

**MiniFlex600/600-C**  
**Benchtop X-Ray Diffractometer**

**SPECIFICATION**

Document No : ADA-S005E

**Rigaku Corporation**

Controlled by Planning Dept. of Rigaku Corporation.

<b>Edition</b>	<b>Revision date</b>	<b>Revision record</b>
9 <sup>th</sup>	February 5, 2019	Added MiniFlex600-C, Terminate MiniFlex300
8 <sup>th</sup>	October 25, 2017	Added SC-70S and ASC-6
7 <sup>th</sup>	May 25, 2017	Adapt for HyPix-400 MF, ASC-8, and D/teX monochromator
6 <sup>th</sup>	August 7, 2014	Modified Sample spinner and ASC-6
5 <sup>th</sup>	July 29, 2014	Added the mid-temperature sample attachment hot plate
4 <sup>th</sup>	February 5, 2013	Correction: Display 19-inch TFT→17-inch TFT
3 <sup>rd</sup>	February 10, 2012	Added power cable specifications
2 <sup>nd</sup>	January 19, 2012	Added variables slit specifications
1 <sup>st</sup>	January 15, 2012	

## 1. Overview

**MiniFlex600/600-C** is a compact, light-weight benchtop X-ray diffractometer which can be used in broad range of area in R&D and quality control, such as from qualitative analysis to environmental quantitative analysis (general quantitative analysis, free silicic acid) or diffraction pattern comparison of crystal, amorphous, and crystal polymorph for pharmaceutical drug. Compared with the MiniFlex series in the past (MiniFlex, MiniFlex+, MiniFlexII), **MiniFlex600/600-C** has increased intensity, improved angle precision, and also able to select more various X-ray optical parts. Therefore, **MiniFlex600/600-C** has broken through conventional benchtop diffractometers. The **MiniFlex600/600-C** advanced capability enables a high resolution measurement and is effective for profile analysis such as the Rietveld method, etc. or measurement of organic material where the observed peaks are complicated.

The **MiniFlex600/600-C** is a space-saving X-ray diffractometer which is compatible with universal power supply (1 $\phi$ , AC100 $\sim$ 240V $\pm$ 10%) and is simple to install. It can be installed and used conveniently at a desired location such as at on-site fields or laboratories where the samples are.

The **MiniFlex600** can start a measurement just by connecting it to power supply and water supply, and then turning on the power. For locations without water facilities, a separate external air-cooled water chiller is available as an option.

The **MiniFlex600-C** has a built-in X-ray tube cooling system, and thus a water facility or an external water chiller is unnecessary.

The **MiniFlex600/600-C** offers various optional accessories such as high-speed 1D detector, high-speed 2D detector, sample spinner, auto sample changer, detector monochromator, and non-ambient attachments as well as various analysis software for qualitative and quantitative analysis, etc. Thus it can be used at wide range of area, from work sites to various academic and research institutions.



Fig.1 Appearance of **MiniFlex600** benchtop X-ray diffractometer

## 2. Features

### (1) Space-saving, simple installation, easy to move

The power required to operate the **MiniFlex600/600-C** main unit is wide band single phase – AC100 to 240V $\pm$ 10%, and can be used with mains electricity all over the world. Also, being compact and light-weight makes it able to install and move freely around. Furthermore, the **MiniFlex600-C** has a built-in X-ray tube cooling system, and thus no water facility or an external water chiller is necessary.

### (2) Safety design

The **MiniFlex600/600-C** only uses minimal amount of power required for X-ray generation, and the cabinet is designed to be complete-airtight. Therefore the amounts of X-ray which may leak out are the same as radiations existing in nature. Also, to ensure safety even more, it incorporates an interlock mechanism which the X-ray cannot be irradiated unless the sample chamber door is locked.

### (3) High intensity measurement

By mounting the D/teX Ultra2 1D high-speed detector or the HyPix-400 MF 2D high-speed detector with taking the high-speed para-focusing method, the detection intensity can be improved approx. 100 times better than that of the scintillation counter under the equivalent silt conditions. Also, the development of new X-ray generator enabled **MiniFlex600** to realize a high X-ray output of 600W, which is the highest spec in the benchtop XRD industry and is power-saving at the same time, requiring only 1 $\phi$  -1.0kVA. This is effective for detecting small amount of components and for high resolution measurements which accompanies decrease in intensity.

### (4) Hybrid incident slit system

Two types of divergence slit (:DS, fixed and variable) functions as a hybrid incident slit. By opening the incident fixed slit, the variable slit can be used alone, and thus a high sensitivity measurement with the X-ray irradiation width on the sample (approx. 20 mm) kept constant can be run (up to 2 $\theta$ =approx. 67°). Furthermore, the DS fixed slit same as the high-end system components is available, so that much data compatibility is given when you compare with the other cabinet type equipment data. The DS fixed slit had the weak point that the P/B ratio declines at the low angle where the X-ray beam irradiates to area outside of sample. With the new type which the **MiniFlex600/600-C** incorporates, the good P/B ratio at low angle area can be maintained.

### (5) Enhanced accuracy of diffraction angle (2 $\theta$ axis)

The goniometer incorporates high-precision mechanical link axis, and by its equal interval control, realized a high reproducibility. By combining this with real-time angle correction and correcting the reproducible mechanical error, the accuracy of diffraction angle (2 $\theta$  axis) has enhanced considerably.

(6) Various slit optics (optional)

Not only various slit (DS, SS, RS) which are standard for high-spec diffractometer can be replaced and used, but a divergence side (incident) height limiting slit (IHS) can also be inserted into the incident side in the direction that crosses perpendicular with the X-ray irradiation. Furthermore, the incident side and receiving side Soller slit, which limits the umbrella effect, can be selected, and thus various measurement conditions that give priority to intensity and resolution can be set.

