Original instructions

WELD CHECKER®

MM-400A EU

OPERATION MANUAL

AMADA®

AA04OM1192558-15

Thank you for your purchase of our Weld Checker **MM-400A**.
Please read this manual carefully to ensure correct use. Keep the manual handy after reading for future reference.

Contents

1. Special Precautions

(1) Safety Precautions

Before using the weld checker, please read through the Safety Precautions carefully to ensure proper use.

- The precautions listed here are designed to ensure safe use and proactively prevent risks and damage to the user and other people. All precautions are critical for safety. Please read them all.
- The hazard signs have the following meanings:

 **DANGER**	Mishandling may cause imminent risk of death or serious injury.
 **WARNING**	Mishandling may cause risk of death or serious injury.
 **CAUTION**	Mishandling may cause risk of injury and physical damage.
	These signs represent “DON’Ts.” They warn of actions not covered by the product warranty” in the previous document.
	These signs represent “DOs" which must be observed by the product user.
	A sign within a triangular border indicates that a hazard (danger, warning or caution) is present.

DANGER

NEVER ATTEMPT to disassemble, repair or modify the instrument.

Do not touch any parts inside the instrument. Failure to observe this may result in an electric shock or fire.
For battery replacement, inspection or repair, please contact your dealer or us.

NEVER burn, destroy, cut, crush or chemically decompose the instrument.

This product incorporates parts containing gallium arsenide (GaAs).

WARNING

DO NOT place your hands between the electrodes.

When welding, be extremely careful not to get your fingers or hand caught in the electrodes.

During or immediately after welding, DO NOT touch the welded areas or electrode.

The welded areas of the workpiece, the electrodes and the welding machine's arm are extremely hot. To prevent burns, do not touch these areas.

Ground the instrument.

If the Power Supply is not grounded, you may receive an electric shock in the event of malfunction or current leak. Be sure to perform grounding work.

ALWAYS use the specified power supply.

Failure to use the power supply specified in the Instruction Manual may result in a fire or electric shock.

Use the specified cables and connect them securely.

Failure to do so or improper connection may result in a fire or electric shock.

Keep the power and connection cables free of damage.

Do not walk on, twist or tug the cables.
Damaged cable may result in an electric shock, short circuit, or fire.
For repair or replacement, contact your dealer or us.

In the event of an anomaly, STOP the operation.

Continuing the operation with anomalies such as a generation of fumes, a burning odor, strange noise, or overheating unattended may result in an electric shock or fire. In the event of the above or other anomaly, immediately contact your dealer or us.

STAY AWAY from the instrument if you have a pace maker.

If you have a pacemaker, do not approach a welding machine in operation or the immediate area unless your doctor has given consent.
Welding machines generate a magnetic field which interferes with the operation of a pacemaker.

ALWAYS wear appropriate work clothing.

Wear protective gear such as gloves, a long-sleeved top and leather apron.
Surface flash and expulsion can cause burns if it contacts the skin.

CAUTION

ALWAYS wear protective goggles.

Directly looking at surface flash and expulsion during welding can temporary impair vision. Welding spatter can cause permanent eye damage, including blindness.

DO NOT splash water.

Electrical parts may cause an electric shock or short circuit if they become wet.

Keep the area clear of flammable objects.

Surface flash and expulsion generated during welding may ignite flammable objects, resulting in a fire. If work involves use of flammable items, place a non-flammable cover over such items.

DO NOT cover the instrument with a blanket or cloth.

During operation, do not cover the instrument with a blanket or cloth. This may lead to the instrument overheating and catching fire.

Wipe off dust from the power plug and securely insert it all the way.

Dust or improper insertion may lead to the plug heat up and catch fire.

Install the instrument on a firm and level surface.

Injury may result if the equipment falls or is dropped.

Do not sit on or place objects on the instrument.

Failure to observe this precaution may lead to malfunction.

Hold the power plug when removing or inserting it.

Removing the power plug by pulling on the cable may damage the power cable, resulting in an electric shock or causing the cable to catch fire.

If you do not use the instrument for extended periods, remove the power plug from the outlet.

Failure to do so may deteriorate the insulation, resulting in an electric shock, current leakage or fire.

Provide fire extinguishers.

Provide fire extinguishers at the welding site as a precautionary measure.

Perform maintenance and inspection on a regular basis.

Perform maintenance and inspection regularly and repair damaged areas and parts before using the instrument.

Wear soundproof earmuffs.

Loud noise may impair hearing.

(2) Precautions for Handling

- Avoid the following locations when installing the instrument:
  - Humid (above 90%) locations
  - Extremely hot (above 45°C) or cold (below 0°C) locations
  - Near a high noise source
  - Location where chemical substances, etc. are handled
  - Location where condensation occurs
  - Dusty location
  - Location exposed to direct sunlight
  - Location that is inclined, insecure, unstable, or weak

- Check the voltage and power frequency before installation.

- Keep the exterior clean with a soft cloth or cloth lightly dampened with water. For stains, clean them off using a diluted neutral detergent or alcohol. Do not use thinner or benzene as they may cause discoloration or deformation.

- To prevent malfunction, do not allow any foreign objects such as screws or coins to enter the instrument.

- Operate the instrument according to the procedure described in the Operation Manual.

- Operate the switches and buttons with care. Rough operation or the use of a tool or pen tip may result in damage or malfunction.

(3) Model-Specific Function

The functionality given for “force/displacement-equipped specification” in the operation manual is available only with the corresponding model. Other functions available are the same as those of the standard model.

Product model	MM-400A-00-00	MM-400A-00-01
Standard (no force/displacement)	○	
Force/displacement-equipped		○

(4) Use of Printer

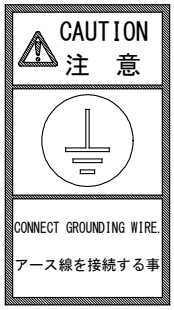
A tape is adhered to the printer on the **MM-400A** so that the lid does not open during transportation. Peel the tape before using.

(5) On Disposal

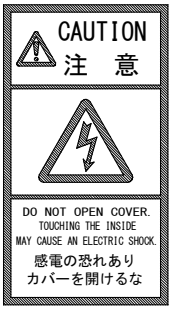
This product incorporates parts containing gallium arsenide (GaAs). At the time of disposal, separate it from general industrial waste or domestic waste and carry out the disposal in accordance with applicable laws and regulations.

(6) Warning Labels

A warning label is pasted on the instrument for safe use. The pasting place and meaning of each label are as shown below.



Pasting place: Top cover
Meaning: Caution for grounding wire connection



Pasting place: Top cover
Meaning: Danger of electric shock

2. Features

The Weld Checker **MM-400A** is a measuring instrument designed for stationary resistance welding machines.
The instrument can measure the current, voltage, current flow time, force[*1], displacement[*1], external voltage input (max. ±10 V)[*1] and external current input (4 to 20 mA)[*1] and display their waveforms.
(*1: Force/displacement-equipped specification function. You can select to measure external voltage input or external input current by setting.)

The LCD screen ensures clear viewing of the welding current and force waveforms for optimal welding quality control. Further, it is equipped with a printer, allowing to print measured values and waveforms without having to attach an external printer.

The **MM-400A** offers the following features:

- **Easy to use with a touch panel**

  Easy setting through the menu selection system on the 5.7-inch color touch panel.

- **ISO17657-compliant measurement**

  In addition to the arithmetic mean RMS which is a conventional calculation system, the RMS in a whole current flow time which is the ISO17657-compliant calculation system can be selected. For the ISO17657-compliant measurement, the dedicated ISO-compliant toroidal coil is required.

- **Extensive waveform display capabilities**

  Incorporates a zoom display function, which permits the user to change the spacings of the X-axis (time) and Y-axis (force/current) freely, and a cursor measurement function, a function for measuring values between parts of the waveforms by moving the horizontal cursor.

- **Optimal waveform redisplay (FIT) capability**

  If the waveform is moved or zoomed off the screen, the instrument can resize the waveform to its optimal size and redisplay it on screen.

- **Simultaneous measurement of force and welding current during current flow (Force/displacement-equipped specification function)**

  You can measure the force and other measurement items during current flow simultaneously using the welding head which incorporates a force sensor in the pressure follow-up mechanism. You can also measure the force and welding current during current flow simultaneously using the optional current/force sensor (**MA-770A/771A**), as conventionally.

- **Storing measured values and waveforms**

  You can store measured values and waveforms in USB or built-in flash memory.

- **Managing measurement data with PC**

  You can transmit measurement data to your PC through the RS-232C, RS-485 or Ethernet communication.

- **Supports a wide range of welding machines**

  The instrument supports single-phase AC, DC inverter, AC inverter, and transistor welding machines.

- **Supports multiple languages**

  Languages available are Japanese, English, Chinese, Korean, German, French, and Spanish.

- **Envelope function**

  The envelope function (making the OK/NG judgment by comparing a waveform within an allowable range and a monitored waveform) enables management with waveforms in addition to conventional measured values.

- **Measurement with seam current**

  Measures current/voltage in AC welding or voltage in DC welding with a max. 5-minute moving measurement.

3. Packaging

Check the contents of the package. In the case of damaged or missing items, please contact us.

(1) Accessories

The model numbers of accessories are subject to change without notice. Depending on the part to be changed, the mounting screw shape may change and a necessary tool may be different. For the latest parts information, contact a nearest sales office.

Item		Model	Q'ty
Voltage detection cable		SK-1193301 (cable length of 3 m)	1
Thermal paper		NPIT5838	1
Connector (D-Sub, 25-pin, male)	Case	HDB-CTH(10)	1
	Plug	HDBB-25P(05)	1
Connector (D-Sub, 37-pin, male)	Case	HDC-CTH(10)	1
	Plug	HDCB-37P(05)	1
Operation manual		AS1192560(OM1192557,OM1192558)	1

(2) Options

a. For **MM-400A-00-00/00-01**

Item		Model
Power cable[*1]		KP-35 KS-16A SVT#18×3 B-TYPE (3-pin plug, for 100–120 V AC) (cable length 3 m)
		KP244 VCTF3*1.25 KS16D 3m Gray (Japan, for 200 V AC) (cable length of 3 m)
		CEE3P-W-1.8 (round plug, for 200–240 V AC) (cable length of 1.8 m)
	3-pin/2-pin conversion adapter for power cable	KPR-24(SB)-B (for 100–120 V AC)
ISO toroidal coil		MB-800M-00 (approx. 250 mm in dia.) 1x sensitivity coil (with 800 mm bracket) (cable length 3 m)
		MB-400M-00 (approx. 120 mm in dia.) 1x sensitivity coil (with 400 mm bracket) (cable length of 3 m)
	ISO toroidal coil extension cable[*2]	SK-1194039 (cable length of 2 m)
		SK-1194040 (cable length of 5 m)
		SK-1194041 (cable length of 10 m)
		SK-1194042 (cable length of 20 m)

Item	Model
Toroidal coil[*3]	MB-800K-00 (approx. 250 mm in dia.) 1x sensitivity coil (with 800 mm bracket) (cable length of 3 m)
	MB-400K-00 (approx. 120 mm in dia.) 1x sensitivity coil (with 400 mm bracket) (cable length of 3 m)
	MB-45F-00 (45 mm in inner dia.) 10x sensitivity coil (mold type) (cable length of 3 m)
Toroidal coil conversion cable[*3]	SK-1193305 (cable length of 0.5 m)
Voltage detection conversion cable[*4]	SK-1193599 (cable length of 0.1 m)
RS-232C communication cable	C06N-09MS-09FS-CROSS-WS15 (cable length of 1.5 m, 9-pin, male/female)
RS-485 connector	L-04742-001 (Connector (D-Sub 9-pin, male))
LAN cable	KB-FL6A-03BL (cable length of 3 m)
Communication software	MA-725A-00-00

*1: Exclusively for the **MM-400A**. Do not use for other devices.

*2: For extending the **MB-400M/800M**.

*3: Toroidal coil conversion cable SK-1193305 is required for connecting to the **MM-400A**.

*4: The conversion cable is required for connecting an old type voltage detection cable (42265).

b. Exclusively for **MM-400A-00-00**

Item	Model
I/O conversion cable (used for conversion of external I/O signals when replacing the MM-370 series with MM-400A)	SK-1201954 (cable length of 0.15 m)

c. Exclusively for **MM-400A-00-01**

Item	Model
Shunt resistor	DS 500A/100MV (range between 25 A and 500 A)
	DS 1000A/100MV (range between 50 A and 1000 A)
Current/force sensor (put between electrodes for measurement)	MA-770A-01 (4903 N (500 kgf) max.)
	MA-771A-01 (9806 N (1,000 kgf) max.)
Replacement plate[*1]	Z-04715-002 (with groove)
	Z-04715-003 (flat)
Force sensor (put between electrodes for measurement)	MA-520B-00 (98.06 N (10 kgf) max.)
	MA-521B-00 (980.6 N (100 kgf) max.)
	MA-522B-00 (9806 N (1,000 kgf) max.)

Item	Model
Force sensor connecting cable[*2]	SK1200686
Load cell (force sensor) [*3] (can be built in a head)	LS-20NB (Rating: 20 N) [*9]
	LS-50NB (Rating: 50 N) [*9]
	LS-200NB (Rating: 200 N) [*9]
	LS-500NB (Rating: 500 N) [*9]
	LS-2000NB (Rating: 2000 N) [*9]
	LS-5000NB (Rating: 5000 N) [*9]
Load cell conversion cable[*3]	SK-1200820 (cable length of 2 m)
	SK-1200821 (cable length of 3 m)
	SK-1200822 (cable length of 4 m)
Load cell (force sensor) [*4] (Kyowa Electronic Instruments) (can be built in a head)	LMA-A-100N-P (Rating: 100 N) [*9]
	LMA-A-200N-P (Rating: 200 N) [*9]
	LMA-A-500N-P (Rating: 500 N) [*9]
	LMA-A-1KN-P (Rating: 1000 N) [*9]
Load cell conversion cable[*3]	SK-1201977 (cable length of 0.15 m)
Multiconnector (for external ±10 V voltage/ 4 to 20 mA current)	SRCN6A21-16P
Displacement sensor (Mitutoyo)	LGK-110 (10 mm) (cable length of 2 m) [*9] [*13]
Displacement sensor extension cable[*5]	902434 (cable length of 5 m)
Displacement sensor [*10] (Mitutoyo)	LG200-110 (10 mm) (cable length of 2.5 m) [*9]
	LG100-125 (25 mm) (cable length of 2 m)
	LG100-150 (30 mm) (cable length of 2 m) [*11]
Displacement sensor conversion cable[*10]	SK-1211379 (cable length of 0.15 m)
Displacement sensor extension cable[*12]	No.21HZA197 (cable length of 5 m)
Displacement sensor (KEYENCE) Contact type sensor head[*6]	GT2-P12 (12 mm)
Sensor head cable[*6]	GT2-CH2M (cable length of 2 m) [*9]
Mounting amplifier unit[*6]	GT2-71D
Displacement sensor relay connector[*6]	SRCN6A16-10P
Displacement sensor[*7] (HEIDENHAIN)	77066186 [*9] ST1278 (12 mm) (cable length of 1.6 m)
Displacement sensor conversion cable[*7]	SK-1179208 (cable length of 0.15 m)

Item	Model
Displacement sensor[*8] (Ono Sokki)	GS-1830A (30 mm) (cable length of 1.9 m)
	GS-1813A (13 mm) (cable length of 1.9 m)
Displacement sensor relay cable[*8]	SK-1194374 (cable length of 0.15 m)
I/O conversion cable (used for conversion of external I/O signals when replacing the MM-370 series with MM-400A)	SK-1201953 (cable length of 0.15 m)

*1: Used with the current/force sensor.

