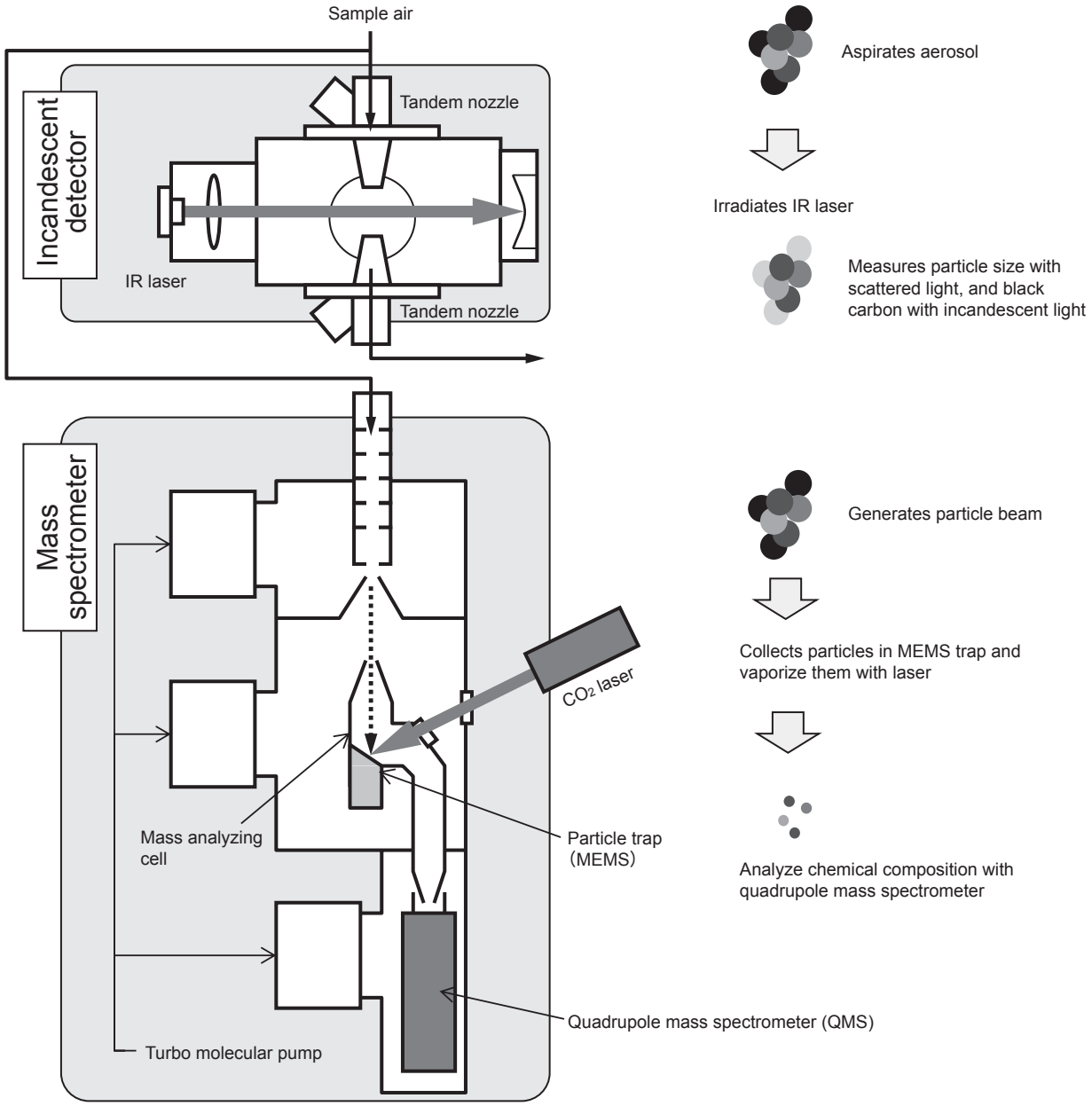


Comparison of daily mean concentration of sulfate measured by ZSF and by filter analysis*2



*2 Conforms to the Federal Reference Method (FRM) defined by the U.S. Environmental Protection Agency (EPA).