Slit configuration

Incident & receiving side Soller slit:	5.0° , 2.5° , or OPEN (For 2D exclusive)	(Selected at the time of order)
Incident fixed slit (DS):	0.625°, 1.25°, none (continuously variable)	Standard
	0.1 mm, 1/4°	Optional
Incident height limiting slit (IHS):	10 mm (OPEN)	Standard
	2 mm, 5 mm	Optional
Receiving side Soller slit:	5.0°, 2.5°, 0.5°	Optional
	(Available to add other after the time of order)	
Anti-scattering slit (SS):	1.25°, 0.625°, 4.2°	Optional
Receiving slit (RS):	0.3mm	Standard
	0.15 mm	Optional
Slit for 1D measurement:	SS8mm	Optional (Included in HyPix or D/teX)
	SS6mm, RS6mm	Optional
Slit for 2D measurement:	2D Slit	Optional (Included in HyPix)
Slit for 0D measurement:	SS1.25°	Optional (Included in SC-70S)

(7) Scattering protector (Included in HyPix or D/teX)

Scattering protector reduces the rise of background caused by scattering X-rays at low angle area during high-speed para-focusing measurement using the 1D high-speed detector, and to obtain a profile superior in P/B ratio.

(8) Compact detector monochromator (optional)

A detector monochromator dedicated for D/teX Ultra2 and SC-70S, which are standard-used for high-spec diffractometer, can be mounted. It can remove distracting components such as continuous X-ray and K $\beta$  or fluorescent X-rays generated from the sample.

(9) Various application software such as qualitative analysis, etc. (optional)

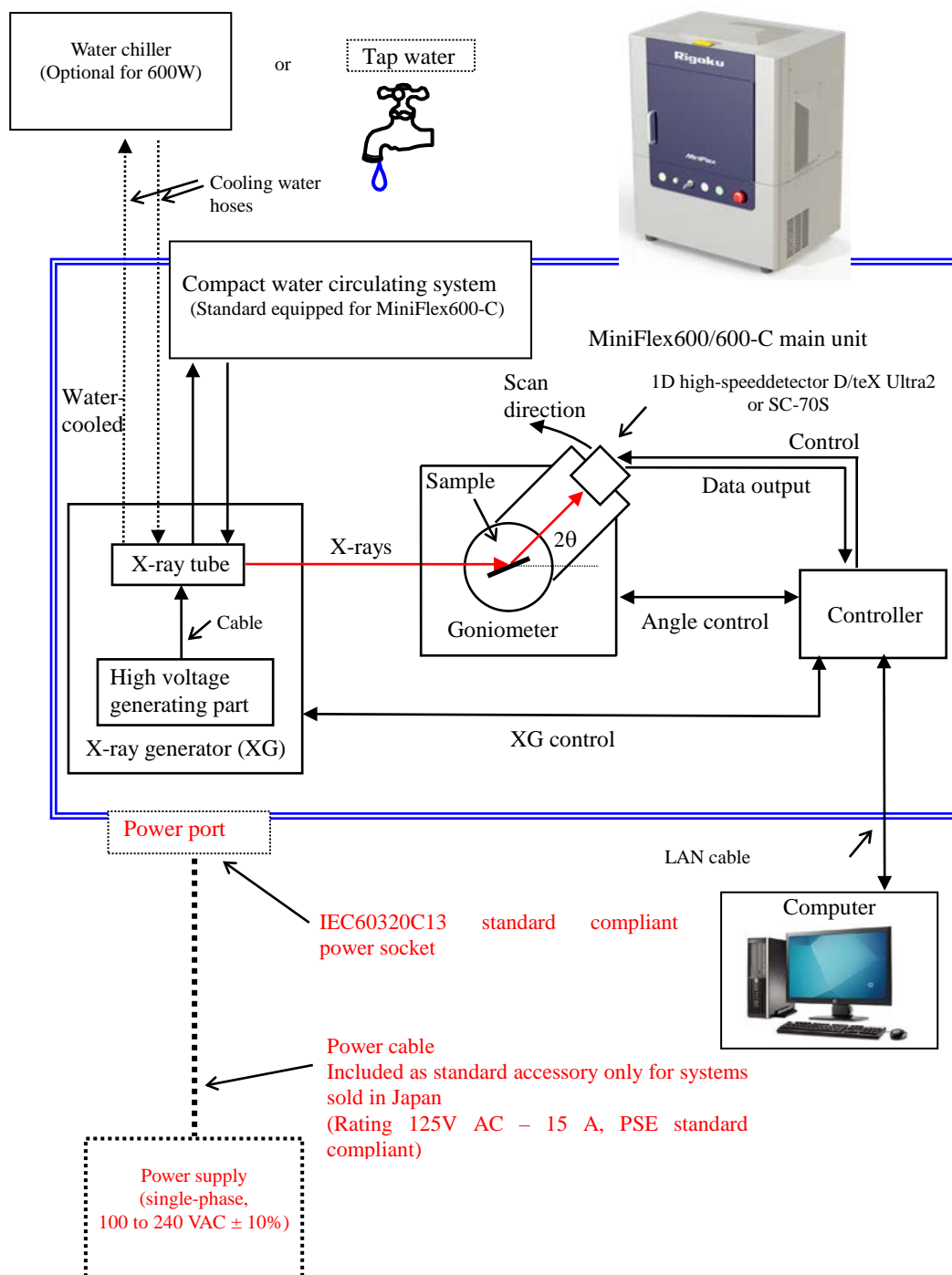
Rigaku offers many types of software as well as various application software of the PDXL series .