*2: Connecting cable when using MA-520-01, MA-521-01 and MA-522-01. Not required when using MA-520B-00, MA-521B-00 and MA-522B-00.

*3: Load cell conversion cable SK-1200820, SK-1200821 or SK-1200822 is required.

*4: Load cell conversion cable SK-1201977 is required.

*5: Extension cable for LGK-110. Use as needed.

*6: A combination of the sensor head, sensor head cable, mounting amplifier unit, and relay connector is required.

*7: Displacement sensor conversion cable SK-1179208 is required.

*8: Displacement sensor relay cable SK-1194374 is required.

*9: Load cell and displacement sensor corresponding to our follow-up mechanism element. (Some are special order items.)

*10: Displacement sensor conversion cable SK-1211379 is required.

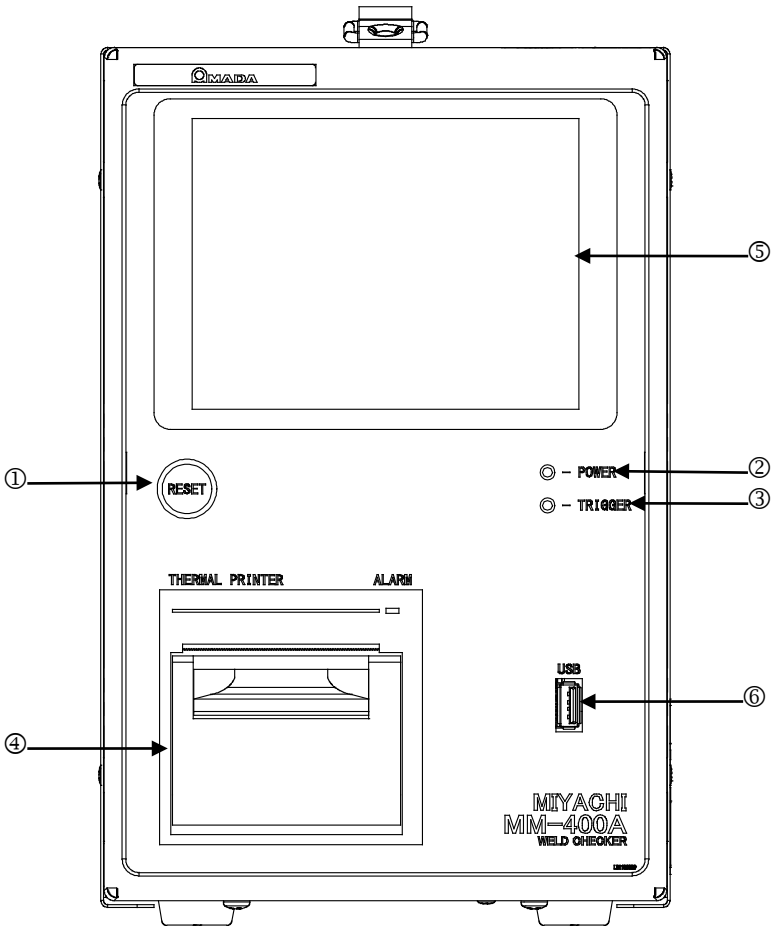
*11: The measurement range of LG-100-150 is 50 mm, but it will be 30 mm when connected to the **MM-400A**.

*12: Extension cable for LG200-110, LG100-125 and LG100-150. Use as needed.

*13: LGK-110 has been discontinued. LG200-110 is an alternative.

4. Name and Functions of Each Section

(1) Front



① [RESET] button:
Resets an error that has occurred.

② [POWER] lamp:
Lit when the power is ON.

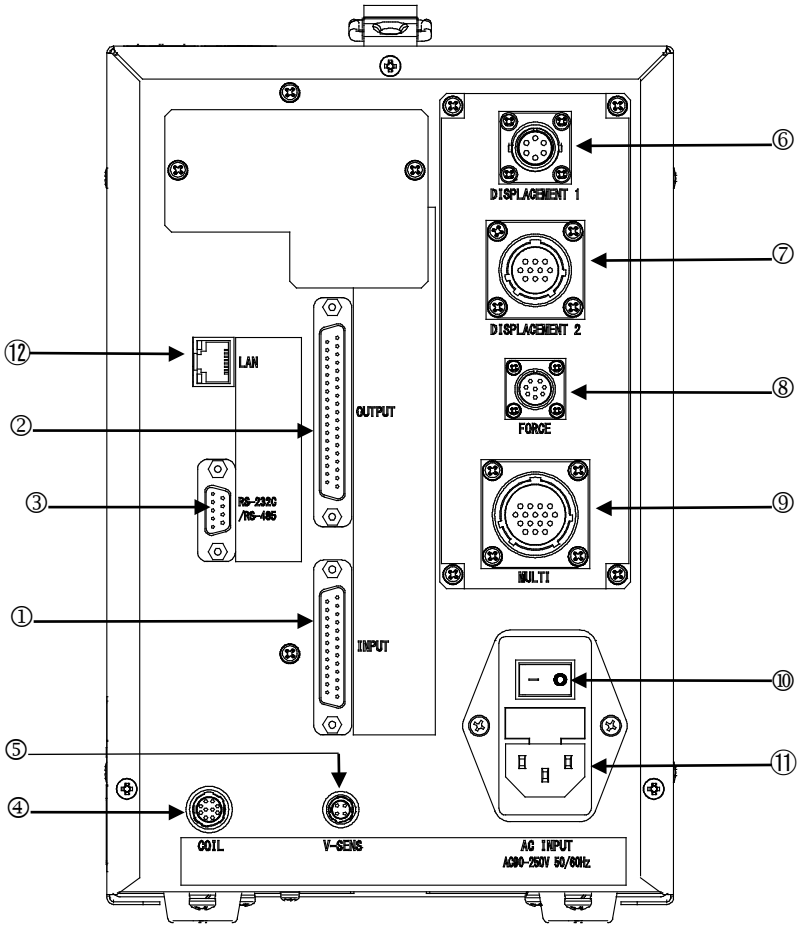
③ [TRIGGER] lamp:
Lit during the measurement operation.

④ Printer:
Prints measured values, waveforms and other information.
(Note) Be sure to turn OFF the power when replacing paper in the printer.

⑤ Touch panel:
Shows measured values, waveforms and operation screens. Refer to Chapter 8, “Operation Screens” for details of the operation screens.

⑥ USB memory connector:
Plug the USB memory into this connector.

(2) Rear



① External I/O connector (1):
A connector to input signals from peripheral devices.

② External I/O connector (2):
A connector to output signals to peripheral devices.

③ RS-232C/RS-485 connector:
Plug the instrument and host computer with an optional RS-232C communication cable. Used to transfer measured values and waveform data to the host computer.

④ Toroidal coil connector:
Plug a toroidal coil into this connector.

⑤ Voltage detection cable connector:
Plug the voltage detection cable into this connector.

⑥ Displacement sensor connector 1[*1]:
Plug a discontinued displacement (**LGK-110/LGF-125L-B/LGF-550L-B**) into this connector.

⑦ Displacement sensor connector 2[*1]:
Plug an optional displacement sensor[*2] into this connector.

⑧ Force sensor connector[*1]:
Plug an optional force sensor (**MA-520B/521B/522B**) into this connector.

⑨ Multiconnector[*1]:
Plug an optional current/force sensor (**MA-770A/771A**) into this connector.
Also used to plug an external voltage/current input and shunt resistor.

⑩ Main power switch:
Switch for the main power. Set this to the ON position (– side) to start the **MM-400A**.

⑪ Power cable connector:
Plug the power cable into this connector.

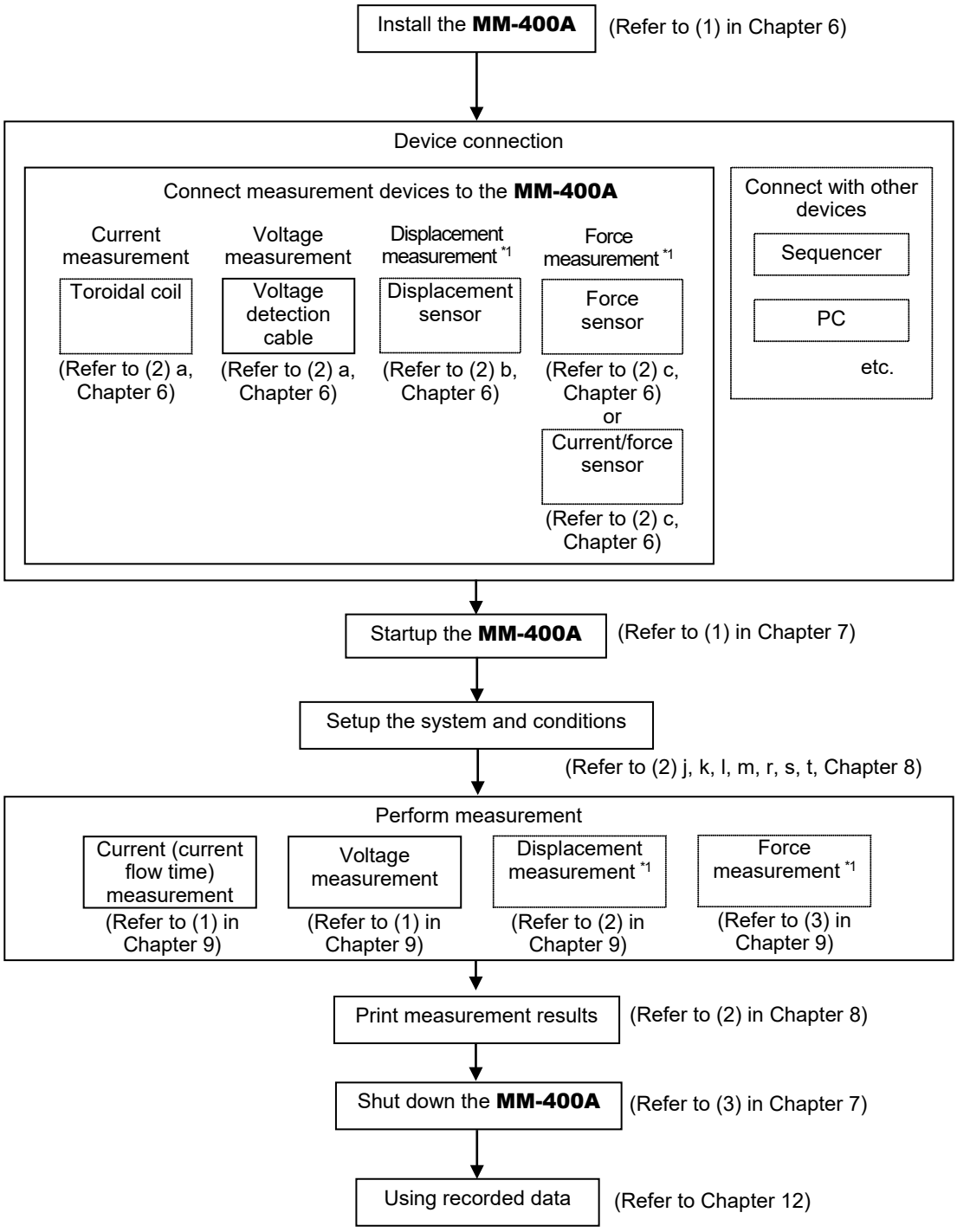
⑫ LAN cable connector:
Plug the LAN cable for Ethernet into this connector. The orange LED is lit when it can be connected and is blinked when the data is being sent or received. The green LED is not lit when operated at 10 MB/s and is lit when operated at 100 MB/s.

*1: ⑥ to ⑨ are force/displacement-equipped specification function connectors.

*2: In addition to the displacement sensor, the dedicated connector and cable are required. Refer to “(2) b in Chapter 3” for details.

5. Operation Flow

The operation flow is shown below.



[ ] .....: Option

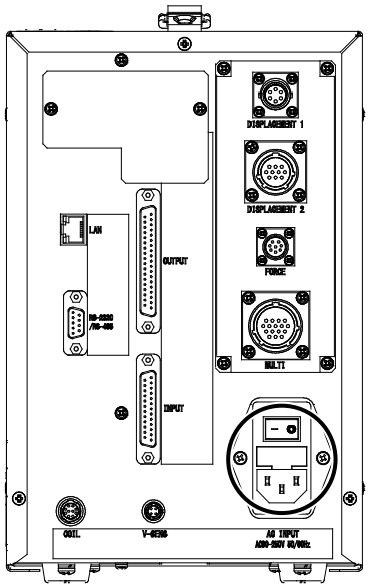
*1: Force/displacement-equipped specification function

6. Installation and Connections

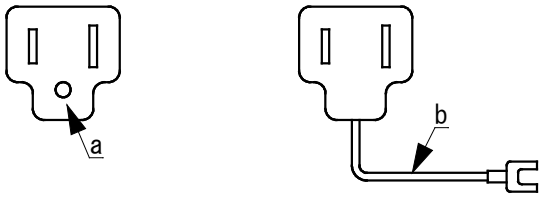
(1) Installing the MM-400A

1) Place the **MM-400A** on a stable surface.
Avoid locations where vibration is generated or the **MM-400A** rotates or moves.

2) Connect the power cable to the power cable connector [INPUT POWER] on the rear panel.
Ground the grounding terminal of the power cable. If not, measurement of the **MM-400A** may be affected. Perform class D grounding work (Ministry of Economy, Trade and Industry "Technical Standards for Electric Equipment").



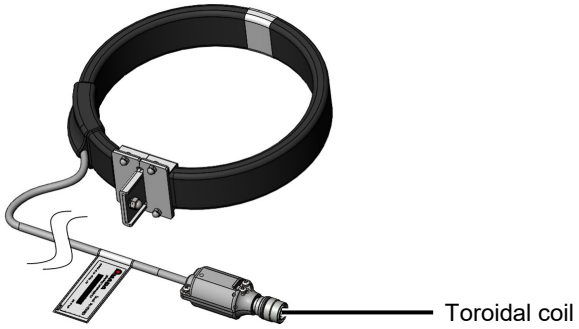
When using the power cable (3 pin), connect it to the outlet which is the grounding terminal is grounded (Fig. a). When using the 3-pin/2-pin conversion adapter, ground the green/yellow-green grounding wire (Fig. b).



(2) Preparations for Measurement – Connection between the MM-400A and Measurement Devices

a. Connecting the Toroidal Coil and the Voltage Detection Cable

To measure the current or voltage, connect the toroidal coil and the voltage detection cable to the rear panel of the **MM-400A**.



Toroidal coil (e.g., **MB-400M**)

Connect a toroidal coil suited to your operating environment.