PRINCIPLE



Aerosol analyzer consists of an incandescent detector and a mass spectrometer.

■ **Incandescent detector**

The incandescent detector measures aerosol and black carbon. It irradiates sample air with high-power IR laser and detects scattered light and incandescent light emitted from particles in the sample air. Based on the intensity and frequency of the scattered light, the detector analyzes particle size and the number of particles to derive mass concentration of aerosol. In the same manner, based on the intensity and frequency of incandescent light, the detector analyzes particle size and the number of black carbon particles to derive mass concentration of black carbon in aerosol.

■ **Mass spectrometer**

Mass spectrometer measures sulfate and nitrate which are ion components of aerosol. Target particles are introduced into the vacuum area, and then collected in the particle trap in the mass spectrometer. The particles caught in the trap are heated with high-power IR laser until they vaporize. Then, the quadrupole mass spectrometer (QMS) carries out quantitative analysis of sulfate and nitrate. The quadrupole mass spectrometer filters the ions by changing the voltage applied to its electrodes. Only ions of a certain mass-to-charge ratio (m/z) can reach the ion detector, where mass concentration of each ion component are obtained based on the intensity of their electrical signals.

CODE SYMBOLS

1	2	3	4	5	6	7	8		9	10	11	12	13		14
Z	S	F	1	L	1	1	1	-	1	1	E		A	-	

Digit	Item	Specifications	Code
1 to 3	Base model	-	ZSF
4	Components	Aerosol and black carbon: size distribution, number concentration, mass concentration Sulfate and nitrate: mass concentration	1
5	Measurement range	PM2.5: 0 to100 μg/m^3, each component: 0 to 30 μg/m^3	L
6	Structure	Cubicle type (integrated)	1
7	Environmental resistance	For indoor installation (with air conditioner)	1
8	Revision code	-	1
9	-	-	1
10	-	-	1
11	Language	English	E
12	Power supply voltage	100 V AC, 50/60 Hz	1
		220 V AC, 50 Hz	2
13	Interface	Analog output (4 points), Ethernet communication, USB memory port, Alarm output (1 point)	A
14	Special specifications	Standard specifications	
		Special specifications	Z

SCOPE OF DELIVERY

Refer to page 5.

