Instruction Manual

Mini Single Sheet Tester

SY-956

IWATSU TEST INSTRUMENTS CORPORATION

Introduction

◇ Thank you for purchasing this IWATSU instrument and please regularly use Iwatsu instruments lastingly in future.
◇ Please read this manual before using this product, then keep the manual handy for future reference.
◇ This instruction manual describes operating precautions, operating procedure, operation examples, and specifications. For the main unit of the B-H Analyzer, please refer to its instruction manual.

Safety Precautions

To ensure safe operation of this product and to prevent injury to the user or damage to property, read and carefully observe the warnings ⚠ and cautions ⚠ in the following sections

Definition of warnings ⚠ and cautions ⚠ used in this manual

⚠ **Warnings**	Incorrect operation or failure to observe the warning may result in death or serious injury.
⚠ **Cautions**	Incorrect operation or failure to observe the caution may result in injury or damage to instrument.

Notes

◇ Parts of the contents of this manual may be modified without notice for improvements in specifications and functions.
◇ Reproduction or reprinting of the contents of this manual without prior permission from IWATSU is prohibited.
◇ All the product and brand names in this document are registered trademarks of their respective companies and individuals, and are used here for identification purpose.
◇ FINEMET® is a registered trademark of Hitachi Metals, Ltd. It shows as follows in this manual.
◇ If any question about this product arises, contact Iwatsu at the address listed at the end of this manual or our sales distributors.

History

◇ June 2014: 1st edition
◇ July 2015: 2nd edition

Read the following safety information.

Read the next page.

⚠ Warnings

- **Please be careful with the pole faces of the measuring yoke.**
  The edges of the measuring yoke are not chamfered, in order to suppress leakage flux. Touching it may result in injury (such as a cut on your hand).
- **Do not use in an environment with explosive gases.**
  It may cause an explosion.
- **If you notice smoke, foul odor or abnormal noise, immediately power off this product and remove the power plug from the receptacle.**
  Continued use under these circumstances may result in an electric shock or fire. Turn off the main power switch on the front (○ side), and remove the power plug from the receptacle. Then contact Iwatsu office or our sales distributors for repair. Do not attempt to repair this product yourself.
- **Make sure no water gets on or inside this product.**
  Do not use this product if wet, otherwise an electric shock or fire could occur. If water gets on or inside this product, turn off the main power switch on the front (○ side), and remove the power plug from the receptacle. Then contact Iwatsu office or our sales distributors for repair.
- **Do not place this product on an unstable support such as shaky base or inclined plane.**
  Dropping or falling-down of this product could result in an electric shock, injury, or fire. If this product is dropped or its cover is broken, turn off the main power switch on the front (○ side), and remove the power plug from the receptacle. Then contact Iwatsu office or our sales distributors for repair.
- **Do not expose this product to excessive vibration or shock.**
  Dropping of falling-down of this product could result in injury.
- **Dropping of this product could result in injury to your body or damage to your property.**
  Before carrying this product, remove the measurement sample and cables, close the cover, and then firmly hold it with both hands while carrying so that it does not fall.

Read the following safety information.

Read the next page.

⚠ Warnings (Continued)

- **Use 3-core power cord.**

  If not, an electric shock or failure may occur.
  - If power is supplied from the 2-wire receptacle using the 3-core/2-core conversion adapter, connect the ground terminal of the 3-core/2-core conversion adapter to the ground.
  - If power is supplied from the 3-wire receptacle using the provided 3-core power cord, grounding is made by the ground line of the power cord.

- **Always use this product with a specified power supply voltage.**

  If not, an electric shock, fire, or failure may occur. The range of operating voltage to be used is stated on the rear panel.
  This product runs on AC power supply of single-phase, 50/60Hz and AC100-240V.
  No voltage selection is required, since this product automatically adapts to the power supply voltage.

- **Strictly observe items below when handling the power cord.**

  If not, an electric shock or fire may occur. If the power cord is damaged, contact Iwatsu office or our sales distributors for repair.

  - Do not modify the power cord.
  - Do not forcibly bend the power cord.
  - Do not twist the power cord.
  - Do not bundle the power cord.
  - Do not pull the power cord.
  - Do not heat the power cord.
  - Do not let the power cord get wet.
  - Do not put heavy objects on the power cord.

- **Do not touch the plug of the power cord with wet hands.**

  If not, an electric shock may occur.

- **Do not make metal touch the blade of the power plug.**

  If not, an electric shock or fire may occur.

- **Do not plug too many leads into a single receptacle.**

  If not, a fire or overheating may occur.

- **If thunder sounds, remove the power plug of this product from the receptacle and do not use it.**

  It causes an electric shock, fire or failure according to the thunder.

Read the following safety information.

Read the next page.

⚠ Warnings (Continued)

- **Do not attempt to modify this product.**
  This may result in an electric shock, fire or failure. The user cannot repair this product. Do not repair this product opening it. Also, requests to repair the unit may be refused if unauthorized modifications have been made. Contact our sales distributors for repair. Please note not responding to the repair when the open security seal is removed, the cover is opened or the product is modified.

- **Do not use this product when being failed.**
  If not, an electric shock or fire may occur. For a failure, contact Iwatsu office or our sales distributors for repair.

- **Do not place any small metal objects or containers containing water or chemical on or near this product.**
  If liquid spills or a small metal object gets in, it may cause an electric shock, fire or failure. If water/chemical/metal object gets in, turn off the main power switch on the front (○ side), and remove the power plug from the receptacle. Then contact Iwatsu office or our sales distributors for repair.

- **Do not put any metallic material or inflammable object through the ventilation port.**
  If any foreign object is put through the ventilation port, an electric shock, fire, or failure may occur. If any foreign object enters this product, turn off the main switch on the front (○ side), and remove the power plug from the receptacle. Then contact Iwatsu office or our sales distributors for repair.

- **Do not put any object near to the ventilation port of this product.**
  If not, heat accumulates inside this product, causing an electric shock, fire, or failure.

- **Before inserting the power plug into the receptacle, confirm no dust attached to it. In addition, remove the power plug and adapter from the receptacle and inspect/clean them once a half year or a year.**
  Dust may cause an electric shock, fire, or failure.

Read the following safety information.

Read the next page.

⚠ Cautions

● **Turn off the main power switch on the front before connecting or disconnecting the power cord.**

Connecting or disconnecting the power cord while the power switch is ON (I side) may result in an electric shock or failure.

● **Insert the power supply plug into the receptacle firmly.**

If not, an electric shock, fire, or failure may occur.

● **When disconnecting the power cord from the receptacle, pull it out by grasping the plug.**

Do not pull on the cord itself, as doing so may damage the cord and could result in an electric shock or fire.

● **Before moving this product, confirm that external connection lines such as the power cord and cables are removed.**

The power cord and cable may be damaged causing a fire or electric shock.

● **Never replace the fuse inside the main unit. Contact Iwatsu office or our sales distributors for replacement.**

● **Use 3-core power cord in accordance with the power supply voltage.**

If not, a fire may occur. In addition, if a 2-core power cord is used, a fire may occur.
Unless specified when purchasing this product, the power cord suitable for 100V system (center voltage: 100V to 120V) is attached. If the power supply voltage is 200V system (center voltage: 200V to 240V), use 3-core power cord suitable for 200V system (optional) specified by Iwatsu (rating voltage: 250V).

● **Do not apply an excessive voltage or current to the input connector.**

If not, a fire, electric shock, damage to this product or a sample, or failure may occur.
The maximum allowable input voltage and current are as follows:

Input connector	Maximum allowable input voltage or current
Between S2-S1	±200V
POWER INPUT	±200V / ±6A

● **Never touch the measuring yoke of this product with your bare hands.**

The measuring yoke is made of FINEMET ®. Touching the measuring yoke may cause it to rust, resulting in incorrect measurements.

● **Do not measure a wet or dirty sample with this product.**

The measuring yoke may rust or deteriorate, causing incorrect measurements.

● **Do not measure a sample with an uneven surface or with foreign objects on its surface.**

Pole faces of the measuring yoke or the press block may get damaged.

Read the following safety information.

⚠ Cautions (Continued)

● **Do not place any object on this product.**
Otherwise, the cover may break and come in contact with the internal circuits, causing an electric shock, fire, or failure.

● **Always use this product only within the rated operating range.**
If used over the rated range, failure may occur. The allowable range is as follows:
- Only indoor use
- Operating temperature: +5°C to +35°C
- Operating humidity: no dew allowed below the moisture amount of 85 % RH (+35°C, non-condensation)

● **Do not expose this product to direct sunlight or high humidity.**
If not, heat may accumulate inside this product, resulting in a fire.

● **Do not place this product in a location with excessive moisture or dust.**
If not, an electric shock or fire may occur.

● **Do not expose this product to oil smoke or steam; e.g. besides cooking table or humidifier.**
A fire or electric shock may occur.

● **Do not use any damaged cable or power cord.**
Otherwise, an electric shock or fire may occur.

● **If this product will not be used for a long time, remove the power plug from the receptacle for safety.**

● **Before transporting, remove the measurement sample from this product, close the cover, and then pack with the packing material provided at the time of purchase or the equivalent or better.**
Excessive vibration or shock applied to this product during transportation may cause it to malfunction, resulting in a fire. The warranty will be voided when a failure or damage is caused by transporting the product while the sample is attached or the cover is open.
If there is not a proper packing material/ shock absorber, contact Iwatsu office or our sales distributors. When having this product transported by a shipping company, write "Precision Instrument - Handle With Care" on each side of the packing box.

● **When cleaning this product, remove the power plug from the receptacle for safety. Use dry cloth to wipe water drops away.**
If not, an electric shock or fire may occur.

Checking packed materials

When receiving this product, check the packed materials referring to components below (for the open bale chart, see the next page). If there is a lacked item or an item damaged during transportation, immediately contact Iwatsu office or our sales distributors.

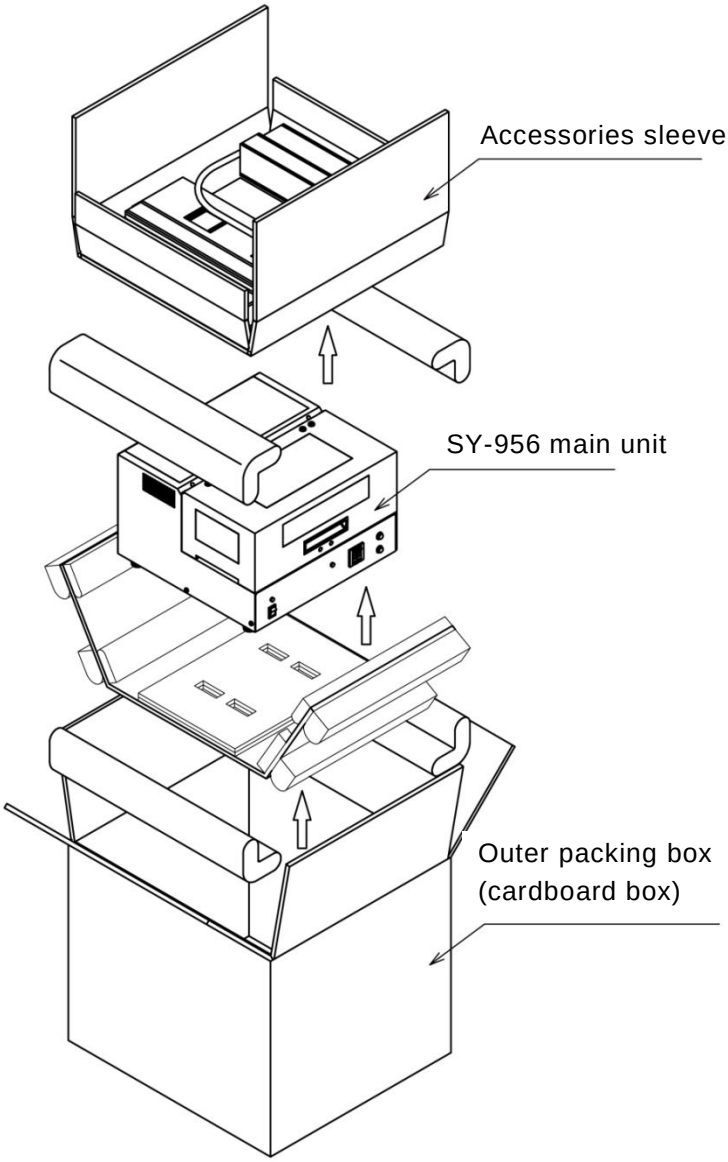
Components

Mini Single Sheet Tester SY-956 main unit.....1

Accessories

- Mini Single Sheet Tester cable (SY-957).....1
- B Coil 01 (SY-958).....1
- B Coil 02 (SY-959).....1
- Thumbscrews for the terminal block.....2
- Tweezers.....1
- Blower brush.....1
- Accessories storage box.....1
- Power cord.....1
- Cord strap.....1
- Instruction manual.....1

Open bale chart (main unit and accessories)



Management of product

When disposing of this product, it is necessary to recycle or dispose of it properly in accordance with a local law or regulation. When disposing of it, request a recycle company to dispose of it in accordance with a local law or regulation

Repair and shipment of the product to be repaired

If a failure occurs, mail this product to our service center. Any failure which occurs within the term of warranty and for which Iwatsu is responsible should be repaired without any cost.

When shipping a product to be repaired, clearly write the product name, serial number (in the label on the rear of this product), description of the failure, and name, division, and telephone number of the responsible person.