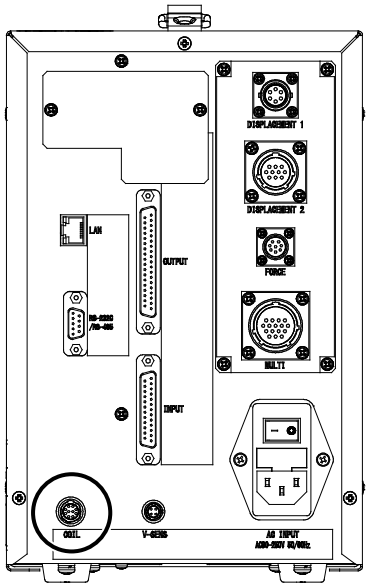
The toroidal coils of the following sizes can be used:

Toroidal coil model	Type
MB-800M	1x sensitivity coil (with 800 mm bracket), ISO-compliant type
MB-400M	1x sensitivity coil (with 400 mm bracket), ISO-compliant type
MB-800K (Note)	1x sensitivity coil (with 800 mm bracket)
MB-400K (Note)	1x sensitivity coil (with 400 mm bracket)
MB-45F (Note)	10x sensitivity coil (mold type)

(Note) Optional toroidal coil conversion cable SK-1193305 is required.

Follow the steps described below to connect the toroidal coil and the voltage detection cable.

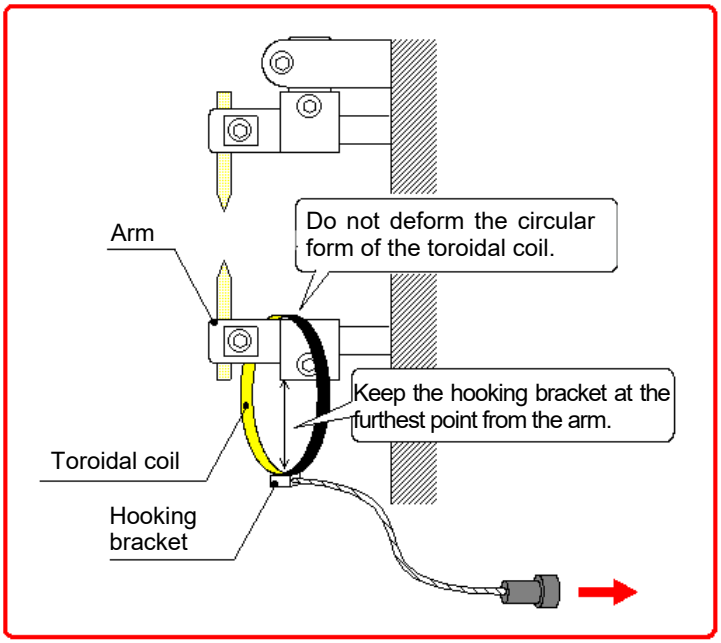
1) Plug the toroidal coil's connector into the toroidal coil connector [COIL] on the rear panel of the **MM-400A**.



2) Fit the toroidal coil onto the welding machine's arm or secondary conductor.

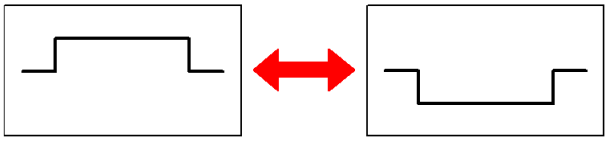
When fitting the coil, be careful with the following:

- Keep the toroidal coil's hooking bracket as far away from the welding machine's arm (secondary conductor) as possible.
- Do not deform the circular form of the toroidal coil when fitting it.



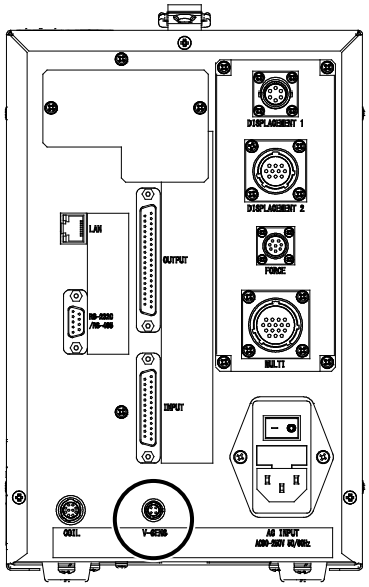
CAUTION

- If the toroidal coil is fitted in reverse orientation, the waveforms in the WAVEFORM screen and the analog output waveforms measured with the oscilloscope are also shown in reverse. The analog output (current and voltage) is output in reverse side of the waveforms in the WAVEFORM screen.



- For a band-type toroidal coil, do not deform it when fitting it. Repeated bending and extension may break internal wires.
- The ISO toroidal coil (**MB-400M/800M**) has an arrow. For DC measurement, match the direction of an arrow and a current.

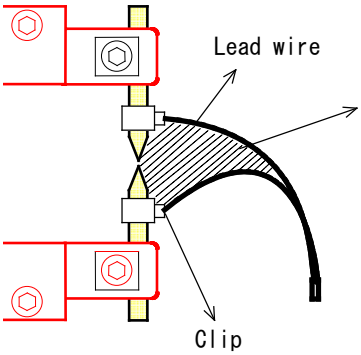
3) Plug the voltage detection cable connector into the voltage detection cable connector [V-SENS] on the rear panel of the **MM-400A**.



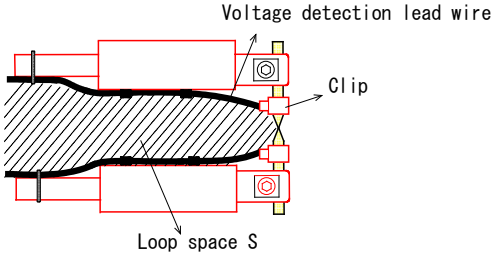
4) Connect the voltage measurement cables to the electrodes (positive/negative).

(Note) To properly perform a voltage detection

The voltage detection cable picks up voltage induced by the welding current. To measure the voltage between the tips, connect the cable as shown below.



Make the distance between clips as small as possible, and twist the lead wires together so that induction voltage is reduced and the voltage between tips can be measured accurately.



When the voltage detection cable wires are placed as shown to the left, voltage induced by the welding current is added to the voltage between tips. When monitoring voltage, fasten the lead wires so that the loop space S does not change and induction voltage does not fluctuate.

b. Connecting the Displacement Sensor (Force/displacement-equipped specification)

As a force/displacement-equipped specification function, the **MM-400A** can measure displacement.

To measure displacement, connect a displacement sensor.

We recommend the following displacement sensors:

Item	Model	Connector
Displacement sensor (Mitutoyo)	LGK-110 (10 mm) *6	DISPLACEMENT1
Displacement sensor*7 (Mitutoyo)	LG200-110 (10 mm)	DISPLACEMENT2
	LG100-125 (25 mm)	
	LG100-150 (30 mm) *8	
Displacement sensor conversion cable*7	SK-1211379	
Displacement sensor (KEYENCE) Contact type sensor head*1	GT2-P12 (12 mm)	DISPLACEMENT2
Sensor head cable*1	GT2-CH2M	
Mounting amplifier unit*1*2*3	GT2-71D	
Displacement sensor relay connector*1*3	SRCN6A16-10P	
Displacement sensor*4 (HEIDENHAIN)	77066186*4 ST1278 (12 mm)	DISPLACEMENT1
Displacement sensor conversion cable*4	SK-1179208	
Displacement sensor*5 (Ono Sokki)	GS-1830A (30 mm)	DISPLACEMENT2
	GS-1813A (13 mm)	
Displacement sensor relay cable*5	SK-1194374	

*1: A combination of the sensor head, sensor head cable, mounting amplifier unit, and relay connector is required.

*2: Use the dip switch of amplifier unit GT2-71D with “1: ON”, “2: OFF”, “3: OFF”, and “4: ON.” (Switches 1 and 2 set the minimum phase difference to 2.5 us, and 3 and 4 set the pulse resolution to 1 um.)

*3: Connect the amplifier unit GT2-71D to the displacement sensor relay connector SRCN6A16-10P. Connect the brown line to Pin 1, the blue line to Pin 3, the black line to Pin 6, the purple line to Pin 7, the white line to Pin 8, the gray line to Pin 9, and the pink line to Pin 10.

*4: Displacement sensor conversion cable SK-1179208 is required.

*5: Displacement sensor relay cable SK-1194374 is required.

*6: LGK-110 has been discontinued. LG200-110 is an alternative.

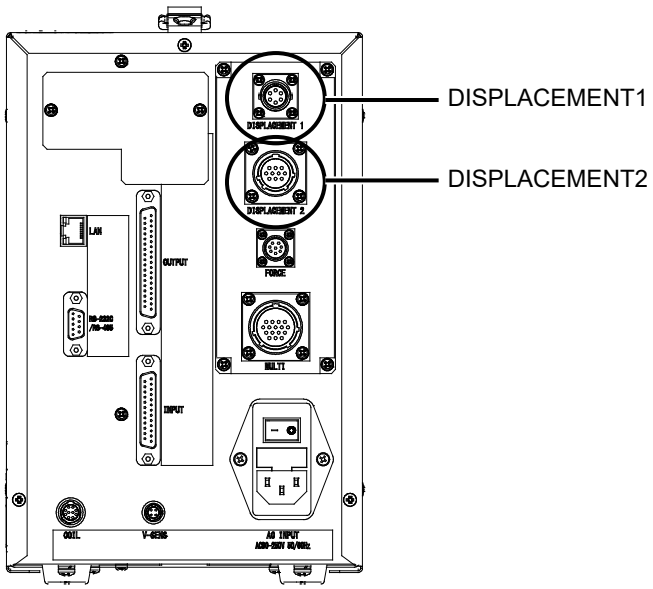
*7: Displacement sensor conversion cable SK-1211379 is required.

*8: The measurement range of LG-100-150 is 50 mm, but it will be 30 mm when connected to the **MM-400A**.

Follow the steps described below to connect the displacement sensor.

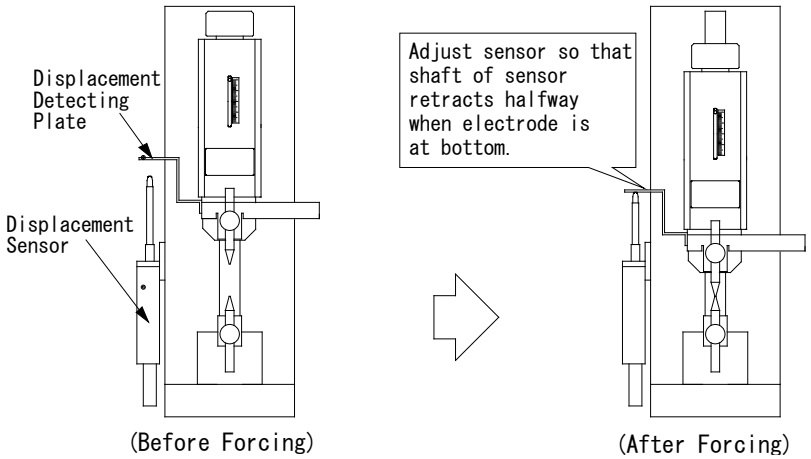
1) Plug the displacement sensor connector into the displacement sensor connector [DISPLACEMENT1] or [DISPLACEMENT2] on the rear panel of the **MM-400A**.

   (Caution) Connect the displacement sensor either to [DISPLACEMENT1] or [DISPLACEMENT2]. Do not connect to both at the same time.



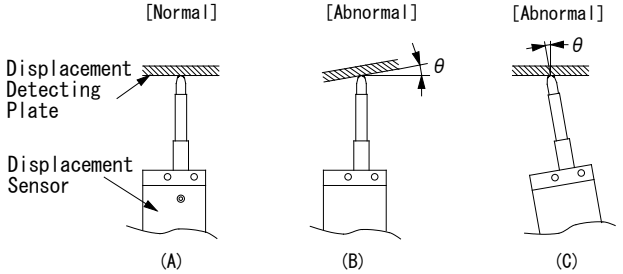
2) Install firmly the displacement sensor not so as to rattle in reference to the figure below.

   When any of ABSOLUTE1 to ABSOLUTE4 is selected for MEASUREMENT MODE in the EXTEND SETUP (3) screen, make the shaft of the displacement sensor retract so as not to separate from the displacement detecting plate.



ATTENTION

As the figure (A) below, be sure to keep the displacement sensor perpendicular to the Displacement Detecting Plate. If Displacement Sensor is slantingly installed like (B) or (C), the life of the sensor becomes shorter.

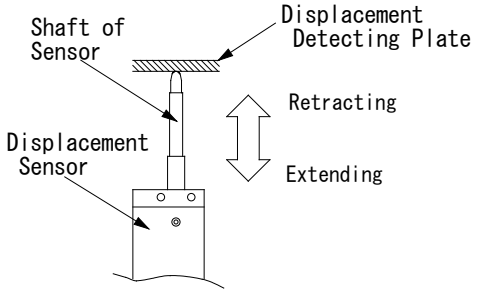


If the sensor is pressed beyond the range of measurement, it results in malfunction. Make sure the displacement sensor and the sensor head are insulated before installed.

The measured value of displacement is minus (-) or plus (+).

When FORWARD is selected for POLARITY in the EXTEND SETUP (3) screen, the counted value is plus (+) in the direction of retraction of the movable part of Displacement Sensor and the value is minus (-) in the extension.

On the other hand, when REVERSE is selected, the counted value is minus (-) in the direction of retraction of the movable part of Displacement Sensor and the value is plus (+) in the extension.



3) When using the absolute value in the displacement measurement (selecting any of ABSOLUTE1 to ABSOLUTE4 for MEASUREMENT MODE in the EXTEND SETUP (3) screen), perform the following:

- Reset displacement (0 mm position setting) at the reference position for the absolute measurement.
  For example, in the method of performing a reset by applying force without setting workpieces, the thickness of the workpiece before and after welding can be measured.
  For resetting displacement, refer to Chapter 8, “n-2. SYSTEM SETUP (2) Screen.”
- When using a KEYENCE’s displacement sensor, displacement at the current position is read until the MEASUREMENT screen is displayed after the power supply of the **MM-400A** is turned on. Do not make the displacement sensor move.
- When using a Mitutoyo’s, HEIDENHAIN’s, or Ono Sokki’s displacement sensor, reset displacement after turning on the power supply of the **MM-400A**.

c. Connecting the Force Sensor (Force/displacement-equipped specification)

The **MM-400A** can measure, as a force/displacement-equipped specification function, force when connected with force sensor **MA-520B/521B/522B**, pressure follow-up mechanism element P unit, or current/force sensor **MA-770A/771A**.

Current/force sensor **MA-770A/771A** incorporates a current sensor (toroidal coil), making it possible to measure force and current at the same time simply by applying a force and passing a current.

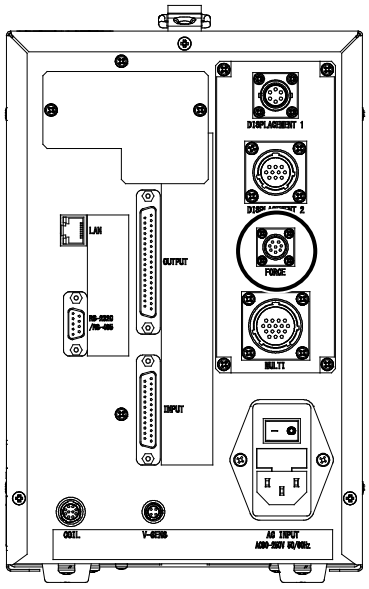
Force sensor

Current/force sensor

Follow the steps described below to connect the force sensor.