(10) Various colors to select for your main body panel

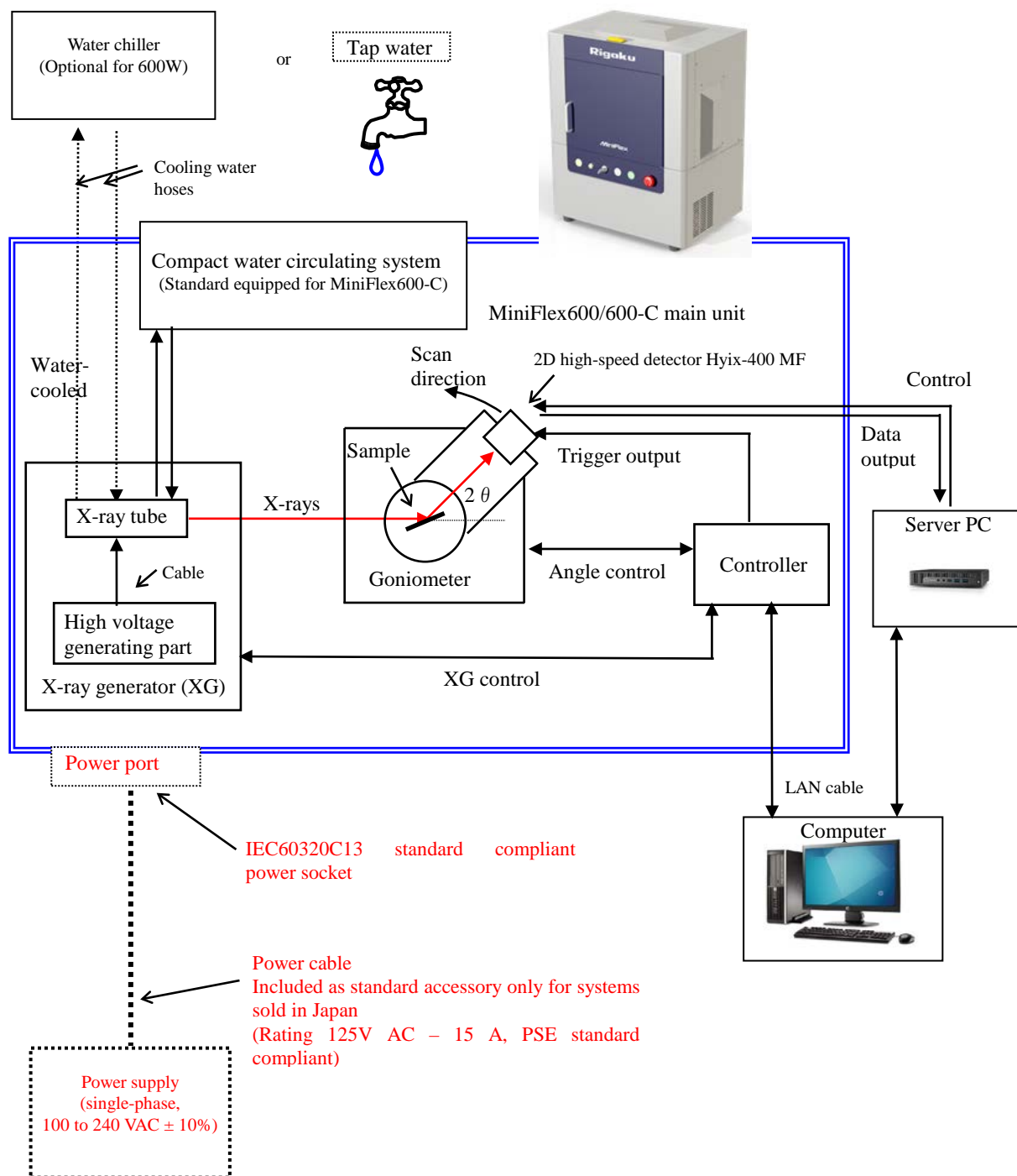


- MiniFlex600/600-C block diagram -

- With D/teX Ultra2 or SC-70S block diagram -



- With HyPix-400 MF block diagram -



### 3. Configuration

#### 3.1 MiniFlex600/600-C Benchtop X-ray Diffractometer main unit

(1) X-Ray Generator	built-in within main unit
(2) Goniometer	built-in within main unit
(3) X-Ray Detector and Controller	built-in within main unit
(4) Standard sample stage	built-in within main unit
(5) Tube cooling system (only for MiniFlex600-C)	built-in within main unit
(6) X-ray tube	x1

#### 3.2 Computer

(1) PC	1 set
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#### 3.3 Software

(1) SmartLab Studio II (basic)	Standard
(2) XRD Measurement plugin	Standard
(3) Powder XRD plugin (basic)	Standard
(4) PDF plugin	Optional
(5) Cluster analysis browser	Optional
(6) Data visualization plugin	Optional
(7) Audit trail & ER/ES system	Optional
(8) Powder XRD option Search/Match(Qualitative analysis)	Optional
(9) Powder XRD option Quantitative analysis	Optional
(10) Powder XRD option Comprehensive analysis	Optional
(11) Powder XRD option Rietveld analysis	Optional
(12) Powder XRD option Structure determination	Optional
(13) Powder XRD option Retain austenite analysis	Optional
(14) Powder XRD option Respirable silica analysis	Optional
(15) Powder XRD option DD method	Optional

#### 3.4 Instruction Manual 1 set

#### 3.5 Standard Accessories (Included in the accessory box)

(1) Aluminum sample holder	x 5
(2) Glass sample holder	x 2 each
(2 types of sample indent depth: 0.2mm or 0.5 mm)	
(3) Setting jig	x 1
(4) Rectangular glass plate	x 1
(5) Hex wrench	x 1
(6) Sytrol plastic case	x 1
(7) O-ring P-8 (for X-ray generator)	x 2
(8) Si powder standard reference material	x 1 (0.5g in weighing paper)



- (9) Water cooling connection part x 1 (only for MiniFlex600)
- (10) Power cable 3 m x 1 (only for system sold in Japan)

NOTE: Rating 125 V AC – 15 A, PSE standard compliant

For using the system outside of Japan, prepare a power cable separately.