About the open security seal

A security seal is affixed on the main unit. (Refer to ■3.3 Rear panel.) We do not accept any repairs orders for the product if the security seal is broken.

Table of Contents

Chapter 1 Introduction

This instruction manual explains only about those functions of the B-H Analyzer that are added by operation and use of a Mini Single Sheet Tester SY-956. Descriptions of the functions that overlap with the standard functions equipped with the B-H Analyzer are omitted. Please refer to the B-H Analyzer's instruction manual.

■1.1 Summary

- In combination with the B-H Analyzer, this instrument allows users to measure core loss of a single sheet sample.

***** Not compatible with B-H Analyzers SY-8232, SY-8217, and SY-8258.

■1.2 Features

- The following are the features of this instrument.

(1) This instrument employs vertical single-yoke type, magnetizing current (MC) method-based single sheet testing (similar to IEC 60404-3).

(2) **FINEMET**® with a small core loss and magnetostriction is used for the measuring yoke.

(3) Highly accurate measurement of single sheet core loss has been achieved by providing the **Yoke Compensation.**[*1] function, which cancels the measurement yoke's magnetic properties, such as core loss.
***1**: **A joint patent application** with Professor Toshihisa Shimizu of Tokyo Metropolitan University has been **submitted** for this function. This function may not work under the measuring conditions in which a core loss of a yoke is small.

(4) Measurement frequency is a **sine wave** between 10 [Hz] to 20 [kHz], which is **one of the widest frequency ranges in the world** for a Single Sheet Tester (SST).

(5) Capable of measuring a single sheet sample that is far smaller than what was possible before. Measurable size is width 35 mm or less, length 36 mm or more, and thickness 3 mm or less (1 mm or less when a provided B coil is in use).

(6) A semi-automatic slider, which presses the sample at a constant pressure, is provided, in order to improve **measurement reproducibility**.

■1.3 Cautions for handling and installation

- **Do not touch** the **measuring yoke** of this instrument **with your bare hands**.
  The measuring yoke is made of FINEMET®. Touching the measuring yoke with your bare hands may cause it to rust, **resulting in incorrect measurements**.

- Please **be careful with the edges of the measuring yoke's pole faces**.
  The edges of the measuring yoke are not chamfered, in order to suppress generation of leakage flux. **Touching it may result in a cut on your hand**.

- **Do not measure a wet or dirty sample** with this instrument.
  The measuring yoke may rust or deteriorate, resulting in incorrect measurements.

- **Do not measure a sample with an uneven surface or with foreign objects on its surface** with this instrument.
  Pole faces of the measuring yoke or the press block may get damaged.

- Use this instrument within a specified range of temperature and humidity.
  If exposed to direct sunlight or used outside an operating range, e.g., high humidity, it may fail.
  Ranges of temperature and humidity for usage are as follows:

  ■ Indoor use only
  ■ Operating temperature: +5°C to +35°C
  ■ Operating humidity: no dew allowed below the moisture amount of 85 % RH (+35°C, non-condensation)

- Do not place this instrument in a location with excessive moisture or dust.
  Placing it in a location with excessive moisture or dust may cause an electric shock or fire.

- Do not place an object on this instrument.
  If an object is placed on top of this instrument, parts such as the cover may get damaged.

- Do not place an object near the ventilation port of this instrument.
  Placing an object near the ventilation port may cause accumulation of internal heat, resulting in an electric shock, fire, or failure.

- If this instrument falls, the impact may inflict bodily harm or cause damage to property. Before carrying, remove all the cables, and then firmly hold with both hands while carrying so that it does not fall.

Chapter 2 Before Measurement

There are several points users need to know before taking measurements with this instrument.

■2.1 For proper measurement

- In order to correctly measure and evaluate samples made of a variety of materials, there are things to be aware of other than excitation conditions.

(1) Conduct a comparative measurement with samples of the same shape (size).

Distribution of magnetic flux density in an excited sample is known to change not only with changes in the manufacturing process of the samples but also with changes in the sample shape (size). Warpage of a sample also needs attention, as it affects the air gaps against the yoke.
The following is an example of the geometry dependence of samples, as researched in our company.

[Measurement Examples of Geometry Dependence]
Figure 2-1 shows a B-H carve of a $0.1^{t}\times5.0^{w}\times107^{L}$ permalloy band (See Fig. 2-2).
The blue curve shows results when the band was an oval. The yellow curve shows results when the band was a circle.
This shows how the saturation magnetic flux density changes drastically when the shape changes.
This measurement result also possesses reversibility.

Fig. 2-2 Permalloy band

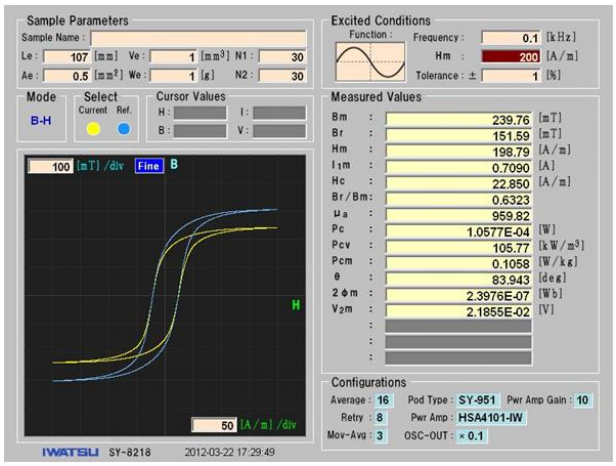


Fig. 2-1 Geometry dependence of a B-H curve

(2) Conduct a comparative measurement, using the same B (magnetic flux density) coil.

Although 2 types of B coils are provided with this instrument, it is the best practice for users to wind a B coil by themselves with consideration to the following (a) to (c):

(a) Always use the same wire for winding.
Eddy current loss generated in the windings by the yoke's leakage flux may change when the size of the wire changes.
(b) Always wind the same number of turns at the same location on the sample.
B to be measured is equivalent to the average magnetic flux density at the location of turns. Therefore, when the location of turns on a B coil is changed, B may change even with the same sample, as magnetic properties differ depending on the location of the sample. Similarly, when the number of turns is changed, B may change even with the same sample, as changing the number of turns is equivalent to changing the testing location.
(c) Always wind tightly around the sample without overlapping.
If air-gaps are formed between the sample and the winding, correct measurement may become impossible, as leakage flux is interlinked with the gaps of turns. The influence of the gaps is more prominent when the permeability of a sample is low.

These considerations apply to the 2 provided B coils with different numbers of turns and hole sizes. Use the same B coil when conducting a comparative measurement.

The example below shows the influence of air gaps, using our B Coil.

[Measurement Example of the Influence of Air-Gaps]
Figure 2-3 shows a B-H curve of a $0.35^{t}\times3.0^{w}$ ferrite slab. The blue curve shows the measurement of a B Coil with the hole size of 32.5 [mm^2]. The yellow curve shows the measurement of a B Coil with the hole size of 82.5 [mm^2]. This shows how the saturation magnetic flux density and amplitude permeability change due to the influence of the air-gaps between the sample and the winding of the B coils.
The influence of the air-gaps is particularly more prominent when the permeability gets lower.

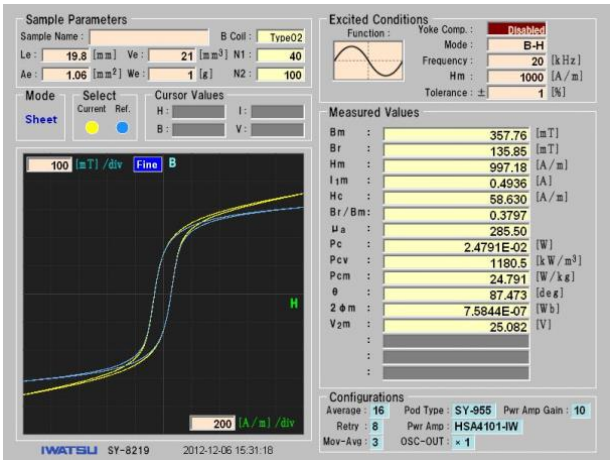


Fig. 2-3 Influence of the air-gap on B-H curves

(3) Pay attention to the front and the back of the sample when conducting a comparative measurement.
Some samples may have different magnetic properties in the thickness direction. Just to be sure, test both the front and back under the same condition and make sure there is no significant differences in the measurement results. Exercise extra caution when using thick samples.

(4) Conduct a comparative measurement by placing samples at the same spot on the yoke.
The location on the yoke where the sample is placed may change the internal distribution of magnetic flux density when the sample is excited, depending on the permeability of the sample. It is the best to align the centers of the width direction of a sample and the yoke.
Place the sample straight between the pole faces of the yoke; do not place it diagonally. Placing the sample diagonally may change the magnetic path length and distribution of magnetic flux density within the sample.

(5) Conduct a comparative measurement with the same pressure.
Firmly press on the yoke the samples that cause magnetostrictive vibration. Otherwise correct measurements may not be possible, as the vibration moves the sample or air-gaps between the yoke and the sample while measuring.

(6) Conduct a comparative measurement under the same temperature.
It is a basic practice to conduct a comparative measurement under the same temperature, as magnetic properties of some materials, such as permeability, may change with temperature.
Exercise extra caution when using ferritic materials, as their permeability changes, particularly around room temperature.

■2.2 Differences in measured values among Epstein frame, conventional SST, and this instrument

In short, **the values measured** by each device **are never the same**, although there are correlations between the values. The same applies with the differences between measured values of an Epstein frame and a conventional SST. This is because the magnetic field strength and distribution of the magnetic flux density within a sample are thought to be different for each testing device even when measurements are collected from the same sample under the same excitation conditions.

Cross sectional areas of the four corners of a sample, which overlap and form a closed magnetic circuit, differ from the cross sectional area of the other parts in an Epstein frame. Air-gaps are formed also in these four corners. Furthermore, the magnetic field strength and the distribution of the magnetic flux density within a sample are thought to be non-uniform, because magnetic flux tends to pass through the inside of a sample forming the closed magnetic circuit, where magnetic resistance is low.

Unlike the case of an Epstein frame, a sample does not overlap in a SST, but the air-gaps are still formed on the yoke's end face where it comes into contact with the sample.
Four of these areas exist in a double-yoke type tester and two in a single-yoke type tester.
Therefore, the magnetic field strength and the distribution of the magnetic flux density differ between the center and the areas closer to the yoke.
This applies to both double- and single-yoke type testers.

Of course, although the values may differ, the measured values of each device are thought to correlate with

each other, if each measurement device is ideally tuned. For example, it is implausible that a sample that shows the highest core loss with one type of measurement device shows the lowest core loss with another type of device.
In order to conduct accurate measurement, it is important to use a testing device with high measurement accuracy. In addition, as described in (1) to (6) of ■2.1, it is also important to keep the measurement conditions constant.

■2.3 How to find the detection limit

It was noted in the previous chapter that even when ideally tuned measurement devices, with different methods, test the same sample under the same excitation conditions, the resulting values are never the same.

Thus, finding the detection limit of a device, as in the precision of the measurements derived from a specific device, is of the utmost interest. There is an easy trick to find out; this trick may also work with an Epstein frame and a SST. The trick is to take a measurement with no sample. In other words, use an air core coil that has only air inside the winding. The coil needs to be the actual coil used for the measurement.

What to measure with an air core coil?

The easiest is the core loss P_{cv}. With an ideal core coil, there should not be any core loss.
Therefore, without any samples, ideal core loss is $P_{cv}=0$ and the area enclosed by the B-H curve is 0.

In reality, even without any samples, P_{cv} is not 0, because of the eddy current loss generated on the winding of a B coil, due to a leakage flux, or the core loss generated at the measuring yoke in the case of SSTs. As such, P_{cv} measured without any sample is the detection limit of core loss P_{cv} of the particular device with the same frequency under the same excitation conditions. That means the samples with core loss smaller than this value of P_{cv} cannot be measured.

■2.4 Regarding air-gap compensation coils

Some Epstein frames and the ordinal SSTs are equipped with an air-gap compensation coil. This coil is meant to cancel out the added air-gap flux between a B coil and a sample. However, this method does not cancel out the air-gap flux correctly.

This kind of air-gap compensation coil is not attached to the location of the B coil is. As mentioned in ■2.1, the value of B changes with the position of the B coil with respect to the sample. This is because the magnetic flux density within the sample is non-uniform throughout the sample in both an Epstein frame and a SST. Therefore, the air-gap flux generated between the B coil and the sample is thought to differ from the air-gap flux generated in an air-gap compensation coil that is attached away from the B coil.

In addition, an air-gap compensation coil does not take the cross-sectional area of the sample into consideration. Because the hole size of an air-gap compensation coil is the same as that of a B coil, an air-gap compensation coil may cancel out the leakage flux crossing an air-gap larger than the air-gap between a B coil and the sample.

This instrument is not equipped with an air-gap compensation coil. One reason is the extreme difficulty of equipping an air-gap compensation coil that works well with different shapes of single sheet that this instrument can test. The main reason is the inherent problems with the ordinary air-gap compensation coils.

■2.5 Measurement principles

Fundamentally, this instrument employs vertical single-yoke type, magnetizing current (MC) method-based single sheet testing. **The biggest drawback of a conventional MC method-based SST has been the inclusion of the measuring yoke-related core loss in the core loss of a sample.** In other words, a conventional MC method- based SST measures the properties of a soft magnetic composite material core that is made up of 2 materials: the sample itself, and the yoke.