① For force sensor **MA-520B/521B/522B**

1) Plug the force sensor connector into the force sensor connector [FORCE] on the rear panel of the **MM-400A**.



2) Perform a reset (ON setting) without applying loads to the force sensor.

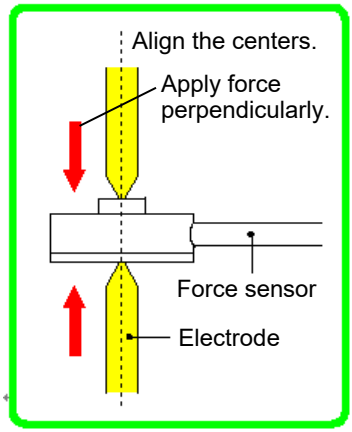
CAUTION

Be sure to set the force sensor's offset to "0" before measuring force. You can set the offset to "0" by touching the FORCE 0 key on the SYSTEM SETUP (2) screen. At this time make sure that no force is applied to the sensor. For resetting a force, refer to Chapter 8, "n-2. SYSTEM SETUP (2) Screen."

3) Attach the force sensor to the welding machine's electrodes.

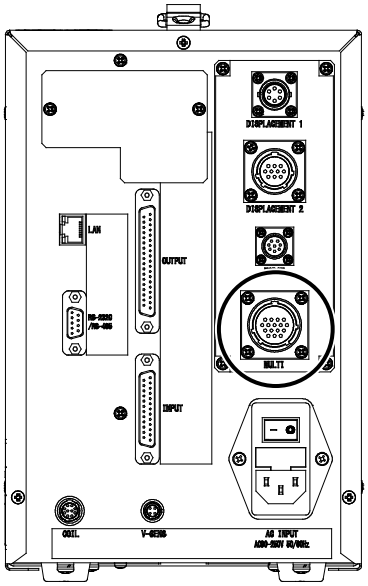
When attaching the sensor, be careful with the following:

- Be sure that the center of the sensor's detection area is aligned with the centers of the welding machine's electrodes.
- Be sure that the force is applied perpendicularly to the force sensor.



② For current/force sensor **MA-770A/771A**

1) Plug the current/force sensor connector into the multiconnector [MULTI] on the rear panel of the **MM-400A**.



2) Perform a reset (ON setting) without applying loads to the current/force sensor.

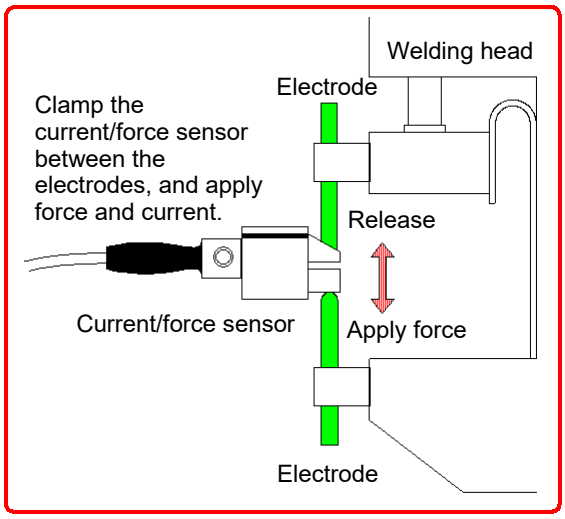
CAUTION

- When using a force sensor, do not connect to the multiconnector [MULTI]. Also, when using a current/force sensor, do not connect to the toroidal coil connector [COIL] and the force sensor connector [FORCE].
- When using a force sensor, be sure to set the force sensor's offset to "0" before measuring force. You can set the offset to "0" by touching the FORCE 0 key on the SYSTEM SETUP (2) screen. At this time make sure that no force is applied to the sensor. For resetting a force, refer to Chapter 8, "n-2. SYSTEM SETUP (2) Screen."

3) Attach the current/force sensor to the welding machine's electrodes.

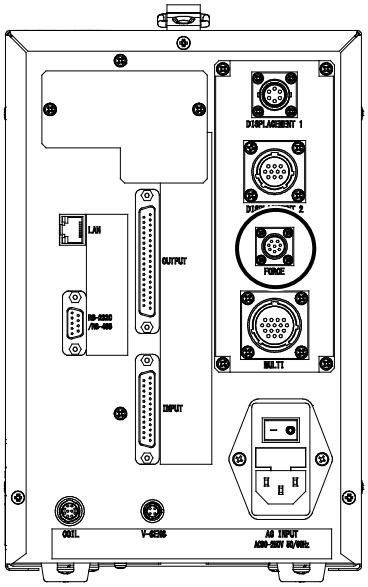
When attaching the sensor, be careful with the following:

- Be sure that the center of the sensor's detection area is aligned with the centers of the welding machine's electrodes.
- Be sure that the force is applied perpendicularly to the sensor.



③ For force sensor of follow-up mechanism element

1) Plug the conversion cable connector into the force sensor connector [FORCE] on the rear panel of the **MM-400A**.



2) Perform a reset (ON setting) without applying loads to the force sensor.

CAUTION

When using a force sensor, be sure to set the force sensor's offset to "0" before measuring force. When using a force sensor built in a head, set the offset to "0" with the force applied to the head stopped. You can set the offset to "0" by touching the FORCE 0 key on the SYSTEM SETUP (2) screen. At this time make sure that no force is applied to the sensor. For resetting a force, refer to Chapter 8, "n-2. SYSTEM SETUP (2) Screen."

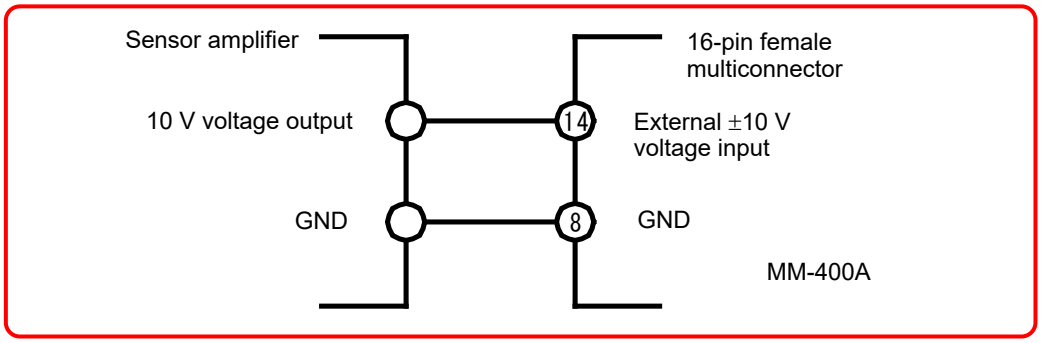
3) Set a force of the follow-up mechanism element with a knob.

d. When Using an External ±10 V Voltage Input (Force/displacement-equipped specification)

1) The **MM-400A** allows for displaying the measured voltage signal using a commercial sensor and amplifier connected to the external ±10 V voltage input.

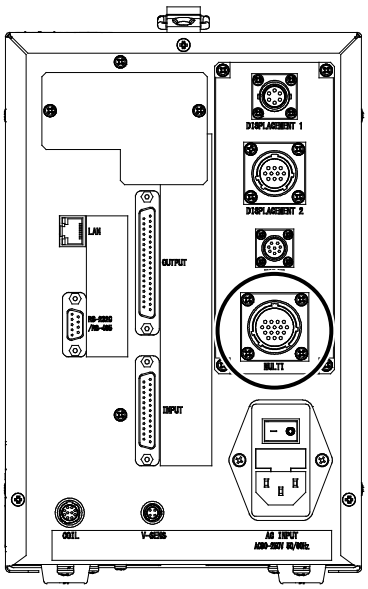
Follow the steps described below to connect the external ±10 V voltage.

External ±10 V Voltage Input Connection Diagram



The 16-pin female multiconnector is optional.
(Multiconnector SRCN6A21-16P: Japan Aviation Electronics Industry)

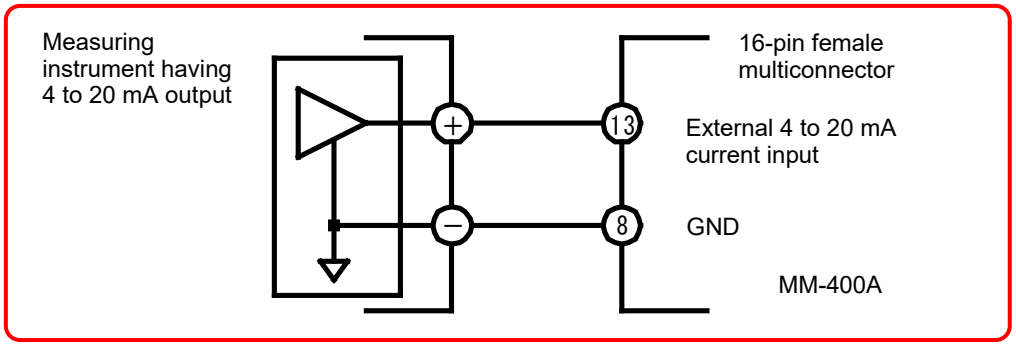
2) Plug the multiconnector into the multiconnector [MULTI] on the rear panel of the **MM-400A**.



e. When Using an External 4 to 20 mA Current Input (Force/displacement-equipped specification)

1) The **MM-400A** allows for measurement connecting a commercial 4 to 20 mA output sensor connected to the external current input. Input it in a range of 4 to 20 mA.

External 4 to 20 mA Current Input Connection Diagram



The 16-pin female multiconnector is optional.
(Multiconnector SRCN6A21-16P: Japan Aviation Electronics Industry)

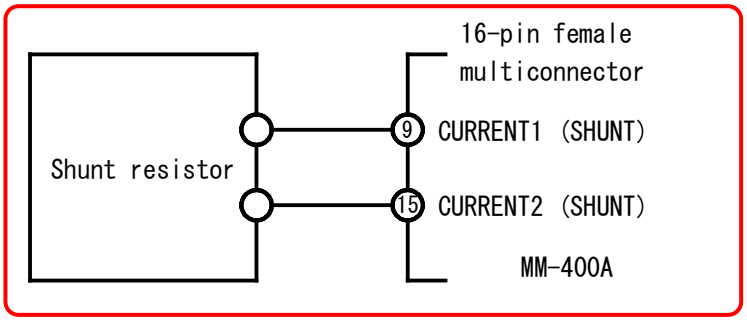
f. When Using a Shunt Resistor (Force/displacement- equipped specification)

1) The **MM-400A** allows for current measurement connecting a shunt resistor connected to the shunt resistor input.

A shunt resistor is a resistor for detecting current of a circuit. It is connected in series to the welding current circuit.

Be sure to using a shunt floating it from the ground. Note that a resistance value changes by heat. Take care when using it with high current or high duty cycle. Also, it is not affected by an inductance component by using a noninductive type.

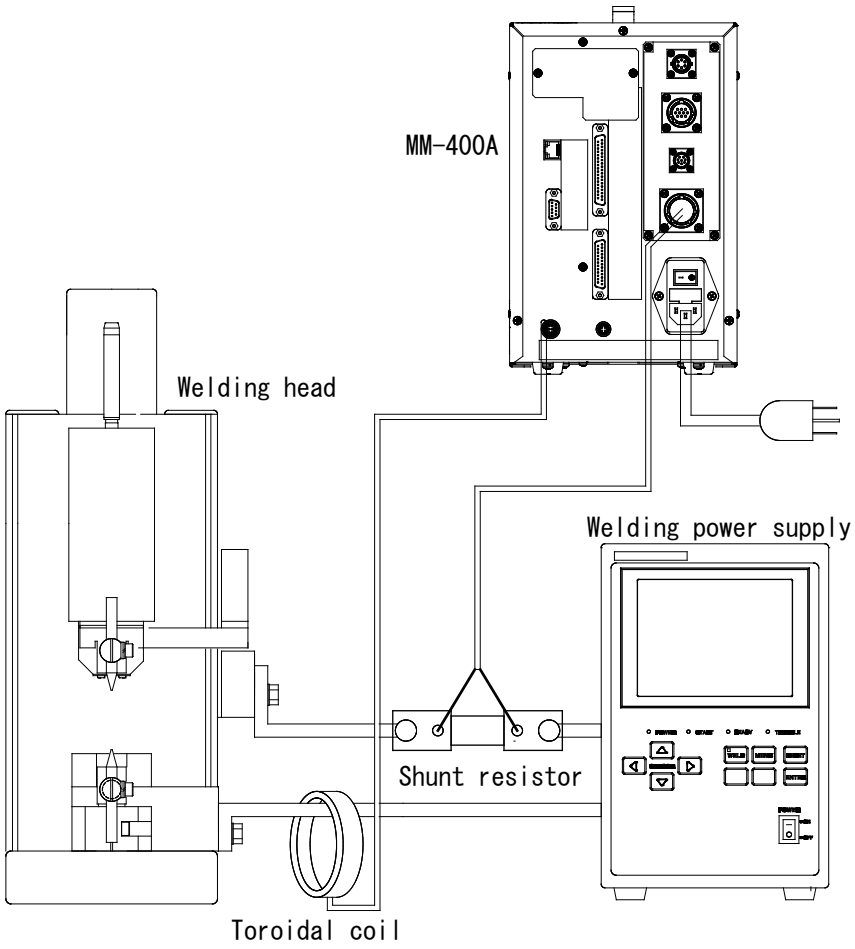
Shunt Resistor Connection Diagram



The 16-pin female multiconnector is optional.
(Multiconnector SRCN6A21-16P: Japan Aviation Electronics Industry)

(Reference) Current measurement by a shunt resistor

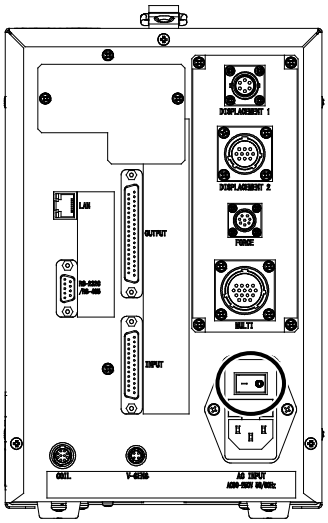
The shunt resistor detects a current in circuit. As shown below, connect it to welding current circuit in series. Be sure to use the shunt with floating off the ground. Since the resistance value changes by heat generation, be careful of use with large current or high duty cycle. By using a non-inductive type, it is not affected by an inductance component. Connect the shunt to the multiconnector. (Refer to “4. Name and Functions of Each Sections” (2) Rear ⑨. For connections, refer to “10. Interface.”)