OPTIONAL ITEM

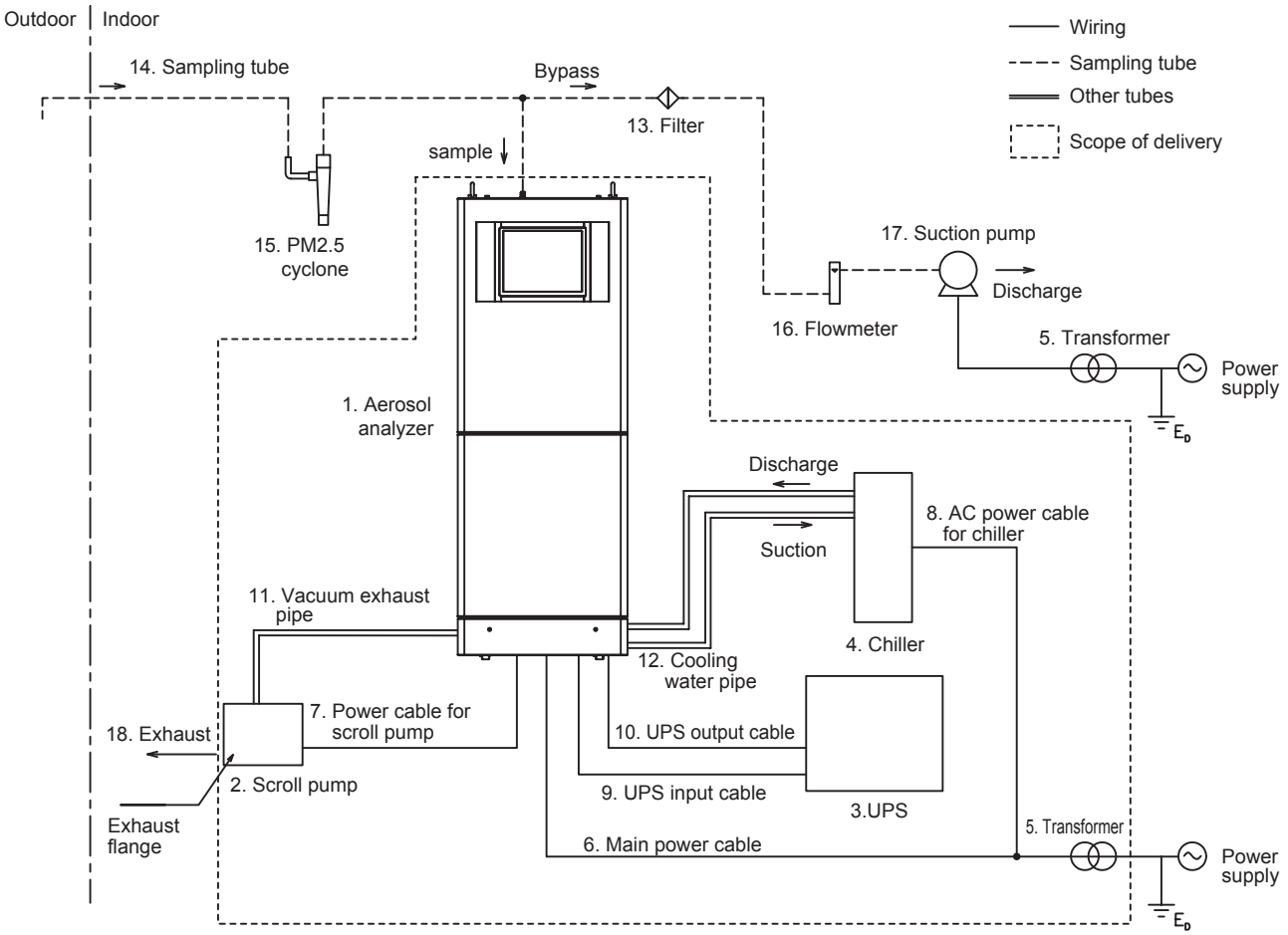
- Sampling system: pipes, PM2.5 cyclone, filter, flowmeter, suction pump
- Maintenance service

Periodical maintenance

The following maintenance work is required to keep your equipment running safely and efficiently.

Maintenance cycle	Item
Monthly	Simple calibration
Every 6 months	Replacement of air-cooling fan filter of mass spectrometer
	Replacement of MEMS particle trap
	Overhaul of scroll pump
Every 2 years	Replacement of air-cooling fan of semiconductor laser driver
	Replacement of air-cooling fan of CO2 laser
	Overhaul of analyzer tube of mass spectrometer
	Replacement of channeltron KSB-1 of mass spectrometer
	Overhaul of vacuum gauge (PKR)
	Replacement of oil reserver of turbo molecular pump
	Replacement of cooling fan of turbo molecular pump
	Replacement of line filter
	Replacement of heat exhausting fan
	Replacement of cooling fan of excitation laser unit
Every 4 years	Replacement of semiconductor laser
	Overhaul of turbo molecular pump