When the core loss of a yoke is sufficiently smaller than the core loss of a sample, the yoke-related core loss can be ignored. However, there was no way of knowing the amount of this yoke-related core loss with a conventional MC method-based SST. FINEMET® with an extremely small core loss is used for the measuring yoke of this instrument. In addition, this instrument is equipped with the function to extract only the sample's magnetic properties, such as core loss, from the soft magnetic composite material core that is made up of 2 materials, the sample and the yoke, by cancelling the yoke-related core loss. This function is called **Yoke Compensation** (**Yoke Comp.**).

A joint patent application with Professor Toshihisa Shimizu of Tokyo Metropolitan University has been submitted for this Yoke Comp. function. A summary of the Yoke Comp. is explained below.

First of all, the composition of this instrument is as follows. As shown in Fig. 2-4, this instrument is composed of a measuring yoke (Core area A_y, Relative permeability μ_y), equipped with an excitation coil (Number of turns n_1) and a B coil (Number of turns n_3); similarly, a double-yoke (Core area A_y, Relative permeability μ_y), equipped with an excitation coil (Number of turns n_1) and a B coil (Number of turns n_3); a signal generator that sends excitation current to each excitation coil; and a shunt resistor (Resistance value R_s) that converts the excitation current into a voltage. The measuring yoke and the double-yoke are made of the same FINEMET®. The double-yoke is hidden inside the casing.

Also provided is Relay 1, which switches the excitation coil through which an excitation current is sent, and Relays 2 and 3, which switch the B coil, which measures an induced voltage. A sample single sheet (Core area A_p, Relative permeability μ_p) is placed on top of the measuring yoke and wound with the B coil (Number of turns n_2).

Yoke Comp. is achieved by dividing the measurement into 3 repetitions. The 1st measurement is explained first. The number of the current measurement repetition is shown in magenta color on the graph on the Measurement screen of the B-H Analyzer.

Connect Relay 1 to the a-side, Relay 2 to the ii-side, and Relay 3 to the a-side. Send an excitation signal of a frequency f (cycle T) from the signal generator and send an excitation current i_{1a} to the excitation coil on the measuring yoke. This excitation current i_{1a} is converted into a voltage V_{1a} with the shunt resistor. At this time, induced voltage V_2 is generated at both ends of the B coil of the single sheet.

When the magnetic path length of a single sheet is L_p, the magnetic field strength of the single sheet is H_p, magnetic path length of the measuring yoke is L_{ya}, and the magnetic field strength of the measuring yoke is H_{ya}, according to Ampere's law,

$$\begin{aligned} n_1 i_{1a} &= H_p L_p + H_{ya} L_{ya} \\ &= \left\{ H_p + \left(\frac{L_{ya}}{L_p} \right) H_{ya} \right\} L_p \end{aligned} \qquad (1).$$

When a new magnetic field strength H_v is defined in formula (1) as follows:

$$H_v = \left\{ H_p + \left(\frac{L_{ya}}{L_p} \right) H_{ya} \right\} \qquad (2),$$

formula (1) turns into

$$n_1 i_{1a} = H_v L_p \qquad (3).$$

Therefore, H_v is

$$H_v = \frac{n_1\, i_{1a}}{L_p} = \frac{n_1\, V_{1a}}{L_p\, R_s} \quad (4).$$

Magnetic flux density B_p inside a single sheet is

$$B_p = \frac{1}{n_2\, A_p}\int V_2 dt \quad (5).$$

A conventional MC method-based SST is equivalent to measuring the iron loss P per unit volume of a single sheet from this H_v and B_p. (Whenever “iron loss” is indicated hereafter, it mean iron loss per unit volume.) Because iron loss P is determined by dividing the area of the B-H curve by the cycle of the excitation signal,

$$P = \frac{1}{T}\int_0^T H_v \frac{dB_p}{dt} dt \quad (6),$$

when formula (2) is substituted into this, it becomes

$$P = \frac{1}{T}\int_0^T \left\{H_p + \left(\frac{L_{ya}}{L_p}\right) H_{ya}\right\} \frac{dB_p}{dt} dt = \frac{1}{T}\int_0^T H_p \frac{dB_p}{dt} dt + \frac{1}{T}\int_0^T \left(\frac{L_{ya}}{L_p}\right) H_{ya} \frac{dB_p}{dt} dt \quad (7).$$

The first term of formula (7) is the actual iron loss $P_{p,}$ which only includes the magnetic field strength H_p and the magnetic flux density B_p in a single sheet. The second term is related to the iron loss H_{ya} in the measuring yoke, which includes the magnetic field strength in the yoke. A conventional MC method-based SST ignores the second term of formula (7) by assuming that the magnetic field strength in a measuring yoke H_{ya} is small compared to the magnetic field strength in a single sheet H_p ($H_v \approx H_p$) in formula (2).

With this instrument, magnetic field strength in the measuring yoke H_{ya}, which was unmeasurable with conventional MC method-based SSTs, can be calculated from this 1st measurement and the 2nd and 3rd, explained later. Using the value of H_{ya}, find the magnetic field strength H_p of the single sheet and then calculate the actual iron loss P_p of the single sheet with only the first term of formula (7).

In the 1st measurement, H_v and B_p are calculated by formulas (4) and (5).

The 2nd measurement is explained next.

Reconnect Relay 2 to iii-side. Do not change Relays 1 and 3. From the signal generator, send an excitation sine wave signal of the same frequency f (cycle T) used in the 1st measurement so that the excitation current i_{1a2}, which flows through the excitation coil on the measuring yoke, is the same as the excitation current i_{1a} from the 1st measurement. At this point, an induced voltage V_{3a} is generated at both ends of the B coil on the measuring yoke.

Magnetic flux density B_{ya} in the measuring yoke is

$$B_{ya} = \frac{1}{n_3\, A_y}\int V_{3a} dt \quad (8).$$

Since the excitation current sent through the excitation coil of the measuring yoke is the same for the 1st and 2nd measurements; B_{ya} derived in the 2nd measurement is, in fact, the magnetic flux density of the magnetic field strength H_{ya} in the measuring yoke from the 1st measurement.

Finally, the 3rd measurement is explained next.

Reconnect Relay 1 and 3 to b-side. From the signal generator, generate an excitation sine wave signal of the same frequency f (cycle T) used in the 1st and 2nd measurements, and send the excitation current i_{1b} to the excitation coil on the double-yoke this time. This excitation current i_{1b} is converted into a voltage V_{1b} with the shunt resistor. At this point, an induced voltage V_{3b} is generated at both ends of the B coil on the double-yoke.

This excitation current i_{1b}, which is sent through the excitation coil on the double-yoke, needs to be adjusted so that the magnetic flux density B_{yb} in the double yoke is the same as the magnetic flux density B_{ya} in the measuring yoke obtained in the 2nd measurement. In reality, i_{1b} is adjusted so that B_{yb} and B_{ya} match within the Tolerance set in the measurement conditions.

Magnetic flux density B_{yb} in the double-yoke is

$$B_{yb} = \frac{1}{n_3 A_y} \int V_{3b} dt = B_{ya} \tag{9}.$$

When the magnetic path length of the double-yoke is L_{yb}, the magnetic field strength H_{yb} in the double-yoke can be calculated from Ampere's Law:

$$\begin{aligned} H_{yb} &= \frac{n_1 i_{1b}}{L_{yb}} \\ &= \frac{n_1 V_{1b}}{L_{yb} R_s} \end{aligned} \tag{10}.$$

H_{yb} is the magnetic field strength when the magnetic flux density in the double-yoke is B_{yb}. This B_{yb} is also the same as the magnetic flux density B_{ya} in the measuring yoke from the 1st measurement, and thus, H_{yb} turns out to be the same as the magnetic field strength H_{ya} of the measuring yoke from the 1st measurement. This is because the B-H curve, which shows the relationship between magnetic field strength and magnetic flux density, is the same for both the measuring yoke and double yokes of the same shape and material composition.

Therefore, formula (10) can be written as

$$H_{yb} = H_{ya} = \frac{n_1 i_{1b}}{L_{yb} R_s} \tag{11}.$$

By modifying formula (2), the magnetic field strength H_p of the single sheet can be calculated as

$$H_p = H_v - \left(\frac{L_{ya}}{L_p}\right) H_{ya} \tag{12}.$$

Therefore, by applying H_v derived from the 1st measurement and $H_{ya}(=H_{yb})$ derived from the 2nd and 3rd measurements into formula (12), the magnetic field strength H_p of a single sheet at the time of the 1st measurement can be obtained. The graph showing the relationship between this magnetic field strength H_p of the single sheet and the magnetic flux density B_p of the single sheet derived from formula (5) is the B-H curve of the sample single sheet.

In conclusion, by substituting H_p of formula (12) into the first term of formula (7),

$$P_p = \frac{1}{T}\int_0^T H_p \frac{dB_p}{dt} dt \quad (13),$$

the actual iron loss of only the single sheet P_p can be calculated.

Yoke Comp. comes into effect when Yoke Comp. is Enabled, as explained in ■4.15. When Yoke Comp. is Disabled, testing is completed after the 1st measurement.

Still, **Yoke Comp. does not necessarily work at all times**. In order to make the magnetic flux density B_{ya} of the double-yoke in the 3rd measurement equal to the magnetic flux density B_{ya} of the measuring yoke in the 2nd measurement, this instrument controls the amplitude of the signal generator precisely and adjusts the excitation current i_{1b} sent through the double-yoke. However, the generator cannot be controlled when this B_{ya} is extremely small. When a warning message is displayed and the 3rd measurement does not proceed after the 2nd measurement, it is usually the case that this B_{ya} is extremely small (i.e., measurement conditions are such that the core loss related to the measuring yoke is extremely small).