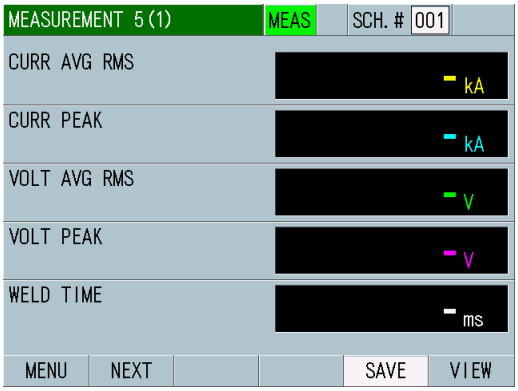
7. Basic Operation

(1) Startup

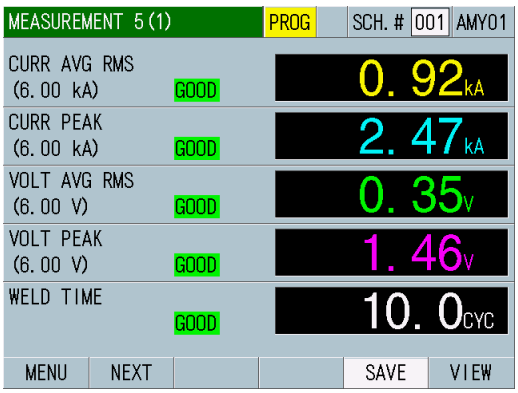
1) Set the main power switch on the rear panel to the ON position (– side).



The MEASUREMENT 5(1) or MEASUREMENT 10 screen appears on the display after a while. (The MEASUREMENT 5(1) screen appears first used after shipment.)



To display a waveform or change or check the setting, touch MEAS to change it to PROG. (Alternately switched by touching.)



(2) Changing the Display Language

1) Touch the MENU key on the lower-left portion of the screen.
The MENU screen appears.

2) Select SYSTEM SETUP.
The SYSTEM SETUP (1) screen appears.

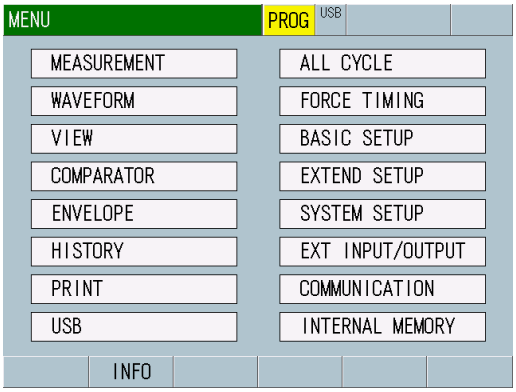
The display language can be changed by the LANGUAGE setting. Select a language to display.

For operation, refer to “(3) Basic Usage of the MM-400A” and Chapter 8, “n-1. SYSTEM SETUP (1) Screen.”

(3) Basic Usage of the MM-400A

This section describes the basic usage of the **MM-400A**.

1) Touch the MENU key on the lower-left portion of the screen.
The MENU screen appears.



2) Touch the desired menu on the MENU screen.
For operations on each screen, refer to Chapter 8, “Operation Screen.”

IMPORTANT

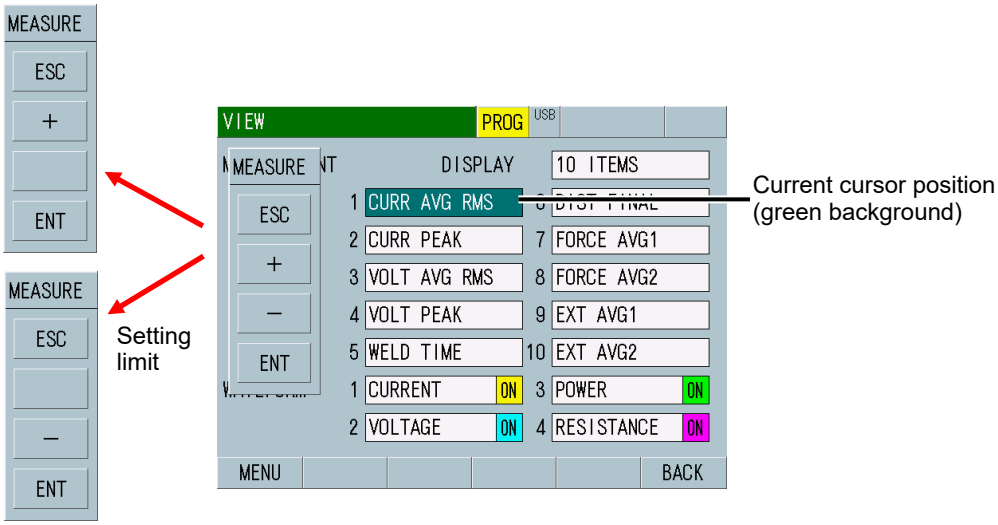
- Press switches and touch panel display carefully by hand. Handling them roughly (using a screwdriver or the tip of pen) may result in a malfunction or failure.
- Press switches and touch panel display one at a time. Pressing more than one switch at a time may result in a malfunction or failure.

3) When you touch a desired item on each screen, a ten-key for the item appears. Items that can be operated are restricted by the setting of password and the external input “PROGRAM PROTECT” to be selectively used for the supervisor and the operator.

For the password setting, refer to Chapter 8, “n-3. PASSWORD Screen.” For the external input “PROGRAM PROTECT”, refer to Chapter 8, “o-1. EXT INPUT/OUTPUT (1) Screen” and Chapter 10, “(2) a. Input Connector.”

- Selecting an item in the VIEW screen

In this screen example, the cursor is positioned at the DISPLAY selection field. The settable item is switched by “+” and “-.” Since the setting items do not loop, only “+” or “-” appears when the setting limit is reached. After selection, touch ENT to determine. To exit a ten-key display without determining setting, touch ESC.

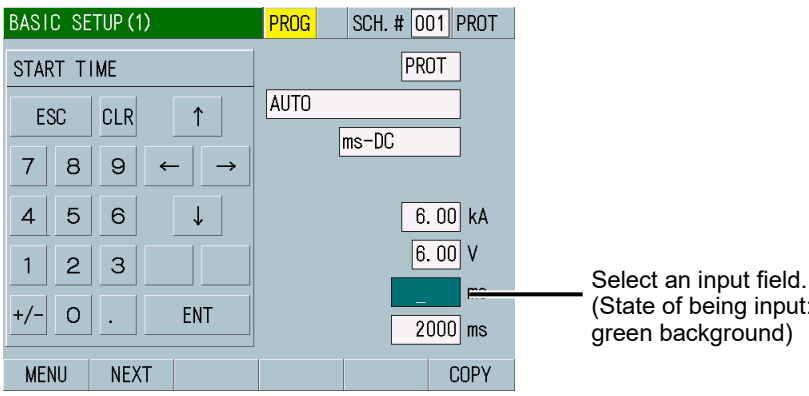


- Inputting a value

In this screen example, the cursor is positioned at the START TIME setting field. Set a value using numbers and decimal point, and touch ENT to determine. To exit a ten-key display without determining setting, touch ESC.

Touching ↑ ↓ moves the input field up and down. Touching ← → moves the digit of the input number right and left. Touching CLR deletes the input letters and numbers one by one.

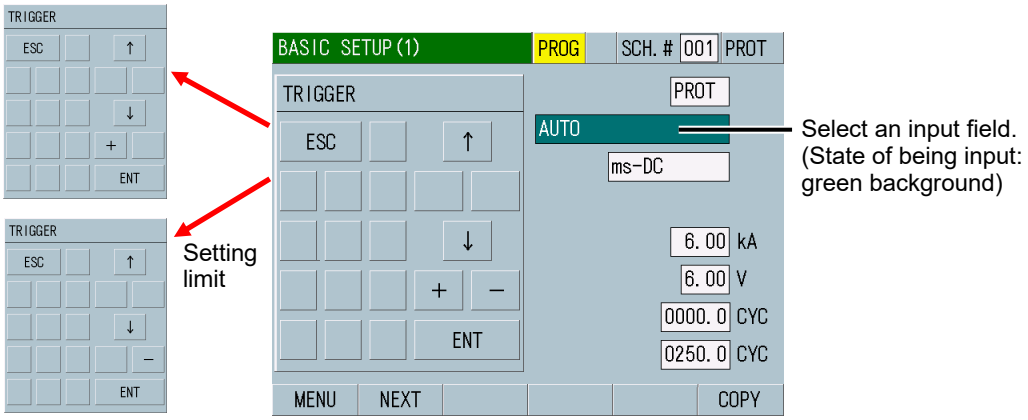
When an unsettable value is input and determined, it returns to the original setting value.



- Selecting a mode

In this screen example, the cursor is positioned at the TRIGGER selection field. The settable item is switched by “+” and “-.” Since the setting items do not loop, only “+” or “-” appears when the setting limit is reached. After selection, touch ENT to determine. To exit a ten-key display without determining setting, touch ESC.

Touching ↑ ↓ moves the input field up and down.



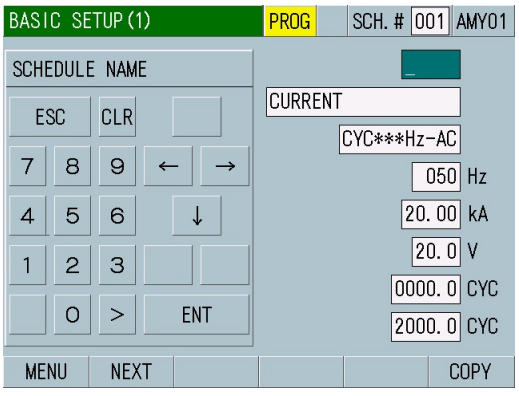
- Setting the SCHEDULE NAME

For SCHEDULE NAME in the BASIC SETUP (1) screen, select up to five letters among numbers of 0 to 9 and alphabetical characters of A to Z using five kinds of ten-keys. After selection, touch ENT to determine. To exit a ten-key display without determining setting, touch ESC.

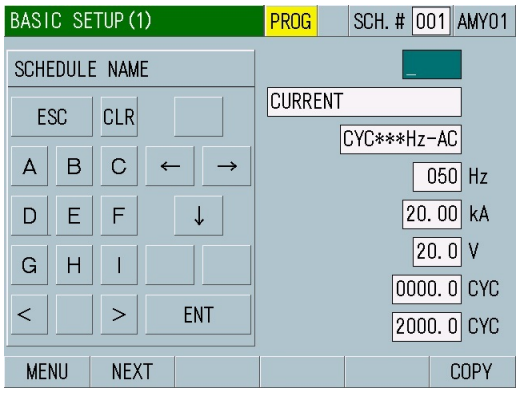
Touching ↑ ↓ moves the input field up and down. Touching ← → moves the digit of the input number right and left. Touching CLR deletes the input letters and numbers one by one.

Touching < > moves between ten-keys (i) to (iv).

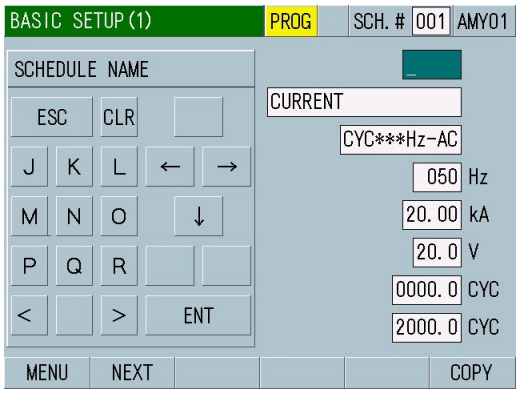
(i) Numbers (0 to 9)
Move to the next ten-key (ii) by >.



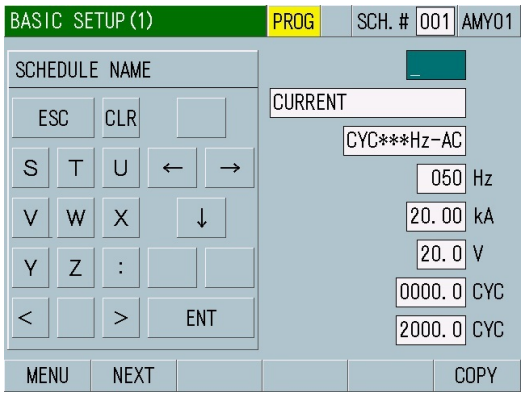
(ii) Alphabetical characters (A to I)
Move to (iii) by > and (i) by <.



(iii) Alphabetical characters (J to R)
Move to (iv) by > and (ii) by <.

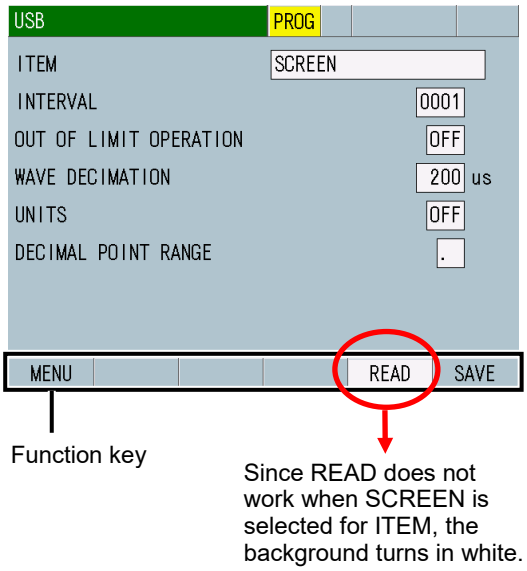


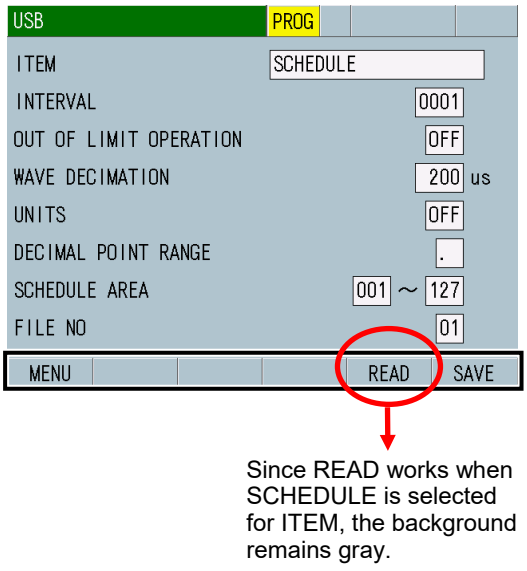
(iv) Alphabetical characters (S to Z)
Move to (iii) by <.



4) Enable the function keys.
Touching the function keys at the lower portion of the screen loads screens or enables various functions.

When the function keys do not work, the background turns in white.