The inlet side of the system is IEC60320C13 international standard compliant socket.

(For details, refer to the Utilities document)

### **3.6 Optional Software**

**3.7 Air-cooled water chiller** (for MiniFlex600, Item No. M00015376)

**3.8 Sample spinner** (Item No. 2701C332)

**3.9 ASC-8 (Automatic 8-position sample changer)** (Item No. A00007458)

**3.10 ASC-6 (Automatic 6-position sample changer)** (Item No. 2455E434)

**3.11 D/tex Ultra2 (1D detector)** (Item No. A00007469)

**3.12 Detector monochromator (D/teX 0D)** (Item No. A00007460)

**3.13 HyPix-400 MF (2D detector)** (Item No. A00007471)

**3.14 Scintillation Counter SC-70S** (Item No. A00007818)

**3.15 Air-sensitive sample holder** (Item No. 2392B101)

**3.16 Si-Low Background Sample Holder** (Item No. M00016288)

**3.17 Hot Plate (mid-temperature sample attachment)** (Item No. A00002079)

**3.18 BTS 150 (Anton Paar mid-temperature sample attachment)** (Item No. A00005532)

**3.19 BTS 500 (Anton Paar mid-temperature sample attachment)** (Item No. A00005533)

## 4. Specifications

### 4.1 MiniFlex600/600-C benchtop X-ray diffractometer main unit

#### 4.1.1 X-ray generator

- |   |   |
|---|---|
| (1) Max. continuous rated output:           | 600 W   |
| (2) Rated tube voltage:                     | 20- 40 kV /1 kV step variable   |
| (3) Rated tube current:                     | 2- 15 mA /1mA step variable   |
| (4) High-voltage generation method:         | High frequency inverter method  |
| (5) Stability (tube voltage, tube current): | $\pm 0.01$ % or less (against $\pm 10$ % mains fluctuation)   |
| (6) Focal point adjustment:                 | $\pm 1$ mm, continuously variable<br>(X-ray tube mounting area overall)   |
| (7) X-ray shutter:                          | Rotary shutter  |
| (8) Safety features:                        | Detects tube voltage, tube current, load, flow rate, and other statuses, and when abnormal status is detected, shuts off X-ray generation and alerts by lamp and alarm.<br><br>Displays X-ray generation and shutter open/close status by LED.<br><br>Shuts off X-ray generation when the LED is disconnected or short-circuited<br><br>EMO switch. |

#### 4.1.2 Goniometer

- |   |  |
|---|--|
| (1) Type:   | Vertical goniometer  |
| (2) Scanning axis:  | $\theta/2\theta$ coupled (mechanical linked axis)  |
| (3) Scanning method:  | Equal interval pulse (step) motor controlled   |
| (4) Maximum scanning speed:   | 500°/min (converted to $2\theta$ )   |
| (5) Scanning speed:   | 0.01 to 100 °/min (converted to $2\theta$ )  |
| (6) Minimum step width:   | 0.005° (converted to $2\theta$ )   |
| (7) Range of movement:  | -3 ~ +145° (converted to $2\theta$ )   |
| (8) Goniometer radius:  | 150 mm   |
| (9) Incident side & receiving side Soller slit: 5.0°, 2.5°, or OPEN | (Selected at the time of order)  |
| (10) Incident fixed slit (DS):                                      | 0.625°, 1.25°, none/continuous variable mode<br><br>*Continuous variable mode: the X-ray irradiation width is kept constant at approx. 20 mm in use below approx. 67° ( $2\theta$ )<br><br>0.1 mm, 1/4° (optional) |
| (11) Incident height limiting slit (IHS):                           | 10 mm (standard)<br><br>2 mm, 5 mm (optional)  |

(12) Receiving side Soller slit:	5.0°, 2.5°, 0.5°, or OPEN	(optional)
	*Available to add other after the time of order	
(13) Anti-scattering slit (SS):	8 mm(D/teX, HyPix), 1.25°(SC-70S)	(standard)
	0.625°, 1.25°, 8 mm, 4.2°	(optional)
(14) Receiving slit (RS):	0.3 mm	(standard)
	0.15 mm	(optional)
(15) K $\beta$ filter:	Ni filter 1 D measurement for Cu tube	
	(standard for D/teX or HyPix)	
	The thickness (23 $\mu$ m) makes the K $\alpha$ :K $\beta$ approx. 500:1.	
	Standard thickness(15 $\mu$ m) Ni filter for Cu tube	
	(standard for SC-70S)	
	The thickness (15 $\mu$ m) makes the K $\alpha$ :K $\beta$ approx. 100:1.	
	2 times thicker Ni filter(30 $\mu$ m) for Cu tube (optional)	
	For Co tube, for Fe Tube, for Cr Tube (optional)	

#### 4.1.3 Standard Sample Stage

(1) Standard sample holder size:	external dimensions:	square shape 35 mm $\times$ 50 mm
	indent:	square shape 20 mm $\times$ 20 mm
	depth:	aluminum sample holder 1.6 mm
		glass sample holder 0.2 mm, 0.5 mm
(2) Standard included sample holder:	aluminum sample holder	x 5
	glass sample holder 0.2 mm	x 2
	glass sample holder 0.5 mm	x 2