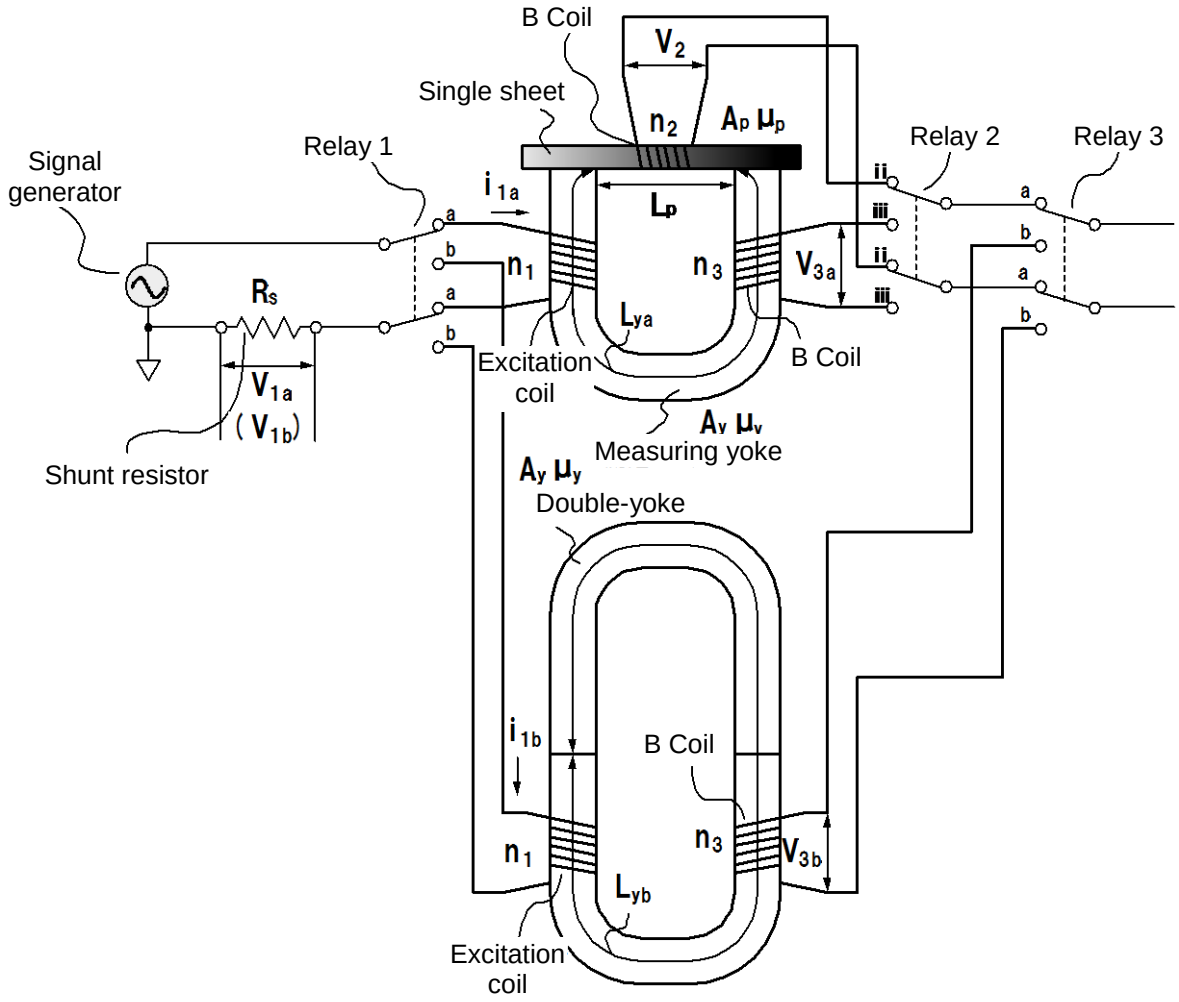


Fig. 2-4 Summary of the measurement principles

Chapter 3 Names and Functions of Each Part

■3.1 Front panel

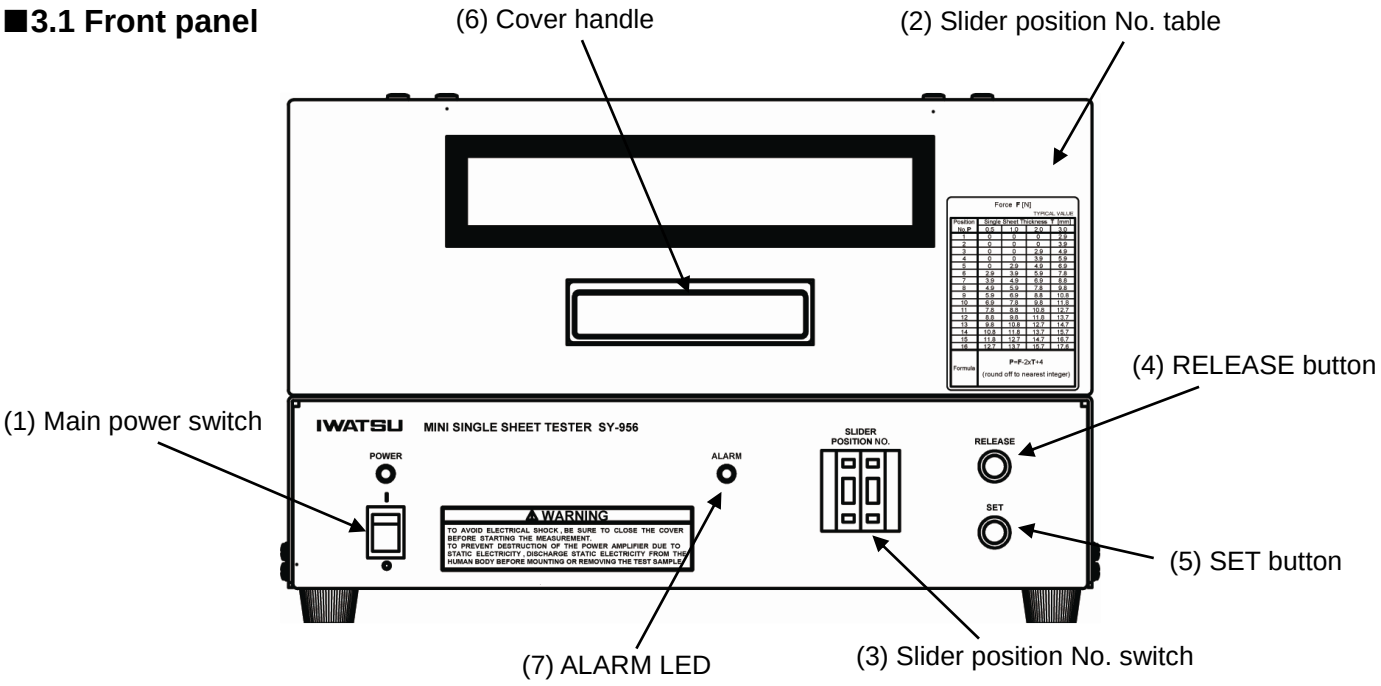


Fig. 3-1 Front Panel of SY-956

(1) Main power switch
Main power switch of a Mini Single Sheet Tester SY-956.

(2) Slider position No. table
From the thickness of the sample sheet and the desired force with which the slider presses the sample, determine the setting value of the slide position No. switch, according to the slider position No. table or the formula written below the table.
* The load value on the table is the typical value. ±3 [N] deviation from the displayed value may occur.

(3) Slider position No. switch
Set the value determined in (2) which corresponds to the force with which to press the sample. Adjust the setting value by pressing the buttons above and below the switch. **The valid setting value is from 1 to 16**. Any other number is invalid.

(4) RELEASE button
Pressing this button when the LED is off will cause the slider to lift up while the LED blinks. When the slider rises all the way up, the LED stays on and the sample can be detached. Operation is invalid if the button is pressed while the LED is blinking.

(5) SET button
Pressing this button when the LED is off will cause the slider to move down while the LED blinks and press a sample with the pressure corresponding to the setting value of the slider position No. switch. When the slider stops at the correct pressure, the LED stays on. Operation is invalid if the button is pressed while the LED is blinking.
Pressing the button again, while the LED is on, after changing the value of the slider position No. switch will readjust the slider to press the sample with the new setting value.

(6) Cover handle
Use this handle to open and close the cover. Push the cover in until you hear a clicking sound. The RELEASE button and the SET button blink when the cover is open, and blinking stops when closing.

(7) ALARM LED
The ALARM LED **turns on or blinks when there is something wrong** with the slider. Contact the service center if the ALARM LED is still on or blinking after restarting.
* It is normal to see a short blinking when the main power is turned on/off.

■3.2 Fixture

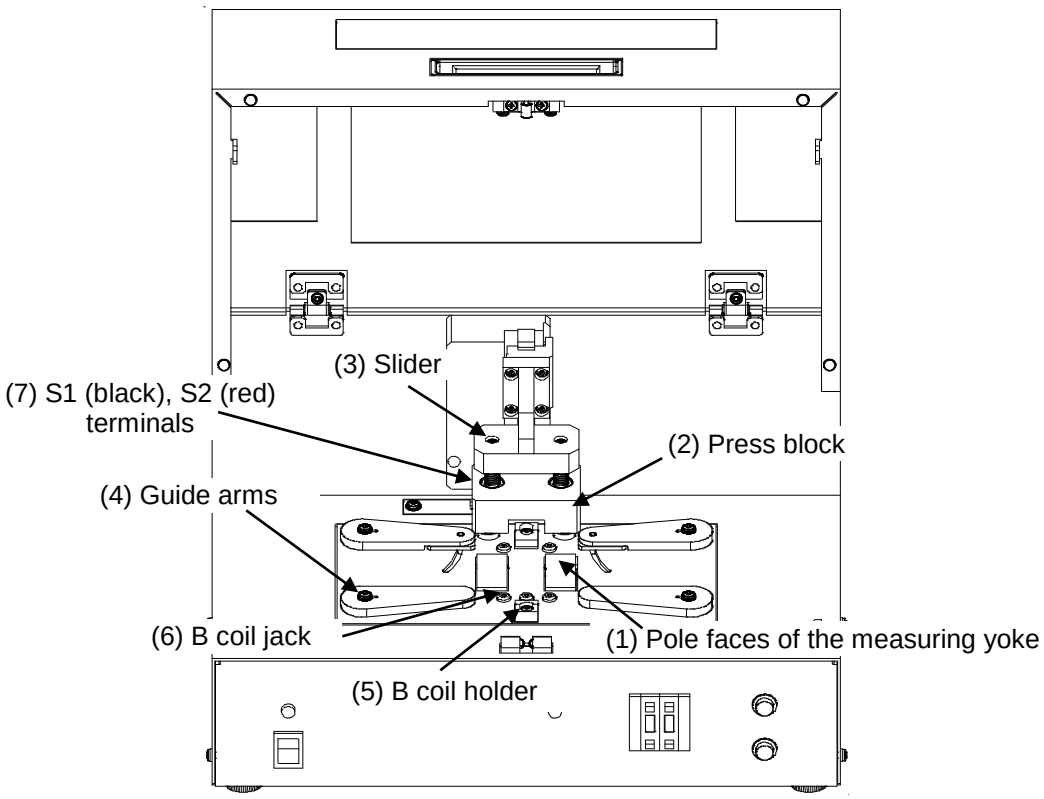


Fig. 3-2 Fixture of the SY-956

(1) Pole faces of the measuring yoke
Place the measuring sample single sheet on these faces.

* **Do not touch** the pole faces **with your bare hands**. The measuring yoke may rust, **resulting in incorrect measurements**.
* Please **be careful with the edges** of the pole faces. Edges of the pole faces are not chamfered, in order to suppress the generation of leakage flux. **Touching it may result in a cut on your hand**.

(2) Press block
Press the sample sheet from above. The press block is made of poly phenylene sulfide (PPS) resin.

* PPS resin may deform at 160°C or higher.

(3) Slider
Move the press block up and down.

(4) Guide arms
Support long samples from the side. Guide arms are made of polyacetal resin (POM).

* POM resin may deform at 80°C or higher.

(5) B coil holder
Supports the provided B Coils 01 and 02 from below.

(6) B coil jack
Insert the plug of the provided B Coils 01 and 02.

(7) S1 and S2 terminals
When using a B coil that did not originally come with the product, connect the beginning and ending of the winding of the B coil to the S1 and S2 terminals.

■3.3 Rear panel

(3) Connection terminals for Mini Single Sheet Tester Cable SY-957

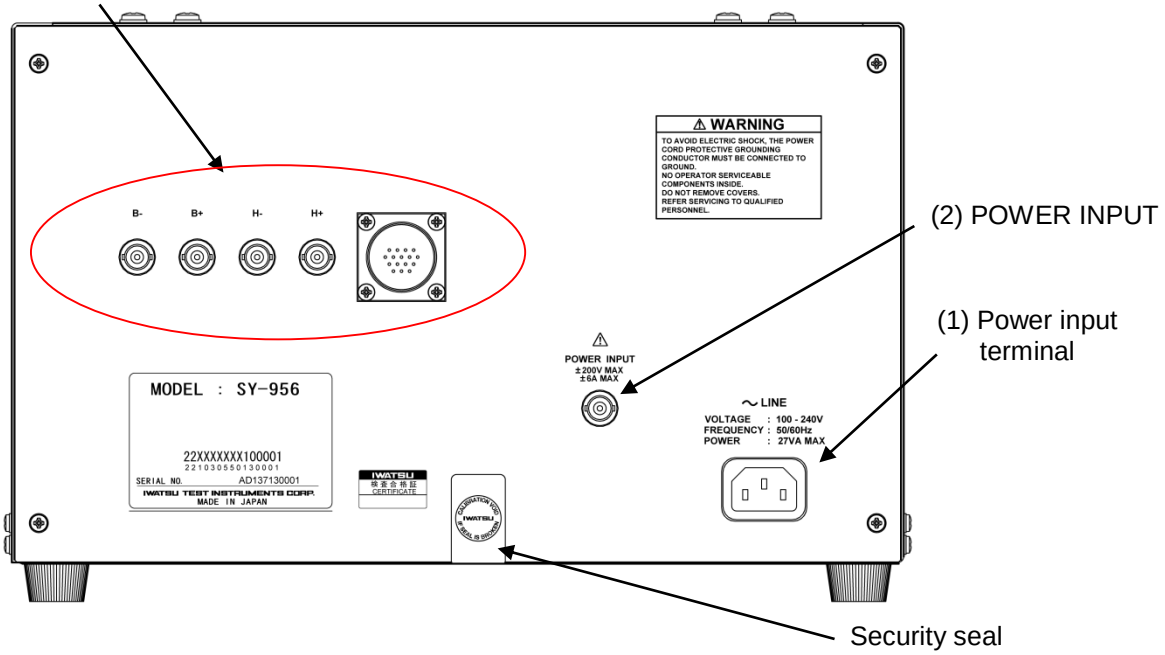


Fig. 3-3 Rear panel of SY-956

(1) Power input terminal

Insert the power cord.

(2) POWER INPUT

Connect the output from the power amplifier with the BNC cable.

(3) Connection terminals for Mini Single Sheet Tester Cable SY-957

Connect to the B-H Analyzer with Mini Single Sheet Tester Cable SY-957.

Chapter 4 Measurement

■4.1 Flow before measurement

- The flowchart below shows procedures for the measurement with a Mini Single Sheet Tester SY-956.