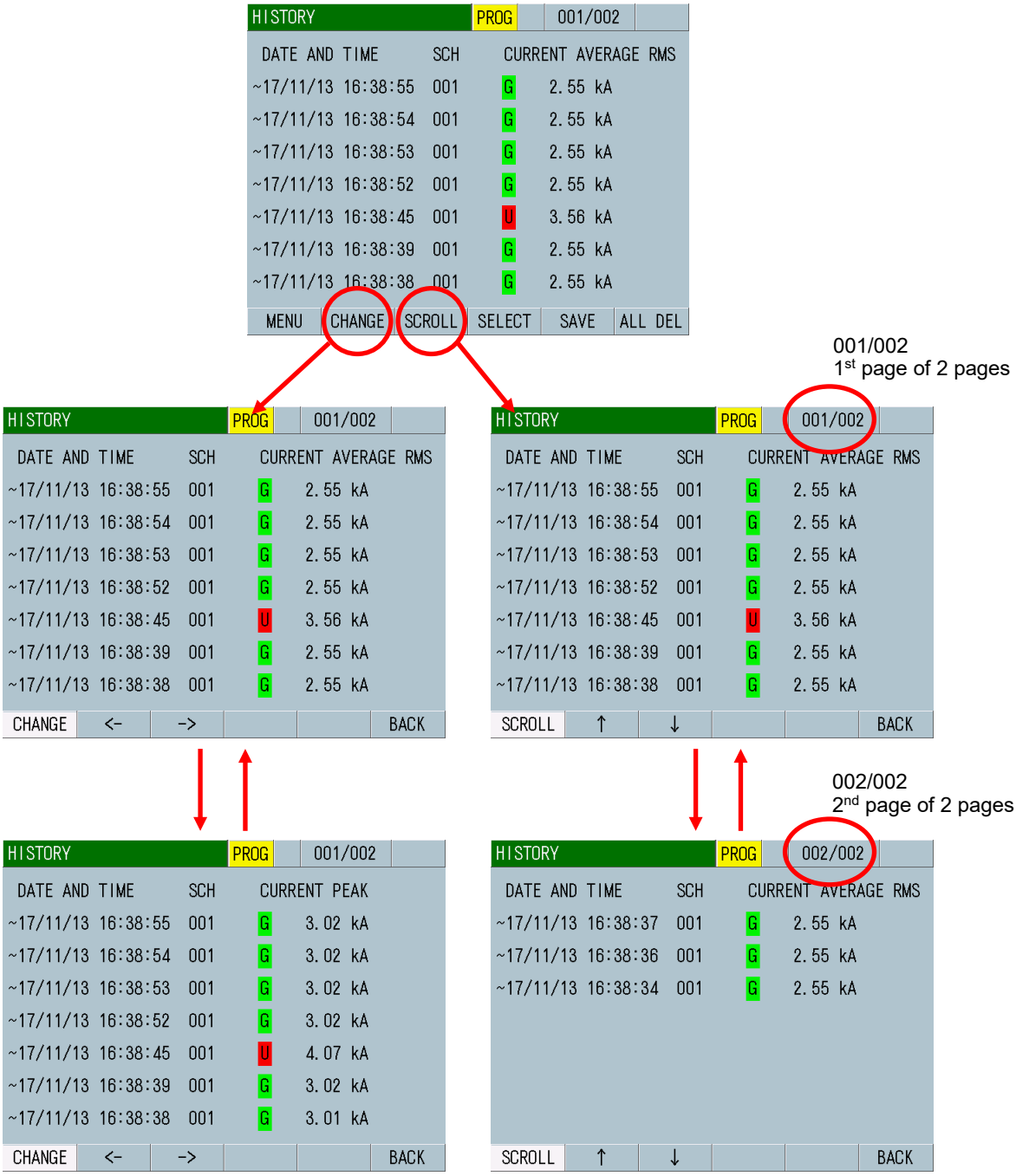




- Scrolling the HISTORY screen.

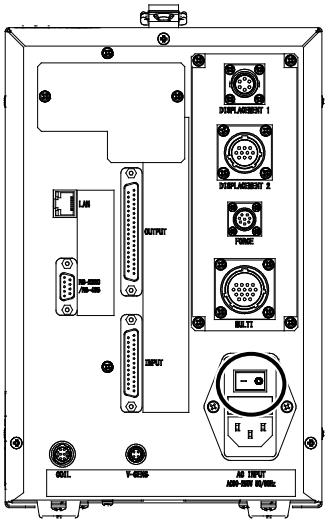
Touching the CHANGE key on the at the lower portion of the HISTORY screen displays ← → to switch ten measurement items selected in the VIEW screen. Touching the SCROLL key displays ↑ ↓ to scroll the screen by seven points.

The page number is shown at the upper-right portion on the screen.



(4) Shutdown

1) Set the main power switch on the rear panel to the OFF position (O side).



8. Operation Screens

(1) Operation Screen Organization

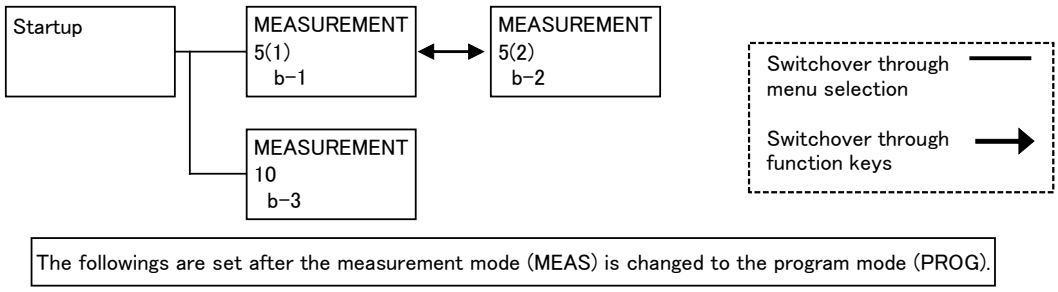
Turn on the power supply and switch the measurement mode “MEAS” and the program mode “PROG” on the MEASUREMENT screen. Touch the MENU key to display the MENU screen, and select each screen.

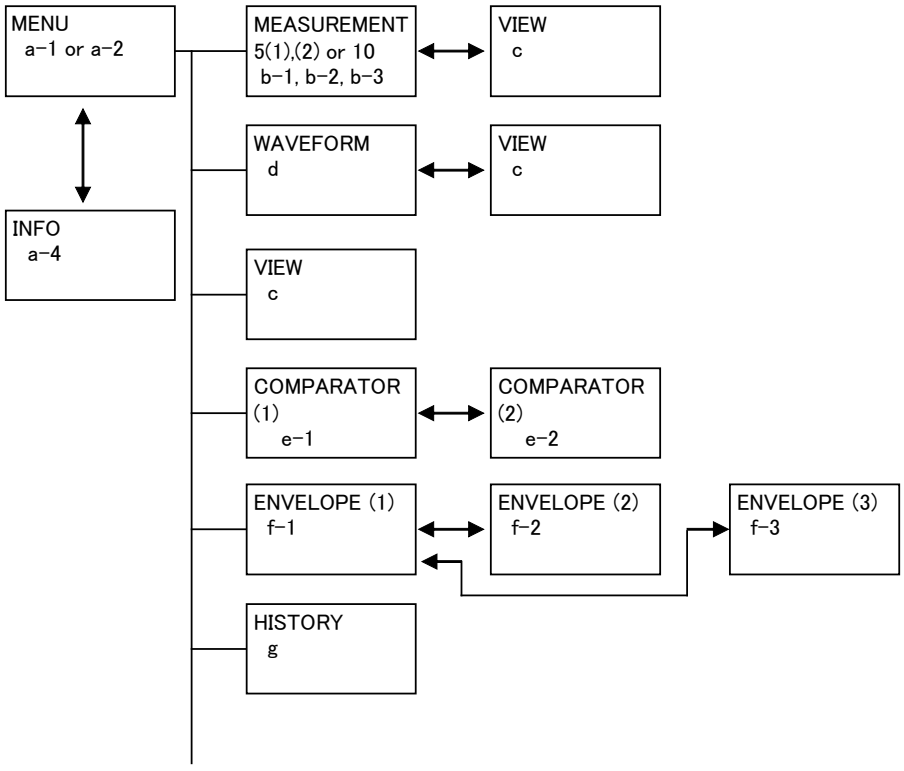
You can measure current, force and others in the MEASUREMENT, WAVEFORM and ALL CYCLE screens.

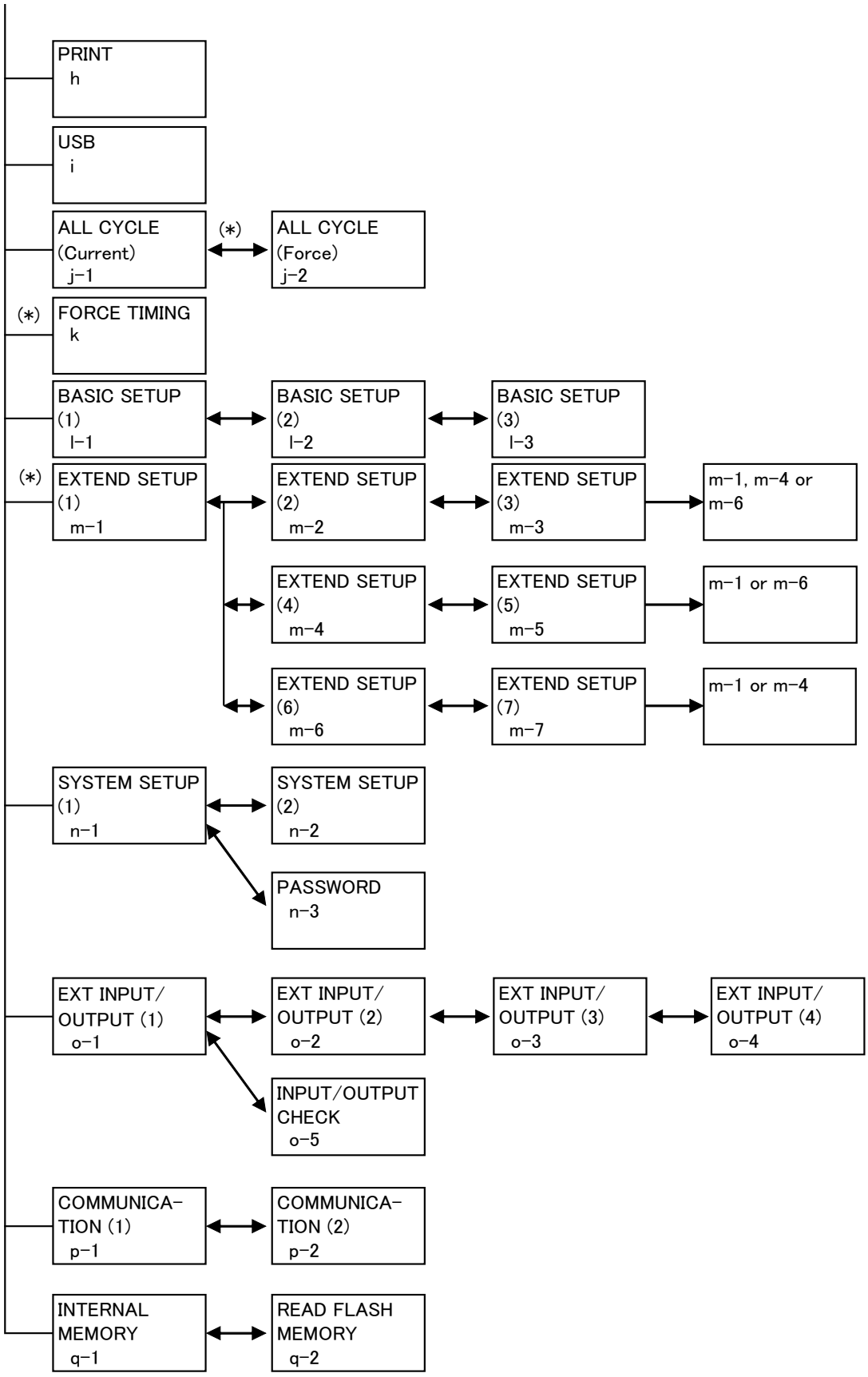
The MEASUREMENT screen accepts next measurement even while the screen is being updated following a measurement.
In contrast, the WAVEFORM, ALL CYCLE and ENVELOPE screens accept next measurement only after the screen is updated.

If you switch to the measurement mode with data shown in a screen other than the MEASUREMENT, WAVEFORM, ALL CYCLE, and ENVELOPE screens, the display returns to the MEASUREMENT screen to move to the measurement mode, after which next measurement starts.

The **MM-400A**’s operation screens (normal screen) are organized as shown below.

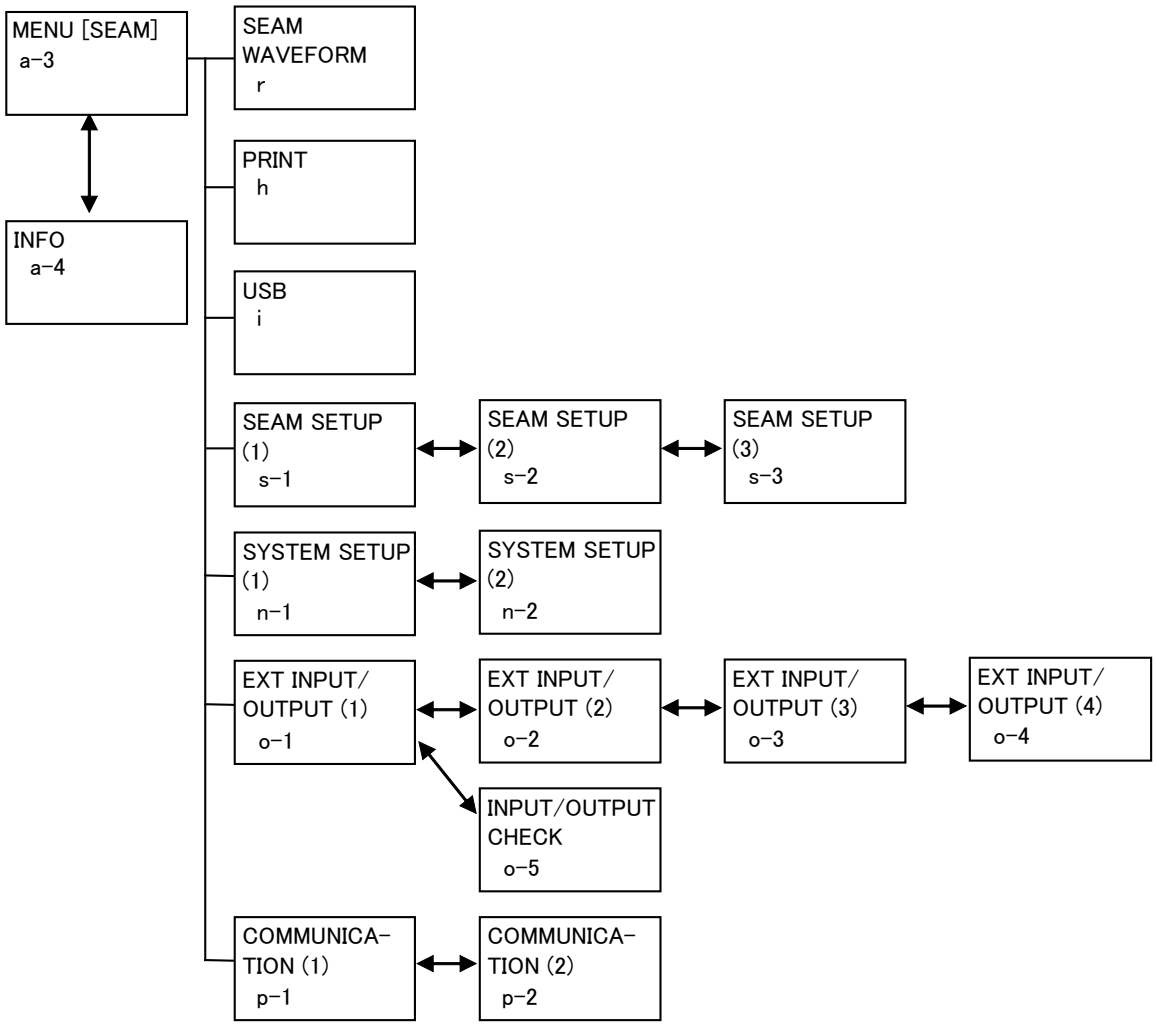






(*) Shown only for force/displacement-equipped specification function

The **MM-400A**'s operation screens (seam measurement) are organized as shown below.