SYSTEM CONFIGURATION DIAGRAM

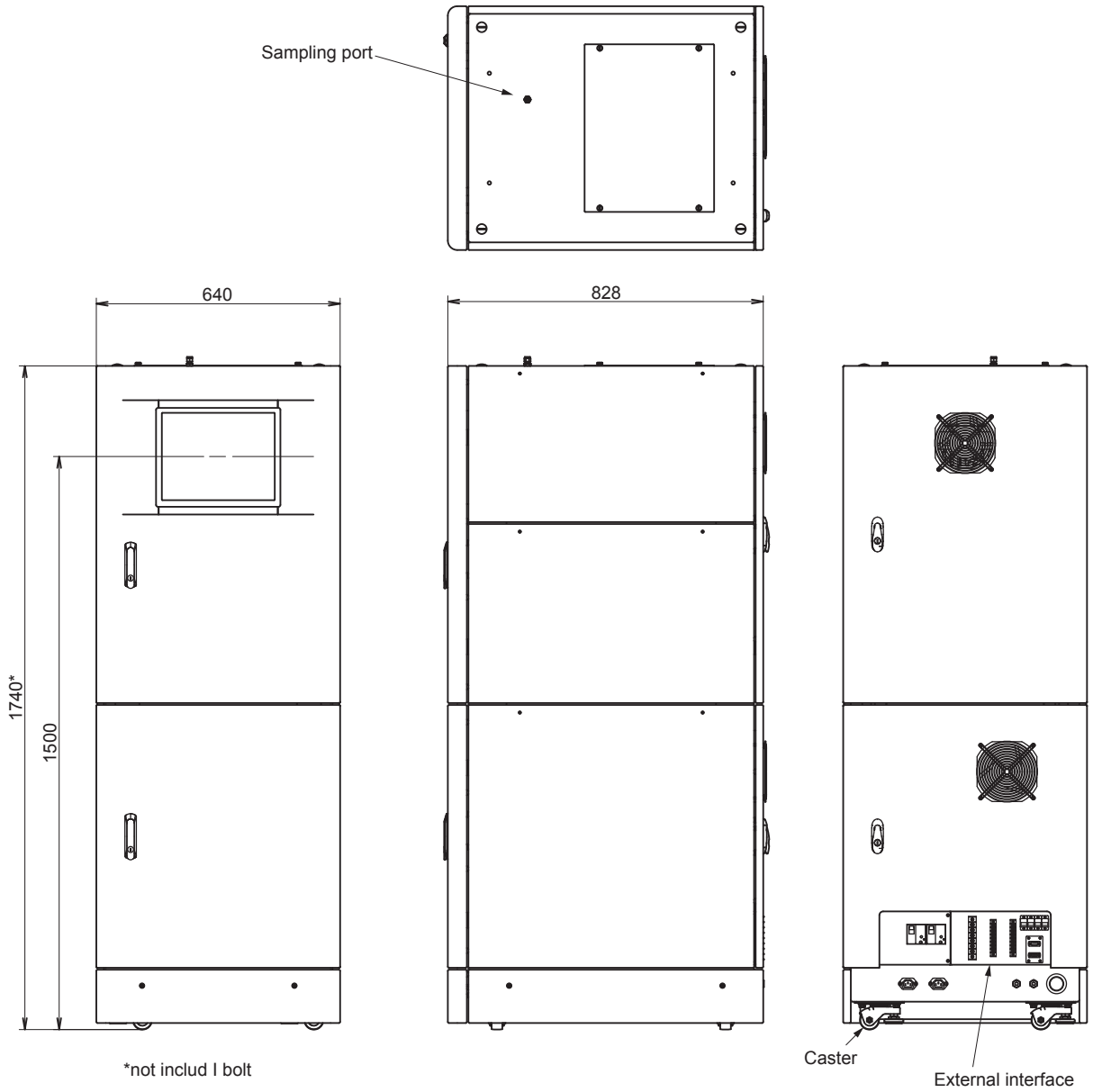


No.	Name	Model & specification	Manufacturer	Q'ty	Remarks
1	Aerosol analyzer main unit	ZSF	Fuji Electric Co., Ltd.	1	
2	Scroll pump	DIS-90	ULVAC Technologies, Inc.	1	
3	UPS	M-UPS020AD1B-U	Fuji Electric Co., Ltd.	1	
4	Chiller	LTC-450A	AS ONE Corporation.	1	
5	Transformer	FFT-SA/3k/200-100B	Fuji Electric Co., Ltd.	1	Only for the 12th code = 2
6	Main power cable		Fuji Electric Co., Ltd.	1	Only for the 12th code = 2
7	Power cable for scroll pump	TK4L1065C1 L = 1.5 m	Fuji Electric Co., Ltd.	1	
8	AC power cable for chiller	JPPSE-SR-G-0.2 Conversion between 3P plug and round terminal	MISUMI Group Inc.	1	Only for the 12th code = 2
9	UPS input cable	TK4L1063C1 L = 1.5 m	Fuji Electric Co., Ltd.	1	
10	UPS output cable	TK4L1064C1 L = 1.5 m	Fuji Electric Co., Ltd.	1	
11	Vacuum exhaust pipe	SUS flexible tube NW25 Approx. 1 m	-	1	
12	Cooling water pipe	Resin tube 3/8"	-	1	