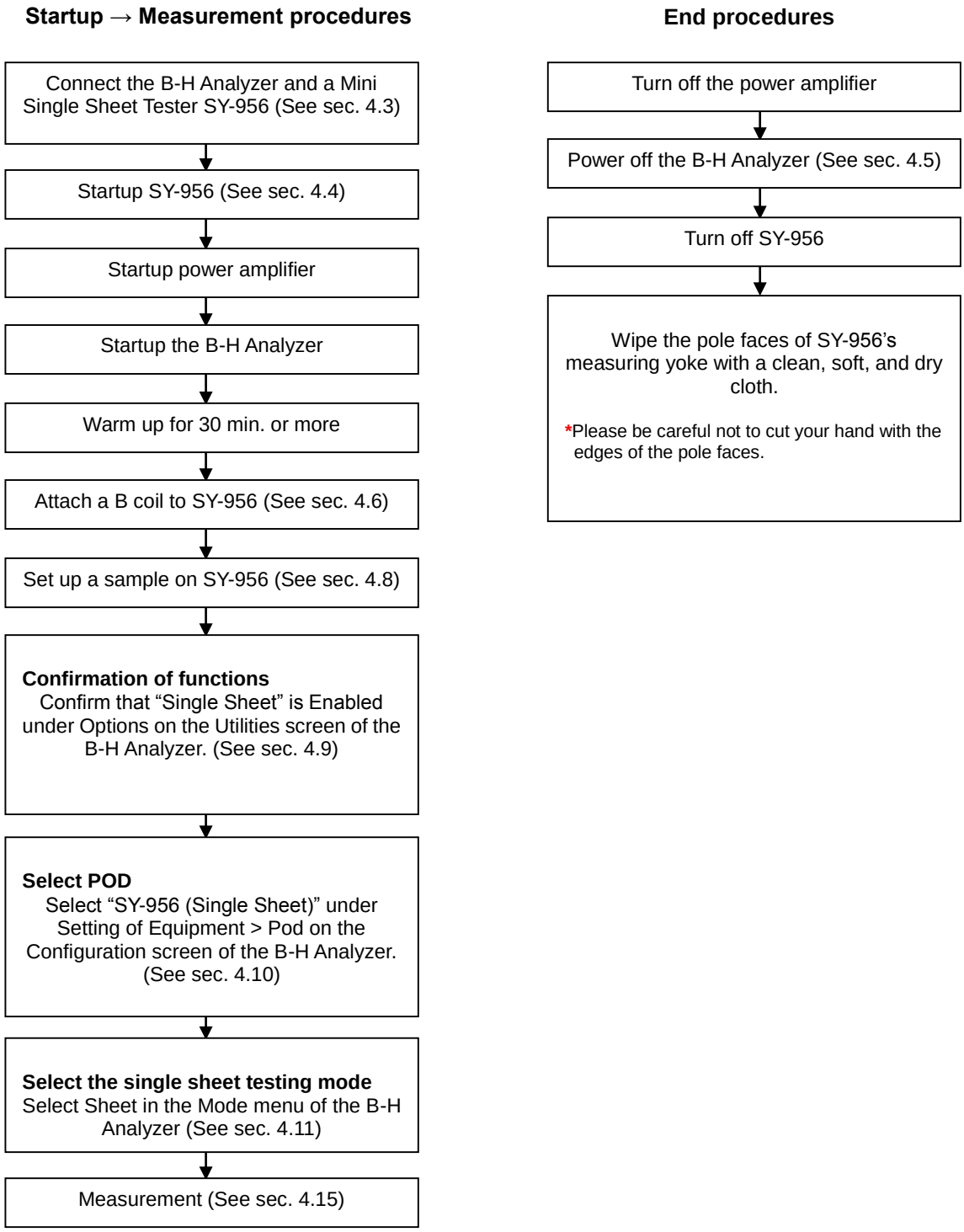


Fig. 4-1 Flow before measurement

■4.2 Connecting equipment

- The following shows how to connect the measuring equipment that integrates a Mini Single Sheet Tester SY-956.

* Mini Single Sheet Tester SY-956 **needs to be connected to the B-H Analyzer with which it has been calibrated together**.
Proper measurement cannot be made by connecting to any other B-H Analyzers.

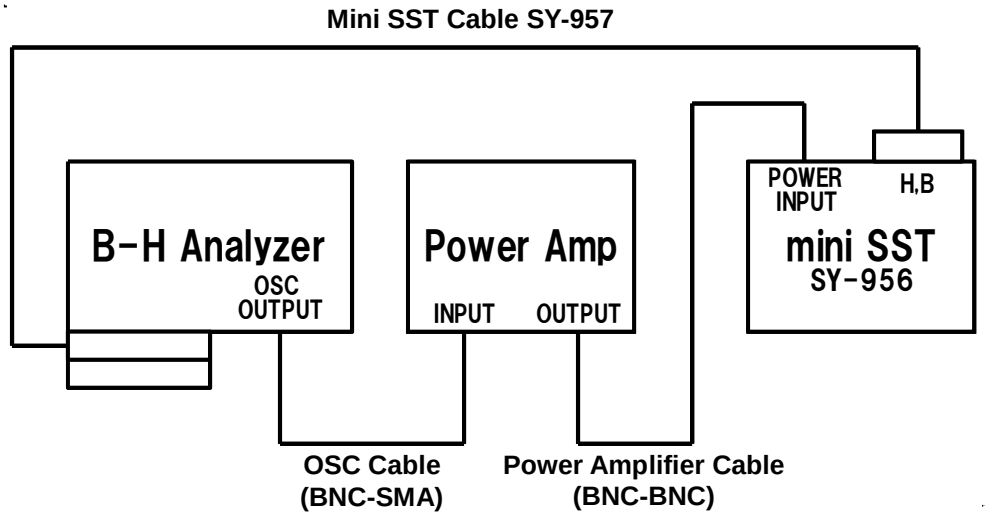


Fig. 4-2 Connecting SY-956

■4.3 Connecting Mini Single Sheet Tester Cable SY-957

● The following shows how to connect the provided Mini Single Sheet Tester Cable SY-957.

(1) Make sure the B-H Analyzer is turned **OFF**.

(2) Remove the measuring terminal block from the POD.

Unscrew 2 thumbscrews on the terminal block first. (See Fig. 4-3)

(3) Then, hold the knobs with both hands and pull up perpendicularly. (See Fig. 4-4)

* Store the M3 screws so that they do not get lost.

(4) Install the measuring block for Mini Single Sheet Tester Cable SY-957.

First, align the terminal block guide with the measuring POD guide. (See Fig. 4-5, 4-6)

Then **slowly** push down the terminal block perpendicularly along the guide. (See Fig. 4-6)

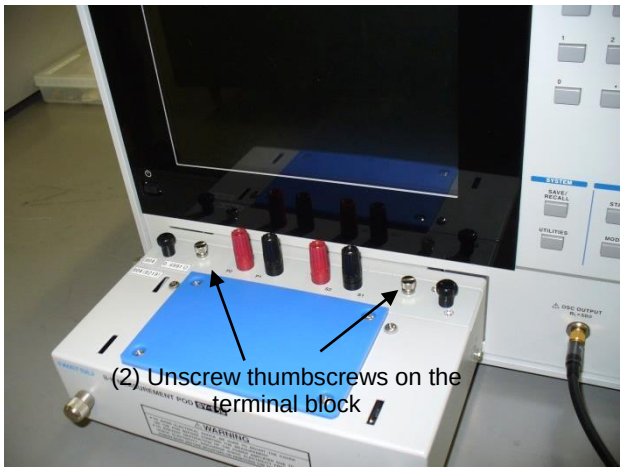


Fig. 4-3 Removing the measuring terminal block

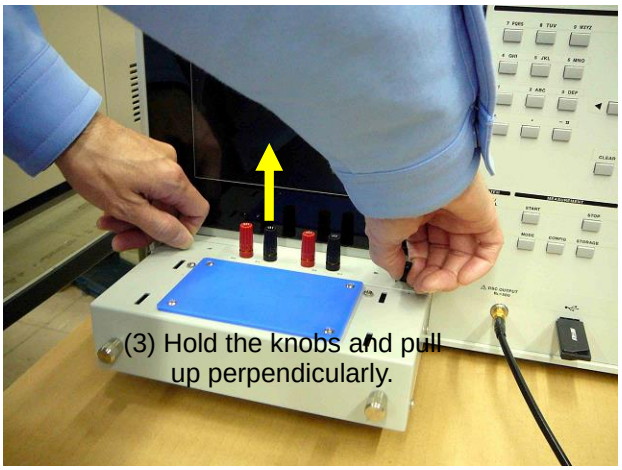


Fig. 4-4 Removing the measuring terminal block

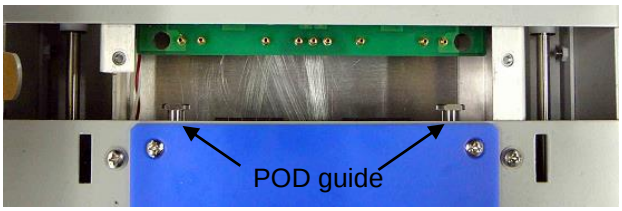


Fig. 4-5 POD guide

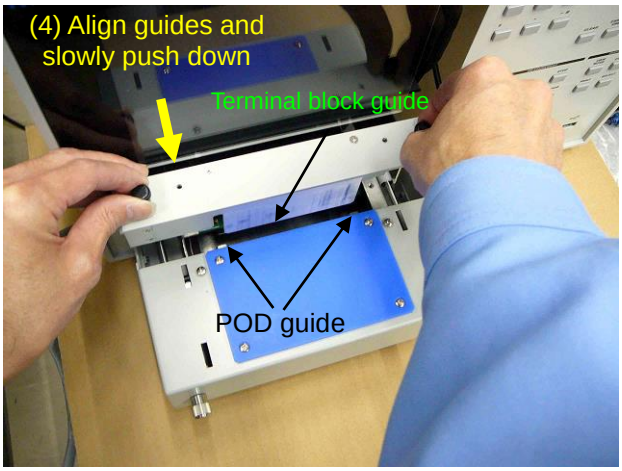


Fig. 4-6 Inserting the SY-957 terminal block

(5) After making sure the terminal block is properly installed on the measuring POD, secure the terminal block on the measuring POD with 2 provided thumbscrews.
(See Fig. 4-7)

(6) Attach the measuring connector of the Mini Shingle Sheet Tester Cable SY-957 on the back of the product.

Fit the 4 BNCs and a multi-pin connector together.
(See Fig. 4-8)

(7) Secure the connector by **turning** the lever **to the right**.
(See Fig. 4-9)

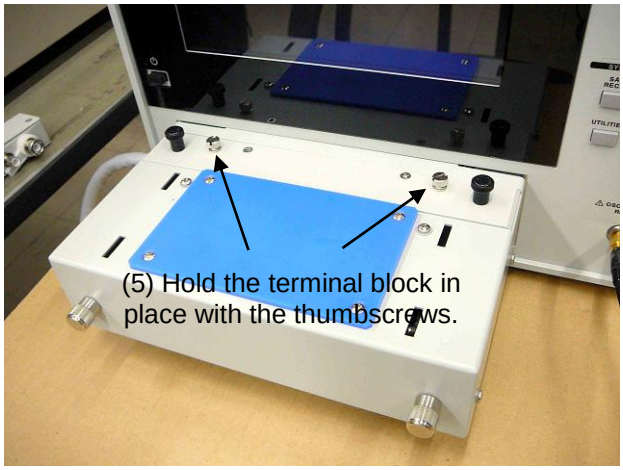


Fig. 4-7 Securing the SY-957 terminal block

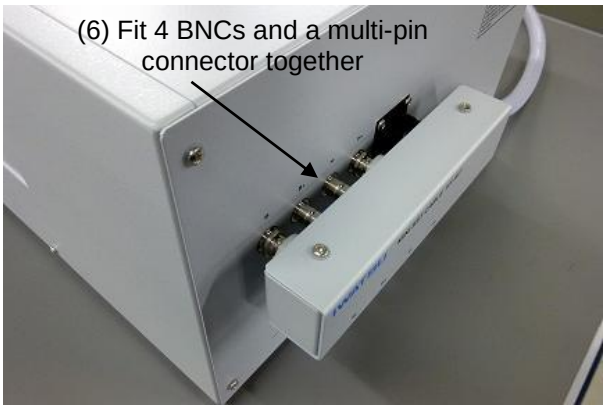


Fig. 4-8 Connecting SY-957

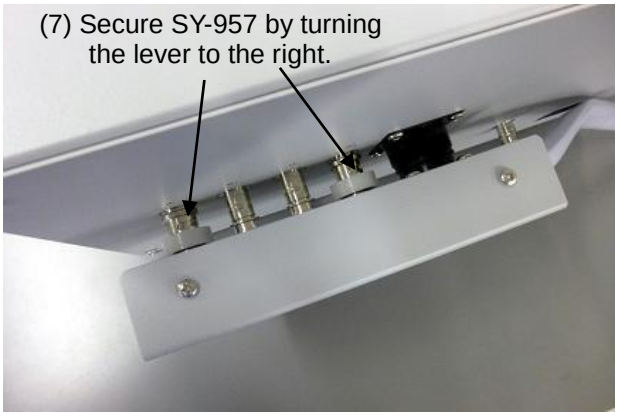


Fig. 4-9 Securing SY-957

■4.4 Powering on

- The following is the method to power on this instrument.

(1) Turn on the main power switch of this instrument.

(2) While the cover is closed, verify that the LEDs of the RELEASE button and SET button stop blinking and stay on.

(3) Turn on the power amplifier when using one.

(4) Turn on the B-H Analyzer and let it start up. Refer to the B-H Analyzer's instruction manual for the operation.

(5) Warm it up for 30 minutes or more.

■4.5 Powering off

- The following is the method to power off this instrument. Follow the power-on procedures in reverse to power off.

(1) Turn off the power amplifier first when using one.

(2) Power off the B-H Analyzer. Please refer to the B-H Analyzer's instruction manual for the operation.

(3) Turn off the main power switch of this instrument.

* It is normal to see short blinking when the main power is turned on/off.

■4.6 Attaching and detaching a B Coil

- The following is the method of attaching and detaching a B coil.

(1) Hold the cover handle and open the cover of this instrument.
LEDs on the RELEASE button and SET button blink.

(2) When attaching the provided B Coil 01 or 02, insert the plug of the B Coil into the B Coil jack and push the four edges of the B Coil from above so that it touches the B coil holder (See Fig. 4-10).

When detaching a B coil, gradually lift up the top and bottom corners of the B coil alternately as shown in Fig. 4-11 and Fig. 4-12.

(3) When attaching a B coil wound by a user, connect the front and the end of turns to the S1 and S2 terminals. Use a pair of tweezers for easier wire insertion into the S1 and S2 terminals.

* Place the excess wire in the concavity of the press block to prevent interference with the press block and the measuring yoke when the slider moves up and down.

* **Do not modify the provided B coils**. Modifying it may cause a failure or damage. The warranty is void if failure or damage occurs. Repair requests cannot be accepted.

* **Do not connect a B coil wound by the user to the B coil jacks.** Doing so may cause a failure or damage. The warranty is void if failure or damage occurs. Repair requests cannot be accepted.