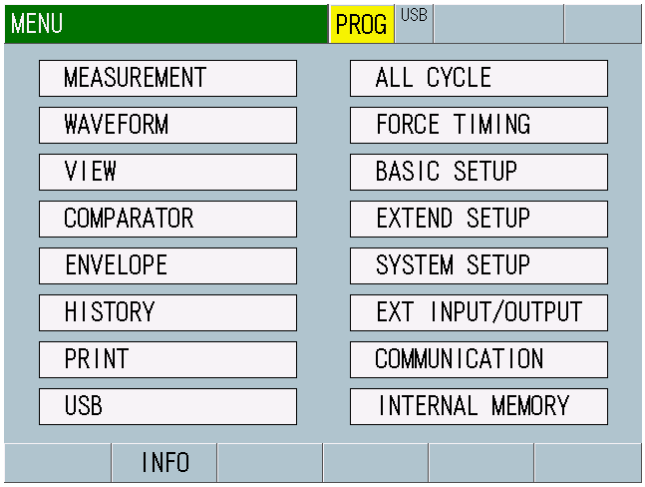


(2) Description of the Operation Screens

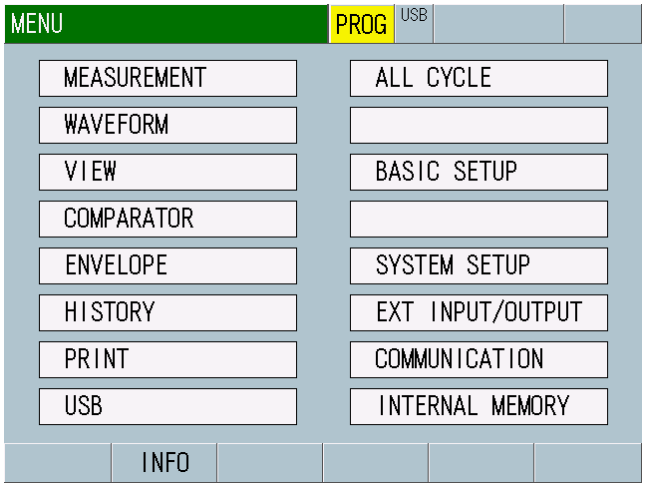
a. MENU Screen

Touching each item moves each screens. The screen varies according to the product specifications and mode settings.

a-1. Normal: force/displacement equipped

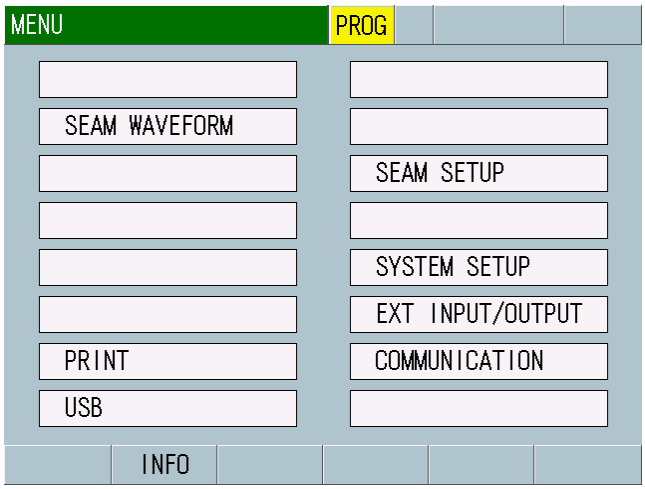


a-2. Normal: standard (force/displacement not equipped)



a-3. Seam Mode: standard and force/displacement equipped

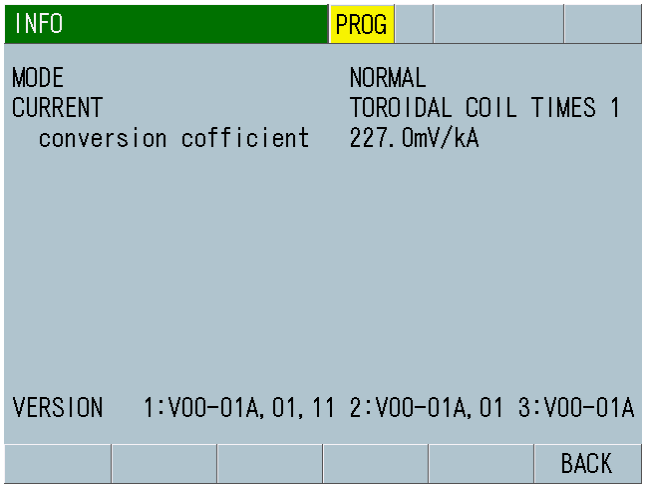
To change to the seam mode, touch SYSTEM SETUP in the MENU screen and set MODE to SEAM in the SYSTEM SETUP (1) screen.



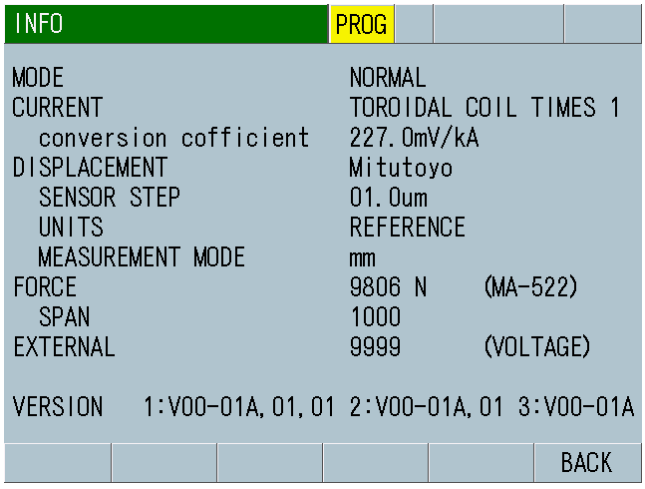
a-4. INFO Screen

Touching the INFO key in the MENU screen displays various settings and software versions. Touching the BACK key returns to the MENU screen.

Standard (force/displacement not equipped)



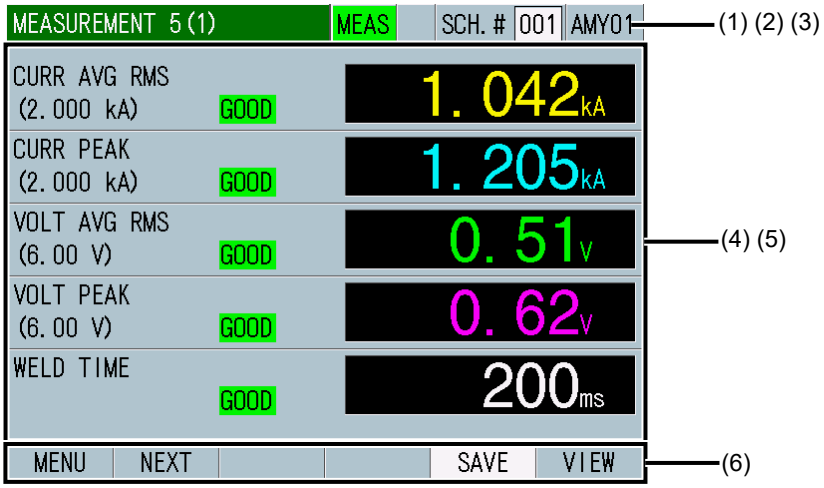
Force/displacement equipped



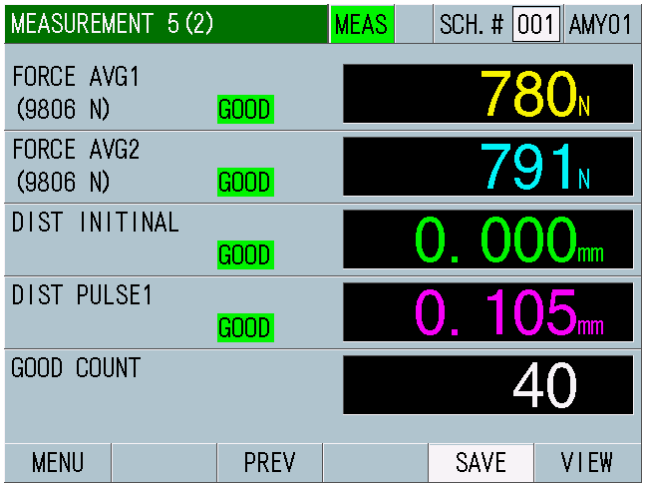
b. MEASUREMENT Screen

The **MM-400A** can display up to 10 measured values simultaneously. There are two modes for the MEASUREMENT screen, a mode to display 5 items in two screens (b-1, b-2) and a mode to display 10 items in a screen (b-3). The display mode is selected in the VIEW screen.

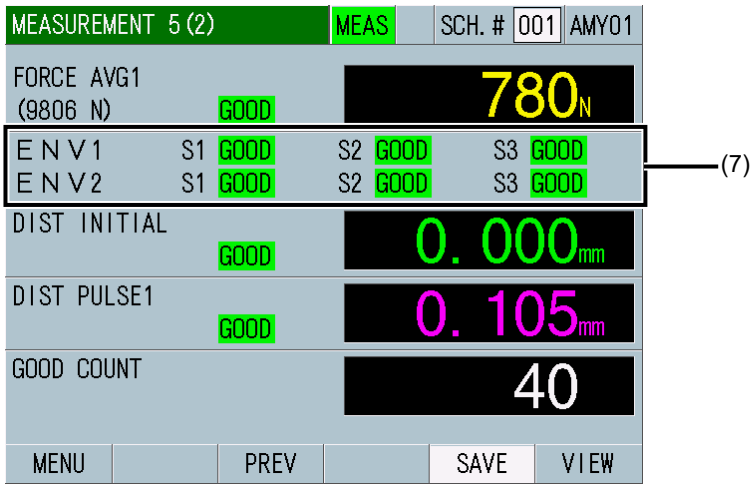
b-1. MEASUREMENT 5(1) Screen



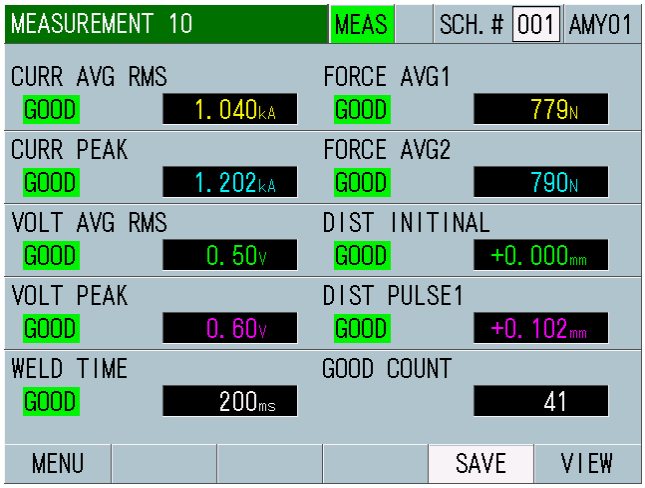
b-2. MEASUREMENT 5(2) Screen



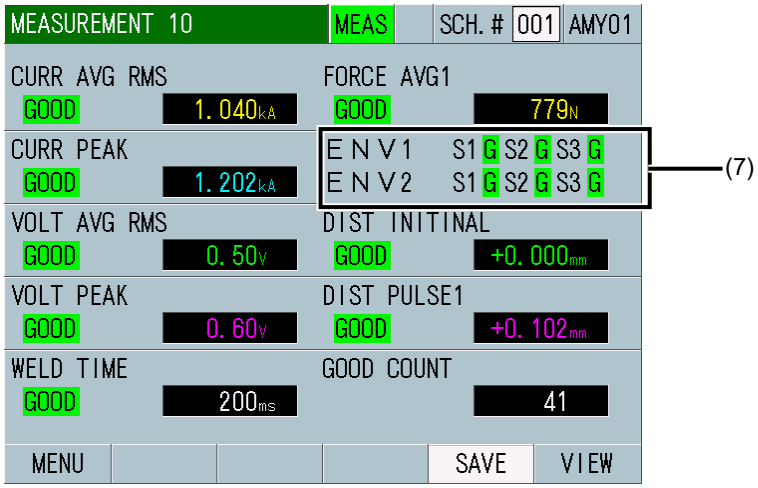
When ENVELOPE is selected



b-3. MEASUREMENT 10 Screen



When ENVELOPE is selected



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) MEAS (MEASUREMENT) / PROG (PROGRAM)

Switches the measurement mode (MEAS) and the program mode (PROG). When the power is turned on, the measurement mode is selected.

MEAS: Measurement enabled and screen operation disabled
PROG: Measurement disabled and screen operation enabled

(4) Measurement item

Shows items selected in the VIEW screen. Shows the measurement range for each measurement item in brackets in the 5-item display screens (MEASUREMENT 5(1) and MEASUREMENT 5(2)).

Also shows the result by GOOD, NG UPPER or NG LOWER when making a judgment. For details, refer to Judgment display in Chapter 13, (1) “Troubleshooting.”

(5) Measured values

Shows the measured value of the each item.

(6) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the MEASUREMENT 5(1) screen. (5-item display only)

PREV: Touching this displays the MEASUREMENT 5(2) screen. (5-item display only)

SAVE: Touching this saves the measured values, all cycle, and waveforms to flash memory in the **MM-400A**. The **MM-400A** operates in the same manner as when saving the HISTORY screen. For more information, refer to “g. HISTORY Screen.” It is necessary to set items to save on the INTERNAL MEMORY screen in advance. If not, the SAVE key remains white and does not function.

VIEW: Touching this displays the VIEW screen.

(7) Envelope judgment

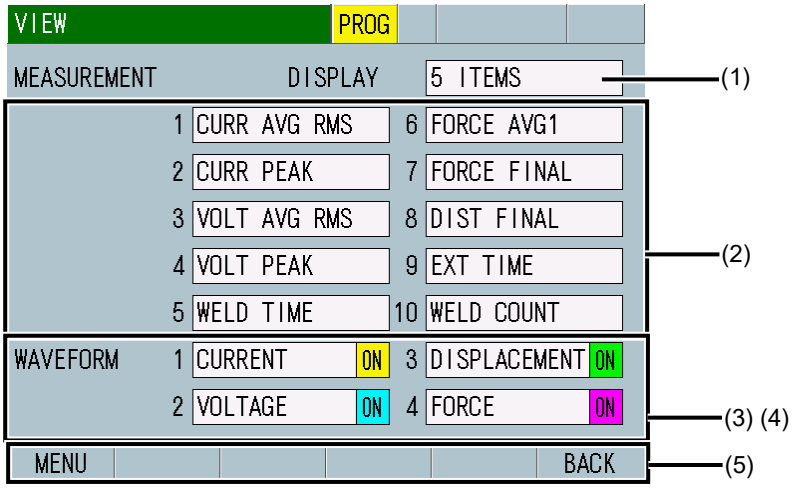
Shows the judgment results of SEGMENT#1 to #3 of ENVELOPE#1 at the upper part and ENVELOPE#2 at the lower part.