#### 4.1.4 X-ray tube cooling system (only for MiniFlex600-C)

(1) Cooling system:	main unit built-in water chiller
(2) Circulating water:	purified water mixed with BTA solution
(3) Cooling capability:	600 W
(4) Heat exhaustion system:	forced heat exhaustion by ventilation fin and fan on rear side of main unit

#### 4.1.5 X-ray tube

(1) Target:	Cu, Co, Fe, Cr	(Selected at the time of order)
(2) Actual focus size:	select either normal focus (N.F.) tube 1.0 mm $\times$ 10 mm	
	or fine focus (F.F.) tube 0.4 mm $\times$ 8 mm	

## 4.2 Computer

- |               |   |
|---------------|---|
| (1) PC:       | Intel Core i5 or later<br>Windows 10 Pro 64 bit (Japanese or English version)<br>Main memory 8GB or more recommended<br>DirectX 10.1, Shader Model 4.0 required<br>Hard disk 100 GB or more free space<br>DVD-ROM drive |
| (2) Display:  | 23inch–TFT equivalent (1920×1080 resolution or higher)  |
| (3) Network:  | 1Gbps LAN port (for controlling the instrument)<br>To use the network function, another port must be added.   |
| (4) USB port: | One USB 1.1/2.0 port (for USB dongle key) or more   |

\* Note PC needs inquiry.  
PC install space is prepared by customers.

## 4.3 Standard software

### 4.3.1. SmartLab Studio II basic

For the instrument's adjustment, measurement, or analysis, the SmartLab Studio II software is used. The functions that can be used as standard in the SLSII basic are as follows.

- Analysis function
- Display / overwrite 1D, 2D data
- Browsing header information of data.
- Data calculation (addition, subtraction, division, scalar multiplication, normalization of data)
- Data processing (smoothing, background removal) and peak search
- Conversion of 2D data to 1D data
- Management function (for administrators)
- Log display function
- User management function
- Measurement / analysis data management function (\* When using SQL database as save destination)
- Material Database Management Function

### 4.3.2. XRD Measurement plugin

The XRD Measurement plugin sets, adjusts, and measures for MiniFlex and detectors.

### 4.3.3. PowderXRD plugin

The Powder XRD plugin provides various analysis functions based on powder X-ray diffraction patterns, including peak search, Scherrer method, FP method and RIR quantification etc.

## 4.4 Optional Software

### 4.4.1. PDF plugin

Calculates radial distribution function and pair distribution function.

### 4.4.2. Cluster analysis browser

Classifies measurement datasets into several groups based on their similarity.

### 4.4.3. Data visualization plugin

Displays and analyzes massive data obtained from various measurements such as XY mapping measurement, temperature variation measurement, and XRD-DSC measurement.

### 4.4.4. Audit trail & ER/ES system

An audit trail & electronic record/electronic signature system that supports CFR21 Part 11 (U.S. FDA) and Annex 11 (EU GMP).

### 4.4.5. Options for Powder XRD plugin

- (1) Search/Match (Qualitative analysis)  
Determinations the substances contained in the sample with a search match engine.
- (2) Quantitative analysis  
Performs quantitative analysis of substances contained in the sample (internal standard method, external standard method and standard addition method)
- (3) Quantitative analysis  
Performs quantitative analysis of substances contained in the sample (internal standard method, external standard method and standard addition method).
- (4) Comprehensive analysis  
Analyzes the “Crystallite size and lattice strain”, refines lattice parameters and calculates the ratio of crystalline and amorphous.
- (5) Rietveld analysis  
Indexing, Rietveld analysis.
- (6) Structure determination  
Determinations initial crystal structure.
- (7) Retain austenite analysis  
Austenite quantitative analysis
- (8) Respirable silica analysis  
Quantitative analysis of asbestos is conducted using the base standard absorption correction method.
- (9) DD method

## 4.5 Air-cooled water chiller (for MiniFlex600)

- (1) Type: air-cooled circulation type

(2) Cooling capability:	1000 W (room temp. 20°C)
(3) Guaranteed operating temperature range:	10 to 30°C (Ambient temperature)
(4) Circulation water quantity:	4.0 liters/min (0.25 MPa or more)
(5) Required power:	Single phase, AC100V $\pm$ 10%, 50/60Hz $\pm$ 1%, 1.3kVA
(6) External dimension (mm):	460W-510D-570H
(7) Weight:	approx. 50 kg

#### 4.6 Sample spinner MF

When the sample grains are large, by performing sample-in-plane rotation while measuring the sample, the adverse effect can be mitigated and the reproducibility of the diffracted X-ray intensity can be improved. This attachment is especially effective for quantitative analysis.

(1) Driver:	Pulse motor drive
(2) Sample spin speed:	10~80 rpm
(3) Sample holder size:	indent 24 mm $\phi$ $\times$ 2.0 mm (with base, 3 holders included as standard) Other various optional sample holders are also available.

#### 4.7 ASC-8 (Automatic 8-position sample changer)

The automatic sample changer includes a sample spin function. This enables averaging the crystal component within the sample and improving the reproducibility of measurement profile. This is effective for automatic continuous operation, especially for 1D high-speed para-focusing method measurement. Also, various type of sample holders are available such as through-hole type, with base type with various depth, sample holder with glass for small sample amount, Si low-background type, etc.

(1) Driver:	Pulse motor drive
(2) Number of sample position:	8 positions
(3) Sample spin speed:	10~80 rpm
(4) Sample holder size:	indent 24 mm $\phi$ $\times$ 2.0 mm (with base, 8 holders included as standard) Other various optional sample holders are also available. Unavailable to use Domed atmosphere separator.

#### 4.8 ASC-6 (Automatic 6-position sample changer)

The automatic sample changer includes a sample spin function. This enables averaging the crystal component within the sample and improving the reproducibility of measurement profile. This is effective for automatic continuous operation, especially for 1D high-speed para-focusing method measurement. Also, various type of sample holders are available such as through-hole type, with base type with various depth, sample holder with glass for small sample amount, Si

low-background type, etc.