* If the left and right of the B-H curve are reversed, switch the wires connected to the S1 and S2 terminals.

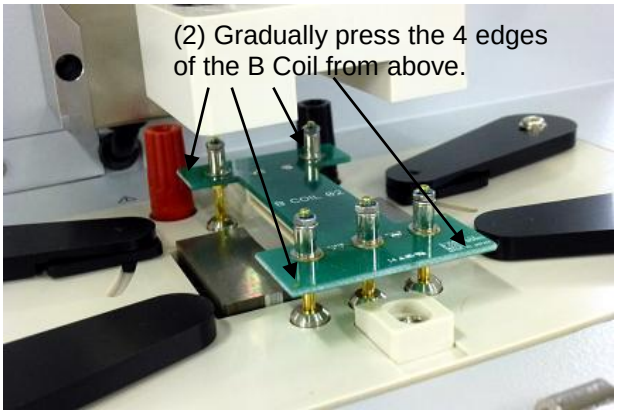


Fig. 4-10 Attaching a B coil

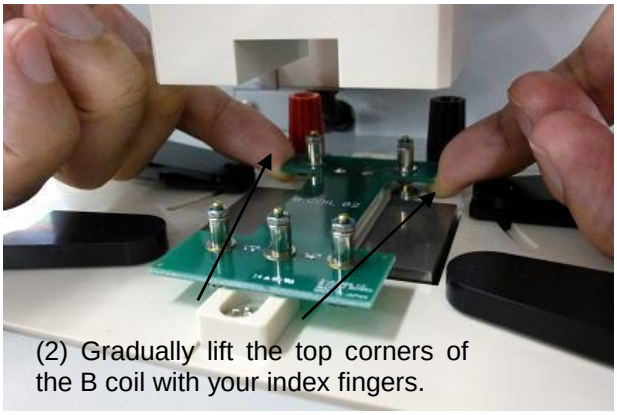


Fig. 4-11 Detaching a B coil

Fig. 4-12 Detaching a B coil

■4.7 Measurable samples

- Table 4-1 shows the sizes of measurable samples

Table 4-1 Measurable sample size and specifications of the provided B coils

Types of B coils	Measurable sample sizes [mm]			Size of the bobbin hole [mm]		Number of Turns
	Thickness	Width	Length	Thickness direction	Width direction	
B Coil 01	1≧	10≧	36≦	$1.5^{\pm 0.1}$	$12^{\pm 0.1}$	35
B Coil 02	1≧	30≧	36≦	$1.5^{\pm 0.1}$	$32^{\pm 0.1}$	100
Coil wound by user	3≧	35≧	36≦	—	—	—

- Table 4-2 shows the conditions of samples that make them unmeasurable, other than size. **Never measure items with the following conditions**. Not only will it lead to incorrect measurement, but it may also cause a failure or damage.

Table 4-2 Unmeasurable conditions of samples

Conditions of samples	Expected failures
・Wet samples	Moisture will be attached to the yoke, causing it to rust.
・Dirty samples	Dirt will be attached to the yoke, causing it to deteriorate.
・Samples with sharp bumps	Pole faces of the yoke or the press block may get damaged when the slider is descending.
・Samples with hard foreign objects attached	

- Table 4-3 shows the conditions of samples that result in incorrect measurements.

Table 4-3 Conditions of samples that result in incorrect measurements

Conditions of samples	Expected failures
・Samples with uneven width	Magnetic flux density inside the sample will be nonuniform.
・Sample that deforms	
・Samples with uneven thickness	
・Samples with uneven surface	Air-gaps are formed between the sample and the pole faces of the yoke.
・Samples with foreign objects attached	

■4.8 Setting a sample

- Following shows how to set a sample.

(1) Remove dust from the pole faces of the measuring yoke with the provided blower brush. Make sure no dust or dirt is on the sample. Remove all the dust and dirt.

(2) Slide the sample through the installed B coil and place the left and right sides of the sample on the pole faces of the measuring yoke, as shown in Fig. 4-13.
When using a long sample, use the guide arms to align the center in the widthwise direction of the sample and the center of the measuring yoke's pole faces.

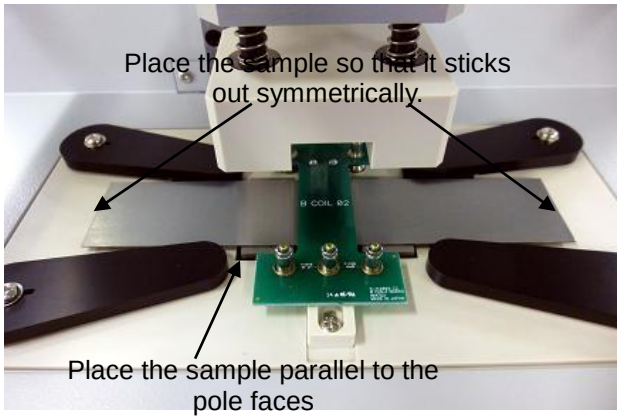


Fig. 4-13 Setting a sample

(3) Determine the setting value of the Slider Position No. Switch P.
The value is determined from the thickness of the sample [mm] and the force with which the slider presses the sample [N]. Two examples of how to determine the value are shown below.

[Example 1] Determine the value directly from the Slider Position No. Table
When the thickness of a sample is 1.0 [mm] and the force with which to press the sample is 3.9 [N], **P=6** as shown in Fig. 4-14.

[Example 2] Determine the value from the conversion formula.
When determining the value directly from the table is difficult, determine the value of the Slider Position No. P with the conversion formula given in the table.
When the thickness of a sample is T=0.7 [mm] and the force with which to press the sample is F=5.7 [N],
Substitute T and F into the conversion formula:

P=F-2×T+4
P=5.7-2×0.7+4=8.3

Round the number to the nearest integer to find **P=8**.

* **The value of P is from 1 to 16 and cannot exceed 16**. Any other number is invalid and the slider doesn't descend.
* The load value on the table is the typical value. ±3 [N] deviation from the displayed value may occur.

Force **F** [N]
TYPICAL VALUE

Position No.**P**	Single Sheet Thickness **T** [mm] 0.5	1.0	2.0	3.0
1	0	0	0	2.9
2	0	0	0	3.9
3	0	0	2.9	4.9
4	0	0	3.9	5.9
5	0	2.9	4.9	6.9
6	2.9	3.9	5.9	7.8
7	3.9	4.9	6.9	8.8
8	4.9	5.9	7.8	9.8
9	5.9	6.9	8.8	10.8
10	6.9	7.8	9.8	11.8
11	7.8	8.8	10.8	12.7
12	8.8	9.8	11.8	13.7
13	9.8	10.8	12.7	14.7
14	10.8	11.8	13.7	15.7
15	11.8	12.7	14.7	16.7
16	12.7	13.7	15.7	17.6
Formula	**P=F-2xT+4** (round off to nearest integer)			

Thickness 1.0 [mm]
Force 3.9 [N]

Fig. 4-14 Slider Position No. Table

(4) Set the Slider Position No. Switch to the value P determined in (3).

(5) Close the cover. Push the cover in until you hear a clicking sound. When the cover is properly closed, blinking of the RELEASE button and the SET button stops.

* Measurement cannot be conducted while the cover is open.

(6) Move the slider down by pressing the SET button. Setup is completed when the LED on the SET button stops blinking and stays on.

* **Visual confirmation of the contact** between the sample and press block and between the sample and the pole faces of the measuring yoke **is possible** by opening the cover when the SET button LED is on.

■4.9 Confirmation of functions

● Make sure the single sheet testing function is enabled.

(1) Press UTILITIES and display the Utilities screen.

(2) Under Options, confirm that Single Sheet is Enabled. (See Fig. 4-15)

(3) Close the Utilities screen by pressing UTILITIES or EXIT.

* Please refer to the B-H Analyzer's instruction manual for the other settings on the Utilities screen. In the single sheet testing mode, Utilities > Unit **does not allow the unit changes for Le, Ae, and Ve**.

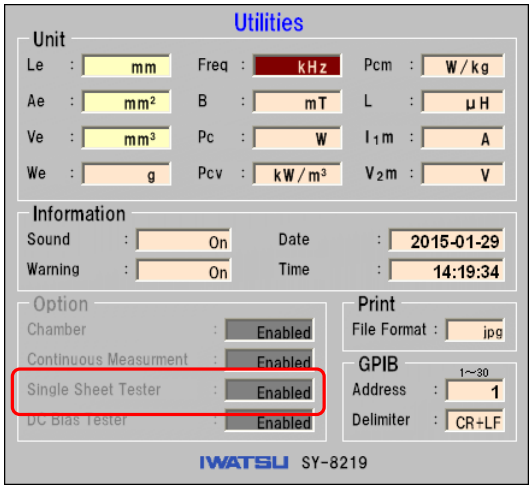


Fig. 4-15 Utilities screen

■4.10 Selecting single sheet testing mode

● Select the single sheet testing mode.

(1) Press MODE to display the Mode menu.

(2) Move the editing cursor to Sheet, press ENTER and confirm selection of the single sheet mode. (See Fig. 4-16)

(3) The single sheet testing mode screen is displayed. (See Fig. 4-18)

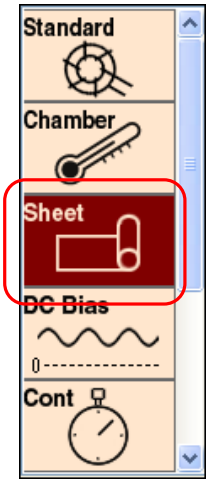


Fig. 4-16 Mode Menu

■4.11 Confirming POD

● Confirm the POD to conduct single sheet testing.

(1) Press CONFIG and display the Configuration screen.

(2) Confirm that Setting of Equipment > Pod is SY-956 (Single Sheet). (See Fig. 4-17)

(3) Press CONFIG or EXIT to close the Configuration screen.

* Refer to the B-H Analyzer's instruction manual for the other settings on the Configuration screen. In the single sheet testing mode, **the method of the primary winding cannot be selected** by Configuration > Measuring Method > Coil.

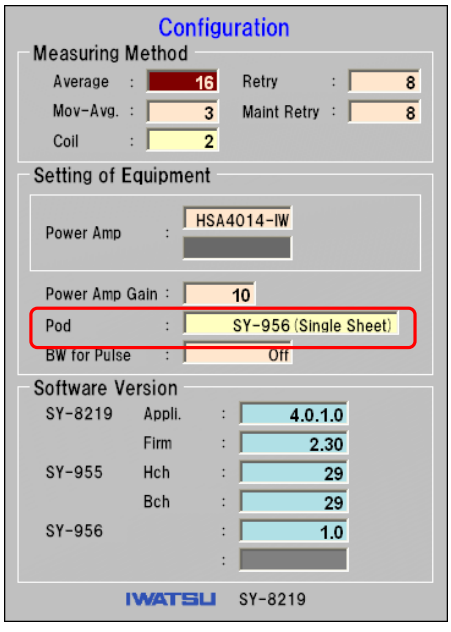


Fig. 4-17 Configuration screen

■4.12 Measurement screen

● Below is a summary of the single sheet testing mode screen.

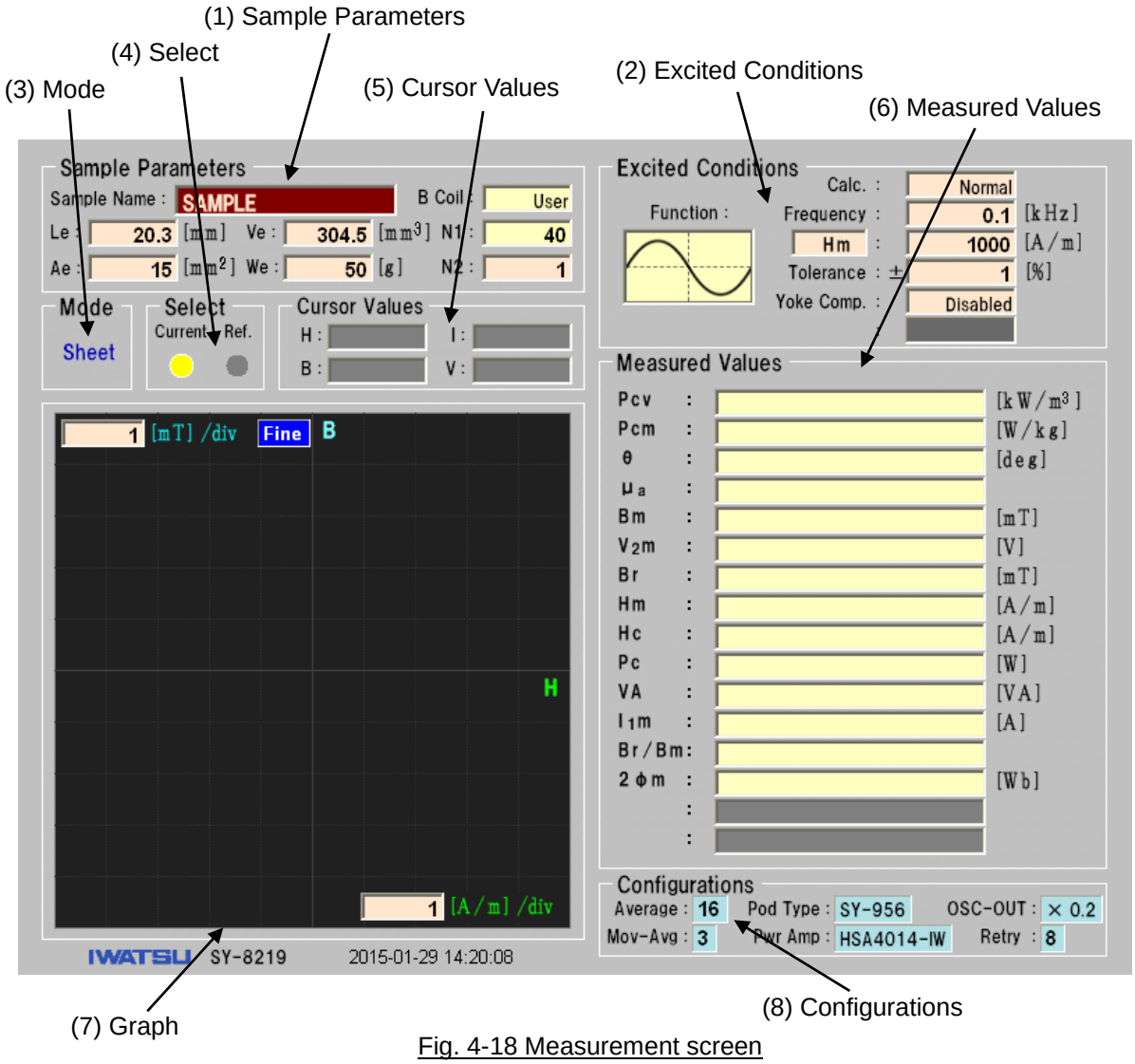


Fig. 4-18 Measurement screen

(1) Sample Parameters: Set and/or display the sample name, sample constant, and the type of the B coil.