Recommended parts (out of the scope of delivery)

13	Filter	KBS-1	KITZ	1	
14	Sampling tube	SUS tube 3/8 to 1/2" and guide tube 1/4"	-		
15	PM2.5 cyclone	URG-2000-30EH 16.7 L/min	URG Corporation	1	with Teflon adapter URG-2000-30AE-2
16	Flowmeter	RK200-V-B-1/4-Air - 25L/MIN	KOJIMA INSTRUMENTS INC.	1	
17	Suction pump	VP0940-V1036-A1-0001	MEDO Industries Co., Ltd.	1	
18	Exhaust pipe	KFT-16	KITANO SEIKI CO., LTD.	1	

OUTLINE DIAGRAM (Unit : mm)

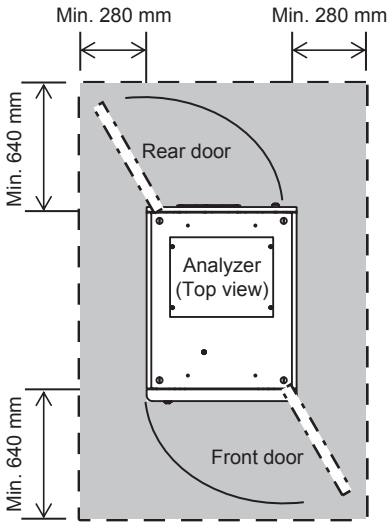


Front view

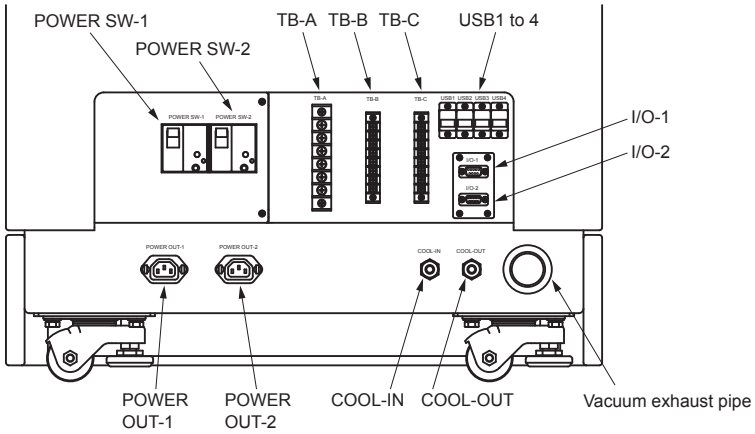
Rear view

Service clearance

The minimum clearance shown in the right figure is required for installation of the aerosol analyzer.



EXTERNAL INTERFACE



External interface

Equipment ID	Name	Usage	Application	Remarks
POWER SW-1	Power switch 1	Main circuit ON/OFF	20 A	Earth leakage circuit breaker
POWER SW-2	Power switch 2	UPS secondary circuit ON/OFF	10 A	Earth leakage circuit breaker
TB-A	External terminal block A	Power inlet	M5 × 6	
TB-B	External terminal block B	Alarm output	M3.5 × 8	
TB-C	External terminal block C	Analog output	M3.5 × 8	
USB1	USB connector	Export of measurement data	Type A	
USB2	USB connector	-	-	Unassigned
USB3	USB connector	-	-	Unassigned
USB4	USB connector	-	-	Unassigned
I/O-1	Connector A	UPS signal input	D-sub 9P female	Connection between the analyzer and external devices
I/O-2	Connector B	LAN communication	D-sub 9P male	Communication interface
POWER OUT-1	Outlet 1	UPS power supply	IEC C13	Connection between the analyzer and external devices
POWER OUT-2	Outlet 2	Power supply for scroll pump	IEC C13	
COOL-IN	Cooling water inlet	Water supply from chiller	3/8" tube	
COOL-OUT	Cooling water outlet	Water conveyance to chiller	3/8" tube	
-	Vacuum exhaust pipe	Connection to inlet of scroll pump	KF25 flange	

EXTERNAL CONNECTION DIAGRAM

1) TB-A: Power supply terminal block

(ML-60-S1AXS-6P, M5 screw)

Terminal No.	Function	Application
1	Primary power inlet (L)	100 V AC, 50/60 Hz
2	Primary power inlet (N)	100 V AC, 50/60 Hz
3	Ground	
4	UPS secondary power inlet (L)	100 V AC, 50/60 Hz
5	UPS secondary power inlet (N)	100 V AC, 50/60 Hz
6	Unassigned	

Terminals are numbered from top to bottom.