- |                                |  |
|--------------------------------|--|
| (1) Driver:                    | Pulse motor drive  |
| (2) Number of sample position: | 6 positions  |
| (3) Sample spin speed:         | 10~80 rpm  |
| (4) Sample holder size:        | indent 24 mm $\phi \times 2.0$ mm<br>(with base, 6 holders included as standard)<br>Other various optional sample holders are also available.<br>Available to use Domed atmosphere separator.<br>(max 3 positions) |

#### 4.9 1D detector D/teX Ultra2

Due to the high-speed para-focusing method, the detection intensity can be improved approx. 100 times higher than that of the scintillation counter under the equivalent silt conditions. Also, due to the excellent energy resolution, a profile with superior P/B ratio can be obtained even for measurement of Fe type sample by a Cu tube. Additionally, with the included scattering protector, the rise of background due to scattering X-rays at low angle area during high-speed para-focusing measurement is reduced, and a profile superior in P/B ratio can be obtained. Furthermore, the measurement blind issue at high angle area can be resolved.

- |  |  |
|--|--|
| (1) Type:  | Direct detecting semi-conductor element strip-type detector  |
| (2) Active area:   | 256 mm <sup>2</sup> (12.8 mm $\times$ 20 mm)   |
| (3) Counting efficiency:   | 99% and more (CuK $\alpha$ )   |
| (4) Discriminator adjustment:                                    | Able to set arbitrary energy load range by baseline and window width setting   |
| (5) Scattering protector:  | automatically link with counter arm  |
| (6) Direct beam absorber:  | protecting the D/teX Ultra2 from the direct beam   |
| (7) Accessories:   | Direct beam absorber<br>Scattering protector<br>SS8mm<br>1.5 times thickness(23 $\mu$ m) receiving K $\beta$ Ni filter   |
| (8) Slit set HIGH for high resolution measurement:<br>(optional) | DS=0.10 mm, x1<br>IHS=2 mm, 5 mm x1 each<br>SS=6 mm, RS=6 mm, x1 each<br>This is an optional accessory for executing high resolution measurement at area of more than approx. $2\theta=10^\circ$<br>It is recommended to combine the F.F. tube |



with 2.5° Soller slit.

- (9) Slit set LOW for high resolution measurement:  
(optional)
- |                                 |         |
|---------------------------------|---------|
| DS=0.10 mm,                     | x1      |
| IHS=2 mm, 5 mm                  | x1 each |
| SS=6 mm, RS=6 mm,               | x1 each |
| Receiving side Soller slit 0.5° | x1      |
- \*This is an optional accessory for executing high resolution measurement at area including those below  $2\theta=10^\circ$
- It is recommended to combine the F.F. tube with 2.5° Soller slit.

#### 4.10 Detector monochromator (D/teX Ultra2 0D measurement, SC-70S dedicated for CuK $\alpha$ )

The receiving graphite monochromator dedicated for CuK $\alpha$  is to be combined with the D/teX Ultra2 or SC-70S. It can remove distracting components such as continuous X-ray and K $\beta$  X-ray generated by the X-ray tube or fluorescent X-rays generated from the sample.

- |                              |                                   |
|------------------------------|-----------------------------------|
| (1) Type:                    | Receiving Monochromator           |
| (2) Crystal:                 | Graphite                          |
| (3) Compatible detector:     | D/teX Ultra2, SC-70S              |
| (4) Applicable measurements: | 0D measurement                    |
| (5) Applicable wave length:  | CuK $\alpha$                      |
| (6) Accessories:             | SS1.25°<br>Al absorber 0.2 mm x 3 |

#### 4.11 2D detector HyPix-400 MF

Due to the high-speed para-focusing method, the detection intensity can be improved approx. 100 times higher than that of the scintillation counter under the equivalent slit conditions. Also, due to the excellent energy resolution, a profile with superior P/B ratio can be obtained even for measurement of Fe type sample by a Cu tube. Additionally, with the included scattering protector, the rise of background due to scattering X-rays at low angle area during high-speed para-focusing measurement is reduced, and a profile superior in P/B ratio can be obtained. With utilizing included incident K $\beta$  filter, 2D slit, and Receiving Soller Box Open, 2D measuring is easily available.

- |                          |   |
|--------------------------|---|
| (1) Type:                | Direct photon counting detector                                     |
| (2) Pixel size:          | 100 $\mu\text{m}$ $\times$ 100 $\mu\text{m}$                        |
| (3) Pixels:              | 385 x 96 = 36,960 (Bad Pixel 0.1% or less)                          |
| (4) Active area:         | 38.5mm $\times$ 9.6mm = 369.6 mm <sup>2</sup>                       |
| (5) Counting linearity:  | 1,000,000 cps/pixel and more,<br>Total $3.7 \times 10^{10}$ or more |
| (6) Counting efficiency: | 99%, Energy resolution 25% or less (at CuK $\alpha$ )               |

\*Source target rather than Cu needs inquiry.

(7) Accessories:

Compact size server PC

Standard thickness(15  $\mu\text{m}$ ) incident  $K\beta$  Ni filter

2D Slit (1 mm)

Receiving Soller Box Open

Direct beam absorber

Scattering protector

SS8mm

1.5 times thickness(Ni 23 $\mu\text{m}$ ) receiving  $K\beta$  filter

(8) Optional items:

1.5 times thickness(Ni 23 $\mu\text{m}$ ) incident  $K\beta$  filter

2D Slit ASC(1mm), 2D Slit low angle (0.5 mm)

Receiving Soller box Open

#### 4.12 Scintillation Counter SC-70S

(1) Scintillator:

NaI (Tl)

(2) effective window diameter:

$\phi 23$  mm

(3) Accessories:

Cu absorber 0.2 mm x 2

SS1.25°

Standard thickness(15  $\mu\text{m}$ ) receiving  $K\beta$  Ni filter

#### 4.13 Air-sensitive sample holder

The air-sensitive sample holder is used to prepare the sample and perform measurement while maintaining an inert gas and dry gas environment within a glove box for samples to be kept away from atmosphere and humidity.