(2) Excited Conditions: Set measuring conditions.

(3) Mode: “Sheet” is displayed to show that the single sheet mode is enabled.

(4) Select: Shows whether the currently displayed graph is Current (current measurement) or Reference (stored measurement).

(5) Cursor Values: Shows the cursor value when the cursor is displayed. Unit is same as the graph.

(6) Measured Values: Shows measured values.

(7) Graph: Displays B-H graphs or time axis graphs.

(8) Configurations: Displays the main values configured on Configuration screen.

■4.13 Input/selection of sample constant

- Input or select sample constant of a measuring sample.

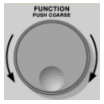
(1) While referring to Table 4-4, move the edition cursor to Edit Box of the sample constant to be entered in Sample Parameters and press 

to confirm the selection.

(2) For those with a Popup List opens, move the editing cursor to a suitable item and press 

to confirm the settings.

(3) When the Popup Edit Box opens, use the ten keys to directly enter numeric characters and press 

, or move the editing cursor to the numeric character to be changed and press 
, or turn 
to change the number. Press 

to confirm the settings.

Table 4-4 Sample Constant

Items	Selected items	Displayed value/ Input rules	Description	
Sample Name	—	Up to 20 characters	—	
Le (Effective magnetic path length)	System*2	Device-specific eigenvalue	Device-specific size inside the poles of the measuring yoke.	**Unit is fixed to [mm].**
	User	0.001 - 99999	Select this when a user wants to enter Le.	
Ae (Effective core area)	—	0.001 - 99999	**Unit is fixed to [mm^2].**	
Ve (Effective volume)	—	0.001 - 99999	**Unit is fixed to [mm^3].** Generally enter the value of Le × Ae	
We (Weight)	—	0.001 - 99999	Generally enter the weight of Le instead of the total weight of the sample.	
B Coil	—	Type01	Provided B Coil 01 is connected	**This instrument recognizes the type of B coil at the start of measurement.** "User" is displayed automatically when using a B coil that was not included in the accessories. Being a "User" allows you to enter the number of secondary turns N2.
		Type02	Provided B Coil 02 is connected	
		User	Conditions other than above	
N1 (Number of primary turns)	—	40 (constant value)	Constant number of the primary windings in this instrument.	
N2 (Number of secondary turns)	—	35 (constant value)	Provided B Coil 01 is connected. Number of turns on B Coil 01.	
		100 (constant value)	Provided B Coil 02 is connected. Number of turns on B Coil 02.	
		0.1 - 9999.9	Enter the number of turns on the B coil being used.	

*2: "System" is selected immediately after displaying the Measuring screen of the single sheet testing mode. For example, although "User" is selected in the single sheet testing mode, this setting is changed from "User" to "System" when displaying the single sheet testing screen again after it is switched to the screen of another testing mode.

■4.14 Setting measurement conditions

- Set the measurement conditions.

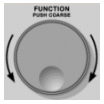
(1) While referring to Table 4-5, move the editing cursor to the Edit Box of the measurement condition to be entered in Excited Conditions and press 

to confirm the selection.

(2) For those with a Popup List that opens, move the editing cursor to a suitable item and press 

to confirm the settings.

(3) When the Popup Edit Box opens, use the ten keys to enter numeric characters directly and press 

, or move the editing cursor to the numeric character to be changed and press 
, or turn 
to change the number. Press 

to confirm the settings.

Table 4-5 Measurement Conditions

Items	Selectable items/Input rules		Descriptions	
Function	Sine		Only the sine wave is used for the single sheet testing mode.	
Calc.	Normal		Selects a calculation mode.	
	μ			
Frequency	10 Hz to 20 kHz		Set the frequency of an excitation signal.	
Fixed Parameter (Target parameter)	Bm (Max. magnetic flux density)	0.001 to 99999	Set a target parameter value for measurement.	
	Hm (Max. magnetic field)			
	I1m (Max. excitation current)			
	V2m (Max. induced voltage)			
Tolerance	0.1 to 100%		When Yoke Comp. is Disabled	Finish the testing when the measured value of the target parameter reaches within **X** [%] of this set value. Set the tolerance **X**.
			When Yoke Comp. is Enabled	Proceed from the 1st measurement to the 2nd measurement when the measured value of the target parameter reaches within **X** [%] of this set value. The 3rd measurement is completed when Bm of the 3rd measurement reaches the Bm of the 2nd measurement and falls within **X** [%] of this set value. * Therefore, the target parameter of the 1st measurement will be within the set Tolerance range, but when testing continues until the 3rd measurement, **the target parameter may not fall within the Tolerance**, due to the Yoke Comp. function.
Yoke Comp.	Disabled		Disables Yoke Comp.	
	Enabled		Enables Yoke Comp.	

■4.15 Measurement

- Take measurements. Different measurement processes and displays are applied depending on whether the Yoke Comp. is Disabled or Enabled.

[When Yoke Comp. is Disabled]

(1) Press 

to start measurement. A blinking message “Measuring!” appears on the screen.

(2) When the measurement has been completed successfully, the message “Measuring!” disappears and the measurement result is displayed.

(3) Press 

to forcibly stop measurement after starting. The measurement result may show “*” if no measurement was conducted.

[When Yoke Comp. is Enabled]

(1) Press 

to start measurement. A blinking message “Measuring!” appears on the screen.

“1st” is displayed in magenta color at the top right corner of the B-H graph screen (the top left corner on the time axis graph) to show that the first measurement is taking place. (See Fig. 4-19)

(2) When the 1st measurement has been completed successfully, the 1st measurement result is displayed. Then, “2nd” is displayed in magenta color at the top right corner of the B-H graph screen (the top left corner on the time axis graph) to show that the second measurement is taking place.

(3) When the 2nd measurement has been completed successfully, “3rd” is displayed at the top right corner of the B-H graph screen (the top left corner on the time axis graph) to show that the third measurement is taking place. (See Fig. 4-20)

(4) When the 3rd measurement has been completed successfully, the message “Measuring!” disappears and the measurement result with Yoke Comp. is displayed.

(5) Press 

to forcibly stop measurement after starting. When the 2nd or 3rd measurement is forcibly terminated, the 1st measurement result is displayed on the screen.

* When Yoke Comp. is Enabled, magnetic properties, such as core loss, of the measuring yoke can be cancelled out. However, it will take a longer testing time, as 3 measurements are required instead of 1. In addition, FINEMET® with an extremely small core loss is used for the measuring yoke of this instrument. Therefore, use this function after deliberating whether the Yoke Comp. is really needed.

* **Yoke Comp. does not necessary work at all times**. A warning message may be displayed when Yoke Comp. does not work because, for example, the 3rd measurement cannot be completed due to the core loss of the yoke being too small.
Please refer to the B-H Analyzer’s instruction manual for the details of the messages.

* “i01” or “i02” message may be displayed immediately after pressing the START button when the B coil is replaced.
Please follow the instruction of the message. Please refer to the B-H Analyzer’s instruction manual for the details of the messages.