2) TB-B: Alarm output terminal block

(ML-260-S1A2XF-8P, M3.5 screw)

Terminal No.	Function	Application
1	Failure alarm output +	Contact output
2	Failure alarm output -	Contact output
3	Unassigned	
4	Unassigned	
5	Unassigned	
6	Unassigned	
7	Unassigned	
8	Unassigned	

Terminals are numbered from top to bottom.

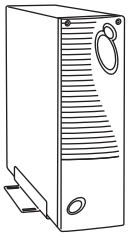
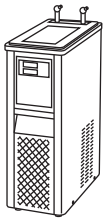
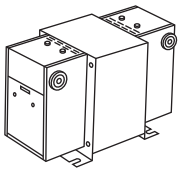
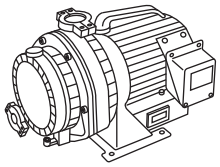
3) TB-C: Analog output terminal block

(ML-260-S1A2XF-8P, M3.5 screw)

Terminal No.	Function	Application
1	Aerosol AO +	4 to 20 mA DC
2	Aerosol AO -	4 to 20 mA DC
3	Black carbon AO +	4 to 20 mA DC
4	Black carbon AO -	4 to 20 mA DC
5	Sulfate AO +	4 to 20 mA DC
6	Sulfate AO -	4 to 20 mA DC
7	Nitrate AO +	4 to 20 mA DC
8	Nitrate AO -	4 to 20 mA DC

Terminals are numbered from top to bottom.

SUMMARY OF EXTERNAL DEVICES

Uninterruptible power supply (UPS) 	Type	M-UPS020AD1B-U
	Maximum input current	20 A
	Rated voltage	85 to 138 V AC, 50/60 Hz
	Number of phase and wire	Single-phase, 2-wire
	Rated output capacity	2 kVA/1400 W
	Output voltage	100 V±2%
	Battery backup	10 minutes (900 W load) 6 minutes (1400 W load)
	Dimensions	130 (W) x 515 (D) x 434 (H) mm
	Weight	Approx. 33 kg
Chiller (manufactured by AS ONE Corporation.) 	Type	LTC-450A
	Circulation system	Circulation for closed system
	Type of liquid used	City water, pure water, ethylene glycol, etc.
	Circulation pump (50/60)	Max. flow rate 12/12 L/min
	Refrigerator	450 W
	Liquid storage tank	ø180 × H 180 mm, approx. 4.5 L
	Power supply	100 V AC, 50/60 Hz
	Dimensions	218 (H) × 580 (W) × 375 (D) mm
	Weight	Approx. 32kg
Transformer 	Type	FFT-SA/3k/220-100B
	Rated capacity	3 kVA
	Primary voltage	220 V AC, 60Hz
	Secondary voltage	100 V AC, 50/60 Hz
	Rated current	0.5 to 100 A (at 100 V)
	Dimensions	340 (H) × 201 (W) × 154 (D) mm
	Weight	Approx. 29.5kg
Scroll pump (manufactured by ULVAC Technologies, Inc.) 	Type	DIS-90
	Pumping speed (L/min)	50 Hz: 90 60 Hz: 108
	Ultimate pressure	5.0 Pa
	Full load current	100 V/50 Hz: 2.6 A 100 V/60 Hz: 2.1 A
	Noise	Max. 52 dB
	Inlet, outlet pipe diameter	Inlet pipe KF25, outlet pipe KF16
	Dimensions	214(W) × 225(H) × 308(L) mm
	Weight	Approx. 14kg

⚠ Caution on Safety

*Before using this product, be sure to read its instruction manual in advance.

Fuji Electric Co., Ltd.

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