(1) Air tightening container main unit:

made by SUS

(2) Container size (mm):

W36.0×D53.2×H26.0

(3) X-ray window:

Kapton (25 $\mu\text{m}$ ), glued on air tightening container

(4) Material and dimensions of sample filling part:

Made by SUS,  $\phi$  18mm ×0.5 mm

The gas pressure is fixed to atmosphere. Be careful of slow leakage, reducing or adding pressure and gas flow cannot be done.

A glove box needs to be provided by customers.

#### 4.14 Si-Low Background Sample Holder

The Si-Low Background Sample Holder is an optional sample holder for powder diffractometer which enables low-background measurement based on symmetrical reflection method by cutting

out Si single crystal for semiconductors in a special direction. The sample can be placed on the front side or rear side of the sample holder, depending on the purpose of measurement. The sample filling part on the front side is approx. 20 mm × 18 mm × 0.2 mm and is suitable for a sample available in a relatively large amount, while the rear side is approx.  $\phi$  5 mm × 0.1 mm and is used for a sample in a limited quantity.

- |                                    |   |
|------------------------------------|---|
| (1) Material:                      | single-crystal silicon for semiconductors cut out in [510]±0.1° |
| (2) External dimensions (mm):      | W35.0×D50.0×H2.0  |
| (3) Sample filling part (mm):      | W20.0×D18.0×T0.2 (front side)                                   |
|                                    | $\phi$ 5.0×T0.1 (rear side)                                     |
| (4) Quantity:                      | 2 holders   |
| (5) Compatible X-ray tube:         | Cu, Co, Fe, Cr  |
| (6) Compatible measurement method: | D/teX Ultra2 + detector monochromator                           |
|                                    | High-speed para-focusing method using 1D high-speed detector.   |

#### 4.15 Hot plate (Mid-temperature sample attachment)

Hot plate is mainly used in temperature variable and atmosphere variable (air and inactive gas) measurements under mid-temperature range. For the temperature control, a dedicated temperature controller (standard component) is operated by manual. This controller cannot be controlled by any programs or computers.

##### 4.15.1 Configuration

- |                                      |       |
|--------------------------------------|-------|
| (1)Hot plate main unit:              | x1    |
| (2)Dedicated temperature controller: | x1    |
| (3)Standard accessory                | 1 set |

##### 4.15.2 Main specification

- |   |   |
|---|---|
| (1)Temperature range of heating plate surface*: | Room temperature to 220°C<br>*Sample temperature may be lower than the temperature of heating plate surface depending on the material, thickness, and thermal conductivity of the sample. |
| (2)Heating speed:                               | 20°C /min. fixed (cooling speed: natural cooling)   |
| (3)Measurement atmosphere:                      | Air, inert gas (nitrogen)*  |
| (4)2θ measurement range:                        | 2 to145°(2θ/θ)<br>*Nitrogen gas cylinder, gas tube, etc. are not included within the hot plate package.   |

##### 4.15.3 Main unit

- |   |   |
|---|---|
| (1) X-ray window:   | Kapton (attached to window of heat insulating cover)  |
| (2) Thermocouple:   | φ50-μm K thermocouple                                 |
| (3) Variation in sample surface height due to thermal expansion of heating plate: | Less than 30 μm                                       |
| (4) Heater:   | Mica heater   |
| (5) Cooling type:   | Air-cooled fans                                       |
| (6) Gas connection:   | PL4-M5 (OD of tube: 4 mm, ID: 2.5 mm)                 |
| (7) Knife edge:   | Attachable/detachable fixed knife edge (height: 3 mm) |

#### 4.15.4 Temperature controller

- (1) Overshoot of target temperature during heating:  
Less than 2°C
- (2) Stability of holding temperature: within  $\pm 1.5^{\circ}\text{C}$
- (3) Input temperature step: 1°C/step
- (4) Power supply and consumption: AC100 to 240V, 150VA or less
- (5) Dimension and weight: W110 mm  $\times$  D305 mm  $\times$  H170 mm, 4.5 kg

#### 4.15.5 Standard accessory

- (1) Sample holder:
  - Quantity: 2 holders
  - Material: Cu
  - External dimensions (mm): W24  $\times$  D30  $\times$  H2
  - Indent size (mm): 20  $\times$  20  $\times$  0.5

#### 4.16 BTS 150/500 (AntonPaar Mid-temperature sample attachment)

The BTS 150/500 Benchtop Heating Stages are the non-ambient stage for benchtop X-ray diffractometers. MiniFlex equips The BTS 150/ or 500 on the standard sample stage to use. Furthermore, the atmospheres are changeable (air, inert gas\*, and vacuum\*) while measuring. The BTS 150/500 employ the method of sample mounting on the heater face to control the sample temperature. The BTS 150/500 can control the heater face temperature through the control programs of MiniFlex.

\* Vacuum (until  $10^{-1}$  mbar) needs BTS vacuum unit (need additional order.)

##### 4.16.1 Configuration

(1)BTS 150/500 main unit:	x1
(2)Temperature controller:	x1 (BTS 150/500 main unit built in)
(3)Standard accessory	1 set

##### 4.16.2 Main specification

(1)Temperature range of heating plate surface\*<sup>1</sup>:

BTS 150:

(Ambient or cooling water temperature -35°C) \*<sup>2</sup> to 150°C

BTS 500:

Room temperature to 500°C

\*<sup>1</sup> Sample temperature may be lower than the temperature of heating plate surface depending on the material, thickness, and thermal conductivity of the sample.