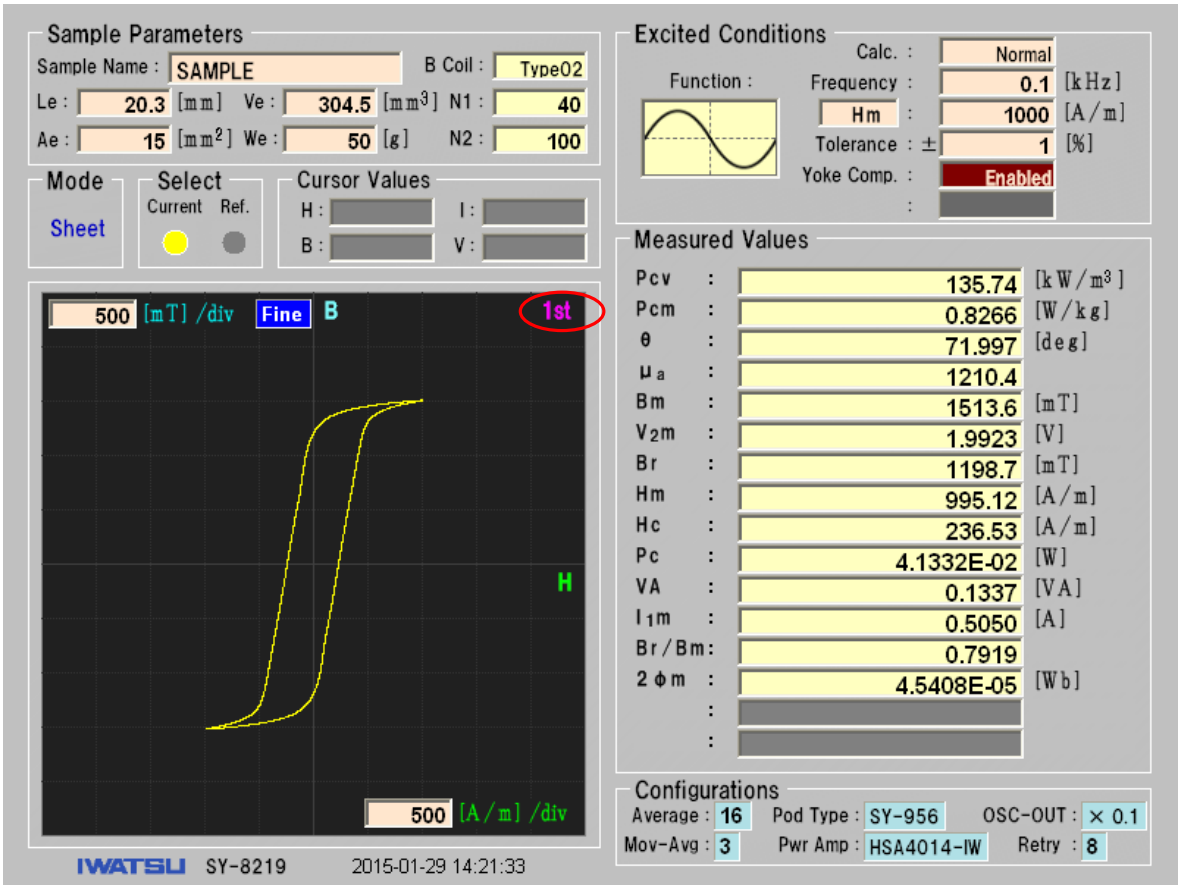


Fig. 4-19 1st Measurement Screen

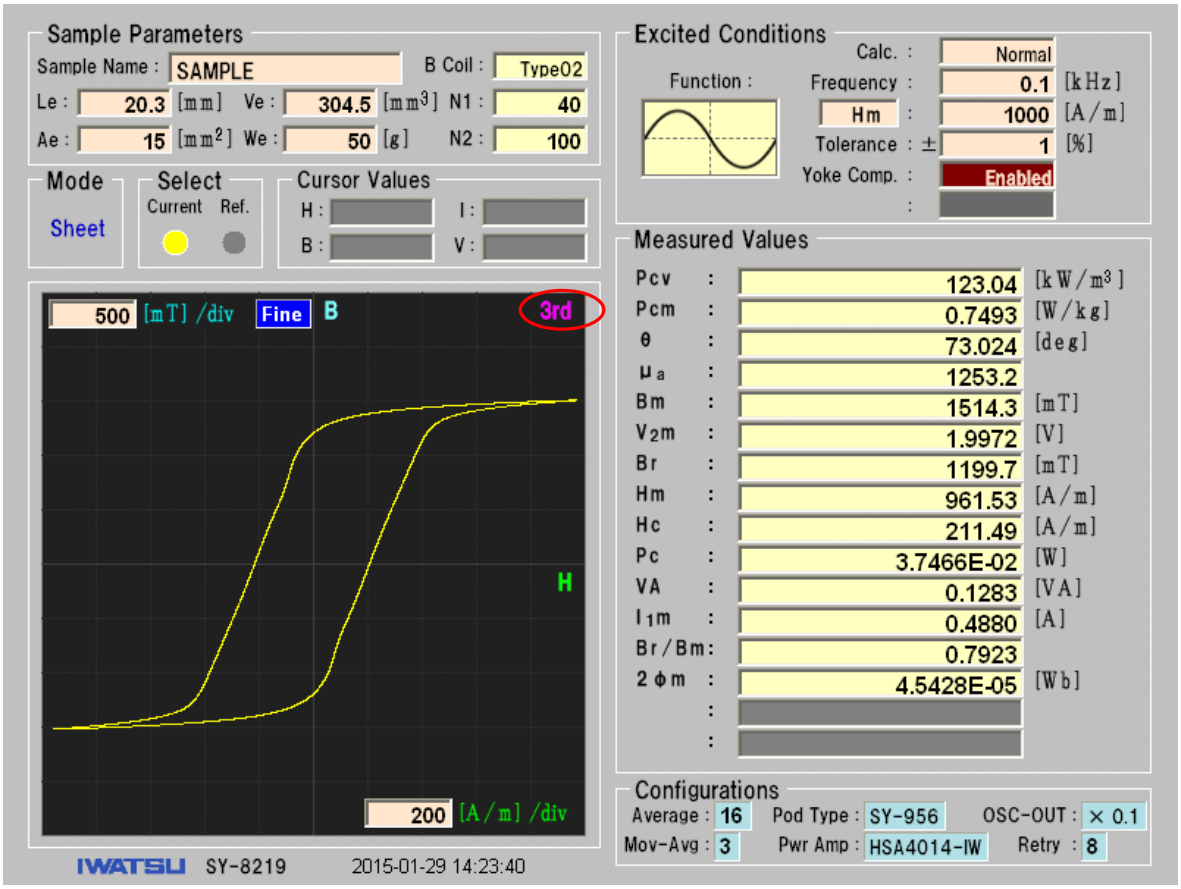


Fig. 4-20 3rd Measurement Screen

■4.16 Switching graphs

- Similar to the normally installed testing modes, the displayed graph can be switched to a B-H graph or a time axis graph. Please refer to the B-H Analyzer's instruction manual for the operation.

■4.17 Cursor measurement

- Similar to the normally installed testing modes, cursor measurement is possible. Please refer to the B-H Analyzer's instruction manual for the operation.

■4.18 Scaling up/down of graph

- Similar to the normally installed testing modes, scaling up/down of graphs is possible. Please refer to the B-H Analyzer's instruction manual for the operation.

■4.19 Reference function

- Similar to the normally installed testing modes, a measurement result can be stored, using the reference function. Please refer to the B-H Analyzer's instruction manual for the operation.

■4.20 USB memory output of screen hardcopy

- Similar to the normally installed testing modes, output of a measuring screen hardcopy to a USB memory is possible. Please refer to the B-H Analyzer's instruction manual for the operation.

■4.21 Save/Read data

- Similar to the normally installed testing modes, saving measuring data and such into a USB memory is possible. Reading the measuring data from a USB memory is also possible. Please refer to the B-H Analyzer's instruction manual for the operation.

* When saving Yoke Comp. enabled measuring data, both a measuring data file (extension .mes) and a hidden **progress file** with the same file name (extension .prg) are **saved in the USB memory**. Please note that this progress file saves the testing progress until the end of the 3rd measurement. In case a failure is suspected, **it is likely to ask for submitting**, and cooperate.

Chapter 5 Maintenance

■5.1 Daily maintenance

- In order to retain the accuracy and precision of this instrument, daily maintenance is necessary.

(1) **Wipe the pole faces of the measuring yoke with a clean, soft, and dry cloth after testing**.
This helps prevent rust on the pole faces.

* Be careful not to cut your hand with the edges of the pole faces.

* Never polish the pole faces with sandpaper or the like. This would cause an increase in core loss of the yoke, leading to incorrect measurement.

(2) Lightly wipe the measuring yoke, except its pole faces, with a soft cloth, moistened with a small amount of diluted neutral detergent.
Never use organic solvent; doing so may cause discoloration and corrosion.

■5.2 Calibration

- Measurement accuracy and precision of this instrument may fluctuate with long-term use, depending on the environment or frequency of its operation. Calibration at least once a year is recommended. For details, contact Iwatsu office or our sales distributors.

Chapter 6 Specifications

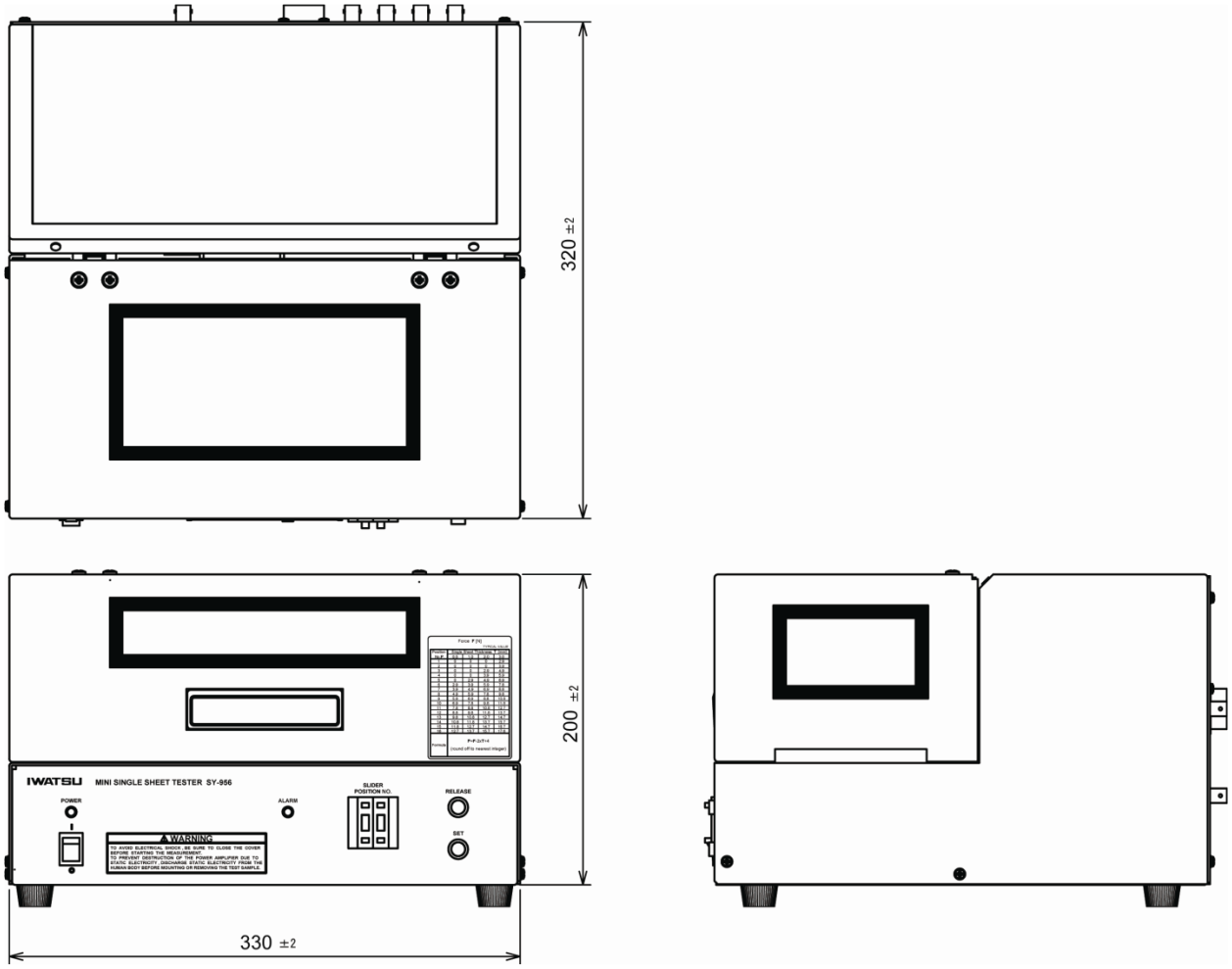
■6.1 Specifications

Table 6-1 Specifications

Items			Specifications
Power	Power supply voltage		AC 100 V to 240 V
	Frequency range		50 Hz/60 Hz
	Power consumption		27 VA (Max.)
Measurement	Measurement method		Vertical single-yoke type, magnetizing current (MC) method-based single sheet testing (similar to IEC 60404-3) (with Yoke Comp. function)
	Number of (primary) turns		40
	Maximum applied magnetic field strength		Approx. 10000*5 A/m
	Measurement frequency		Sine wave 10 Hz to 20 kHz
	Measurable sample sizes		Width 35 mm or less, Length 36 mm or more, and thickness 3 mm or less (Thickness of sample is 1 mm or less when the provided B coil is used)
Signal detection	Current detection resistor		Approx. 1 Ω
	Maximum measurement current		±6 A
	Maximum measurement voltage		±200 V
Measurement accuracy	Amplitude		±2 % (Typical: f =1 kHz, 200 mA, 200 mV range or more)
	Phase angle	Yoke Comp. Disabled*3	±0.15 deg (Typical: f = 10 kHz, 200 mA, and 200 mV range or more, at the amplitude of 80% or more of the range in use)
		Yoke Comp. Enabled*4	±0.15 deg (Typical: f = 10 kHz, 200 mA, and 200 mV range or more, at the amplitude of 80% or more of the range in use)
	Core loss	Yoke Comp. Disabled*3	±5.6% (Typical: Estimated value at phase angle = 80°, f = 10 kHz, 200 mA, 200 mV range or more)
		Yoke Comp. Enabled*4	±5.6% (Typical: Estimated value at phase angle = 80°, f = 10 kHz, 200 mA, 200 mV range or more)
Environmental conditions	Operating temperature		+5°C to +35°C
	Specifications guaranteed temperature		+18°C to +28°C
	Operating humidity		No dew allowed below the moisture amount of 85 % RH (+35°C, non-condensation)
	Warm up time		Measurement accuracy is a guaranteed value more than 30 minutes after powering on.
Outer dimension			330 (W) × 200 (H) × 320 (D) mm, not including projections.
Weight			Approx. 8.5 kg
Accessories			Mini Single Sheet Tester Cable SY-957 × 1 B Coil 01 (Number of turns: 35, hole size: $12^{\pm 0.1}$×$1.5^{\pm 0.1}$ Bobbin length: $17^{\pm 0.15}$) × 1 B Coil 02 (Number of turns 100, hole size: $32^{\pm 0.1}$×$1.5^{\pm 0.1}$ Bobbin length: $17^{\pm 0.15}$) × 1 Thumbscrews for the terminal block × 2 Tweezers × 1 Blower blush × 1 Accessory storage box × 1 Power cord × 1 Cord strap × 1 Instruction manual × 1

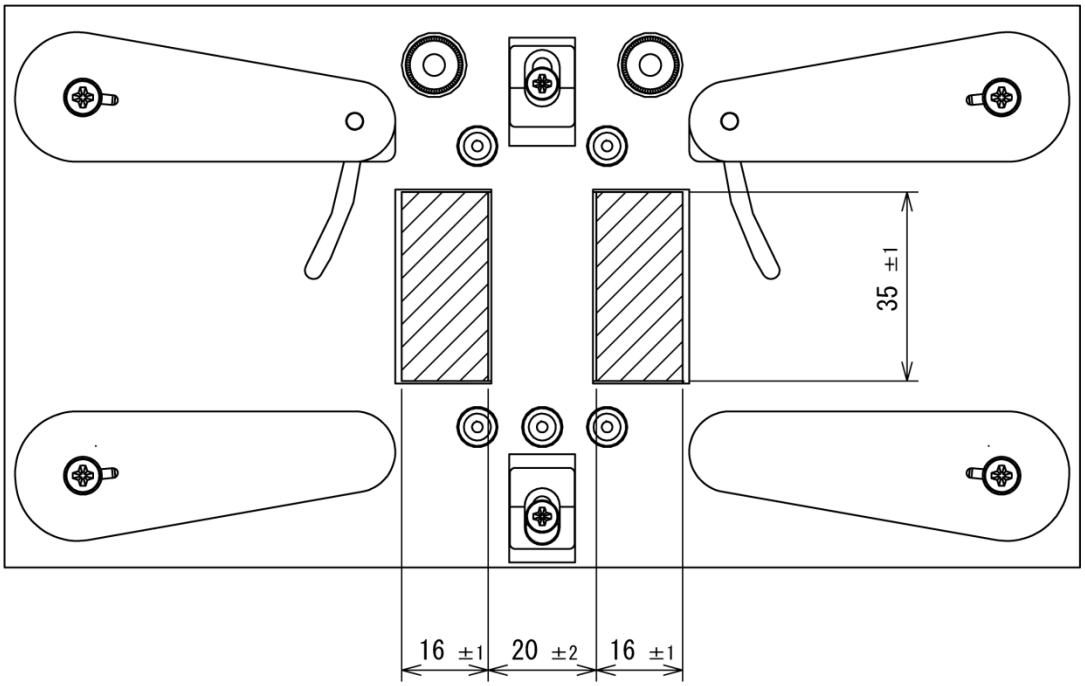
*3: Measurement accuracy of a composite magnet of a sample and a yoke.
*4: Measurement accuracy of a sample.
*5: 5 A exciting current

■6.2 Outside appearance diagram



Unit: mm

■6.3 Outside appearance of the fixture



Unit: mm

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