\*<sup>2</sup> Be aware of measures against the condensation with BTS150 during cooling. The lowest temperature for BTS 150 varies depending on the using environment.

i.e.: when ambient temperature is 25°C, the lowest temperature is -10°C~150°C.

(2)Heating speed: Max. 100°C /min.

(3)Measurement atmosphere: Air, inert gas(N<sub>2</sub>) max 1 bar, and Vacuum ( $10^{-1}$  mbar)

(4)2θ measurement range: 2 to145°(2θ/θ) (in TDI measurement, to 140°)

##### 4.16.3 Main unit

(1) X-ray window:	Kapton (50 μm)
(2) Thermocouple:	Pt100
(3) Variation in sample surface height due to thermal expansion of heating plate:	Less than 30 μm
(4) Heater:	BTS 150: Peltier heater

BTS 500: Resistance heater

- (5) Cooling type: Air-cooled fans
- (6) Gas connection: Outer Diameter of tube: 4 mm, Inner Diameter: 2 mm
- (7) Knife edge: Attachable/detachable  
(Variable range: 0.5~5.0 mm from sample surface, default 4 mm)
- (8) Chamber size: Diameter 80mm
- (9) Weigh: approx. 1 kg

#### 4.16.4 Standard accessory

- (1) Sample holder: Material: Ni  
External dimensions (mm): W18 × D16 × H3  
Indent size (mm): W16 × D14 × H0.8
- (2) Power cable: Included in only the package for inside Japan.
- (3) Kapton material for window: x 5 (Reserved)
- (4) Stand: x 1 set
- (5) Tools: x 1 set
- (6) Gas hose: 10m (Outer Diameter 4mm, Inner Diameter 2mm,  
to integrate into MiniFlex)
- (7) Hose transfer adapter: x 1 (Transfer Gas hose into NW16 flange)
- (8) Blind plug: x 2
- (9) USB extension cable: 4m (to integrate into MiniFlex)
- (10) O-ring: x 2 sets (Large x2, and Small x2)
- (11) Vacuum grease: 20 g
- (12) Instruction manual of BTS 150/500 for MiniFlex : x 1 set (Rigaku issued)
- (13) Instruction manual of BTS 150/500: x 1 set (Anton Paar issued)

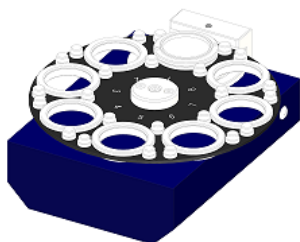
## - Appearance of optional attachments -

### Sample spinner (Item No. 2701C332)



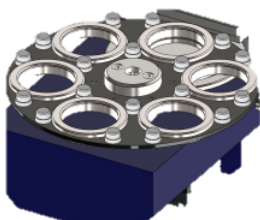
Sample holder  
with base

### ASC-8 (Automatic 8-position sample changer) (Item No. A00007458)



Sample holder  
with base

### ASC-6 (Automatic 6-position sample changer) (Item No. 2455E434)



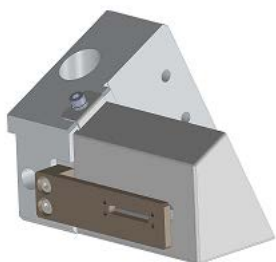
Sample holder  
with base

### 1D detector D/teX Ultra2 (Item No. A00007469)





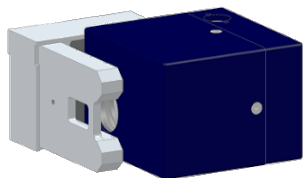
**Detector monochromator (D/teX 0D) (Item No. A00007460)**



**2D detector HyPix-400 MF (Item No. A00007471)**



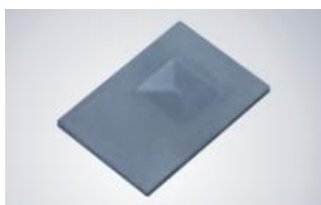
**Scintillation Counter SC-70S (Item No. A00007818)**



**Air-sensitive sample holder (Item No. 2392B101)**



**Si-low background sample holder (Item No. M00016288)**



**Hot plate (Item No. A00002079)**



**BTS 150 (AntonPaar Item No. A00005532)**



**BTS 500 (AntonPaar Item No. A00005533)**



**5. Installation conditions**

Refer to the “Utilities” document.

**6. Acceptance test**

Refer to the “customer acceptance test report” document.

## 7. Warranty

Warranty does not cover damages or defects caused by:

- (1) *Acts of God*
- (2) Improper application
- (3) Tampering, alterations
- (4) Installation contrary to this specification's recommendation, or in any event if the instrument has been altered, defaced, or removed
- (5) Misuse, negligence, inappropriate on-site operating conditions
- (6) Consumption wasting and reaching the end of their working life

After the warranty period expires, products and parts may be repaired and replaced for a reasonable service charge. The following secondary damage: a delay of research and development, receiving inspection, acceptance testing etc. caused by instrument failure, is not covered by warranty.

## 8. Liabilities

- (1) Rigaku shall not be liable for any accidents whatsoever arising out of the following:

- \* Use of the product for unintended purposes
- \* Expiry of service life
- \* Modification without permission
- \* Poor maintenance by the user
- \* Act of God, war, riot, or conflict
- \* Operation not specified in this manual
- \* Installation condition violation
- \* Expendables

- (2) In no event shall Rigaku be liable for the results and consequences of the use of this manual by the user or operator of this product.