The judgment results are shown as follows.

Judgment display	MEASUREMENT 5 screen	MEASUREMENT 10 screen
GOOD	GOOD	G
NG UPPER	NG UPPER	U
NG LOWER	NG LOWER	L

For details, refer to “f. ENVELOPE Screen” and Judgment display in Chapter 13, (1) “Troubleshooting.”

c. VIEW Screen



(1) DISPLAY

Select 5 items or 10 items.

(2) MEASUREMENT 1 to 10

Select ten measurement items from the following thirty-four items.
When the measurement item is changed, upper and lower limits for the changed measurement item may be initialized. Set upper and lower limits again on the COMPARATOR screen. (Refer to “e. COMPARATOR Screen.”)

(Note) Do not make MEASUREMENT 1 to 10 the same setting.

- CURR PEAK
  Shows the peak current during current flow including the outside of the measurement interval.
- CURR RMS
  For ISO17657-compliant measurement. Calculates and shows the arithmetic RMS current over the measurement interval.
  Available only when you have selected ISO17657 for CALCULATION in the BASIC SETUP (3) screen. (Refer to Note 1.)
- CURR AVG RMS
  Original measurement mode. Calculates and shows the arithmetic mean RMS current over the measurement interval.
  Available only when you have selected ORIGINAL for CALCULATION in the BASIC SETUP (3) screen. (Refer to Note 1.)
- VOLT PEAK
  Shows the peak current during current flow including the outside of the measurement interval.
- VOLT RMS
  For ISO17657-compliant measurement. Calculates and shows the arithmetic RMS voltage over the measurement interval.
  Available only when you have selected ISO17657 for CALCULATION in the BASIC SETUP (3) screen. (Refer to Note 1.)
- VOLT AVG RMS
  Original measurement mode. Calculates and shows the arithmetic mean RMS current over the measurement interval in arithmetic mean mode.
  Available only when you have selected ORIGINAL for CALCULATION in the BASIC SETUP (3) screen. (Refer to Note 1.)
- CONDUCTION ANGLE
  Shows the maximum conduction angle within the current flow time including the outside of the measurement interval. Used for the single-phase AC welding machines.

- POWER
  Shows the mean power over the measurement interval.
- RESISTANCE
  Shows the mean resistance over the measurement interval.
- WELD TIME
  Shows the time from the detection of a current trigger to when the current flow is determined to be terminated.
- WELD TIME TP
  Used when measuring the capacitor-type welding current. Shows the time from when the welding current begins to flow to when it reaches the maximum value.
- WELD TIME TH
  Used when measuring the capacitor-type welding current. Shows the time from the welding current exceeds the maximum value to when it falls to half the maximum value.
  (Note) In WELD TIME TP and WELD TIME TH, measurement is made when the time setting is SHORT ms-DC. Also, make measurement with the setting of SET PULSE for MODE and 00 for PULSE No.
- FLOW TIME
  Applied for DC only. Shows the time from the detection of a current trigger to when the current flows is decreased to the 10% level of the measured welding current. Note that the meaning of 10% differs depending on the CALCULATION setting in the BASIC SETUP (3) screen. (Refer to Note 2.)
  ORIGINAL: 10% of welding current peak value
  ISO17657: 10% of welding current RMS
- DIST INITIAL[*1]
  Available only when any of ABSOLUTE1 to ABSOLUTE4 is selected for the measurement mode. Measures and shows the displacement before welding. Select CURRENT START or EXTERNAL INPUT for the timing setting of displacement measurement INITIAL MEASUREMENT in the EXTEND SETUP (2) screen.
- DIST PULSE1[*1]
  Measures and shows the displacement after the end of WELD1. Select CURRENT START or DELAY TIME for MEAS AFTER PULSE in the EXTEND SETUP (2) screen. When DELAY TIME is selected, the displacement between the end of WELD1 and the elapse of the delay time is measured and shown. When CURRENT START is selected, the displacement just before the start of current flow of WELD2 is measured and shown.
- DIST PULSE2[*1]
  Measures and shows the displacement after the end of WELD2. Select CURRENT START or DELAY TIME for MEAS AFTER PULSE in the EXTEND SETUP (2) screen. When DELAY TIME is selected, the displacement between the end of WELD2 and the elapse of the delay time is measured and shown. When CURRENT START is selected, the displacement just before the start of current flow of WELD3 is measured and shown.
  (Note) COOL is required between WELD1 and WELD2 for measurement.
- DIST FINAL[*1]
  Measures and shows the final displacement after the end of current flow (between the final current flow and the end of final delay time).
- DIST REAL TIME[*1]
  The **MM-400A** constantly measures and displays the displacement while MEAS is selected. The **MM-400A** stops measurement when PROG is selected. Measurement is made at intervals of twice a second. If you wish to select FORCE REAL TIME for measurement, select REAL TIME for TRIGGER the BASIC SETUP (1) screen.

- FORCE PEAK[*1]
  Shows the peak force including the outside of the measurement range.
- FORCE AVG1[*1]
  You can specify two measurement ranges for a single force application. Shows the mean force over the force measurement interval 1. (START TIME 1 and END TIME 1 in the EXTEND SETUP (4) screen)
- FORCE AVG2[*1]
  You can specify two measurement ranges for a single force application. Shows the mean force over the force measurement interval 2. (START TIME 2 and END TIME 2 in the EXTEND SETUP (4) screen)
- FORCE INITIAL[*1]
  Measures and shows the force before welding. Select CURRENT START or EXTERNAL INPUT for the timing setting INITIAL MEASUREMENT in the EXTEND SETUP (5) screen.
- FORCE FINAL[*1]
  Measures and shows the force after the end of current flow (between the final current flow and the end of final delay time).
- FORCE REAL TIME[*1]
  The **MM-400A** constantly measures and displays the force while MEAS is selected. The **MM-400A** stops measurement when PROG is selected. Measurement is made at intervals of twice a second. If you wish to select FORCE REAL TIME for measurement, select REAL TIME for TRIGGER the BASIC SETUP (1) screen.
- FORCE TIME[*1]
  Shows the time from when the force signal exceeds TRIGGER LEVEL to when the signal falls below TRIGGER LEVEL.
- EXT PEAK[*1]
  Shows the peak external input voltage or current (±10 V voltage or 4 to 20 mA current) converted at the preset conversion factor.
- EXT AVG1[*1]
  Shows the mean external input voltage or current (±10 V voltage or 4 to 20 mA current) converted at the preset conversion factor.
- EXT AVG2[*1]
  Shows the mean external input voltage or current (±10 V voltage or 4 to 20 mA current) converted at the preset conversion factor.
- EXT INITIAL[*1]
  Shows the measured external input voltage or current (±10 V voltage or 4 to 20 mA current) before welding converted at the preset conversion factor. Select CURRENT START or EXTERNAL INPUT for the timing setting INITIAL MEASUREMENT in the EXTEND SETUP (7) screen.
- EXT FINAL[*1]
  Shows the measured external input voltage or current (±10 V voltage or 4 to 20 mA current) after the end of current flow converted at the preset conversion factor. Select CURRENT START or EXTERNAL INPUT for the timing setting INITIAL MEASUREMENT in the EXTEND SETUP (7) screen.
- EXT REAL TIME[*1]
  The **MM-400A** constantly measures the external input (±10 V voltage or 4 to 20 mA current) while MEAS is selected. The **MM-400A** stops measurement when PROG is selected. Measurement is made at intervals of twice a second. If you wish to select EXT REAL TIME for measurement, select REAL TIME for TRIGGER in the BASIC SETUP (1) screen.
- EXT TIME[*1]
  Shows the time from the start to the end of external input (±10 V voltage or 4 to 20 mA current).

- WELD COUNT[*2]
  Shows the counter that indicates the number of measurements. It counts up irrespective of OK/NG judgment against upper and lower limits.
- GOOD COUNT[*2]
  Shows the good counter within upper and lower limits.
- No selection
- ENVELOPE
  Shows the judgment results of the envelope.

(3) WAVEFORM 1 to 4

Select four items to display in the WAVEFORM screen from the following: CURRENT, VOLTAGE, POWER, RESIST, DISPLACEMENT[*1], FORCE[*1], EXTERNAL[*1], no selection

(Note) Do not make WAVEFORM 1 to 4 the same setting.

(4) Display ON/OFF

Select whether to show the waveforms by selecting ON/OFF. The waveforms with OFF are not shown even when selected.

(5) Function keys

MENU: Touching this displays the MENU screen.

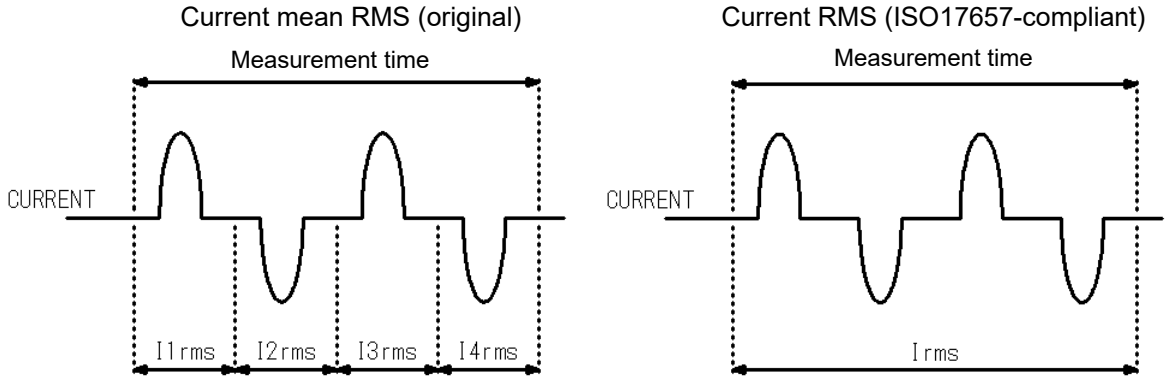
BACK: Touching this returns the display to the previous screen (MEASUREMENT or WAVEFORM screen). When the WAVEFORM screen is selected from the MENU screen, this does not function.

*1: Force/displacement-equipped specification function
*2: The display of WELD COUNT and GOOD COUNT may change in the measurement mode (MEAS) and in the program mode (PROG).

Measurement mode (MEAS): Displays the current counter. When the CT RESET key is touched, the value becomes 0.

Program mode (PROG): Also displays the past counter. When the past measured value is displayed from the history, the counter value is different from the current counter value. Even when the CT RESET key is touched, the value does not become 0.

(Note 1) Difference between the original measurement mode and the ISO17657-compliant measurement mode in RMS calculation



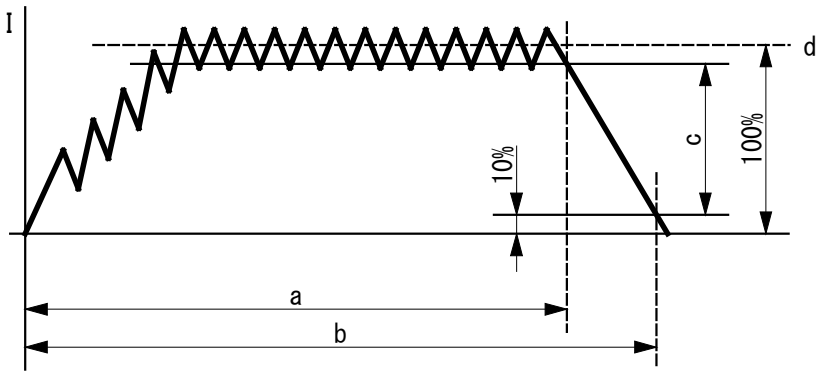
Arithmetic mean RMS current in the measurement interval

$$\text{Arithmetic mean RMS} = \frac{I1rms + I2rms + I3rms + I4rms}{4}$$

RMS current in all measurement intervals

RMS = Irms

(Note 2) Difference between current flow time of the original measurement mode and that of the ISO17657-compliant measurement mode (DC measurement only)



a: Current flow time b: Flow time c: Fall level 10 to 90% d: RMS

- Original measurement mode
  - a: Time till the welding current reaches FALL LEVEL (10 to 90% of **peak value**)
  - b: Time till the welding current reaches 10% of **peak value**

- ISO17657-compliant measurement mode
  - a: Time till the welding current reaches FALL LEVEL (10 to 90% of **RMS**)
  - b: Time till the welding current reaches 10% of **RMS**

(Note) FALL LEVEL is set in the BASIC SETUP (2) screen.

d. WAVEFORM Screen

(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) Waveform

Shows the waveforms of four items on the grid. Waveform display items can be selected in the VIEW screen.

(Note) When EXTERNAL is selected for waveform display item, you need to select VOLTAGE or CURRENT for INPUT in the EXTEND SETUP (7) screen.

① Waveform example when the external input is voltage (WAVEFORM 3)

Displays ON (+0 V) to 500 N (+10 V) with a load cell amplifier prepared separately.

② Waveform example when the external input is current (WAVEFORM 3)

Displays 140°C (4 mA) to 2000°C (20 mA) with a radiation thermometer. Less than 140°C is not displayed.

(4) Grid spacing

Shows the grid spacings for the four waveforms shown on the grid.

(5) Measured values

Shows the measured values of five items. Measurement items can be selected in the VIEW screen.

(6) Function keys

MENU: Touching this displays the MENU screen.

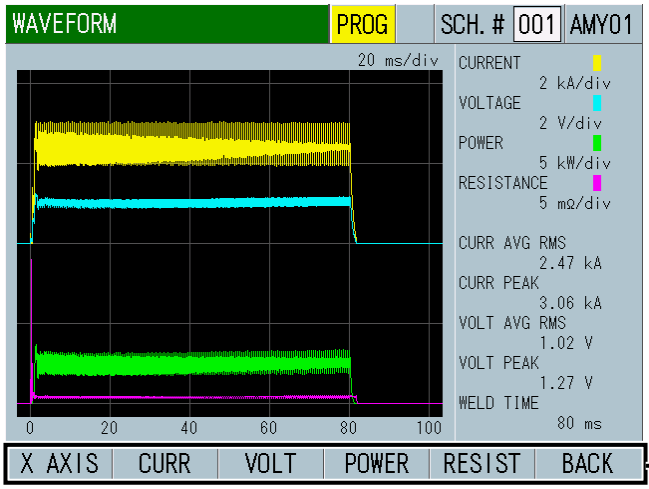
FIT: Touching this redisplays the waveforms by automatically resizing them to fit into the screen.

X/Y AXIS: Touching this displays XY-axis scale command at the function key. (Refer to (6)-1.)

CURSOR: Touching this displays the vertical axis and cursor command at the function key. (Refer to (6)-2.)

VIEW: Touching this displays the VIEW screen.

(6)-1 XY-axis scale command



X AXIS: Touching this enlarges/reduces the time axis of waveform and makes it possible to move the waveforms. In this condition, touch the arrow key (<- ->). This moves the waveforms to the right or left. Touch + (plus) to enlarge the time axis of waveform or - (minus) to reduce it.

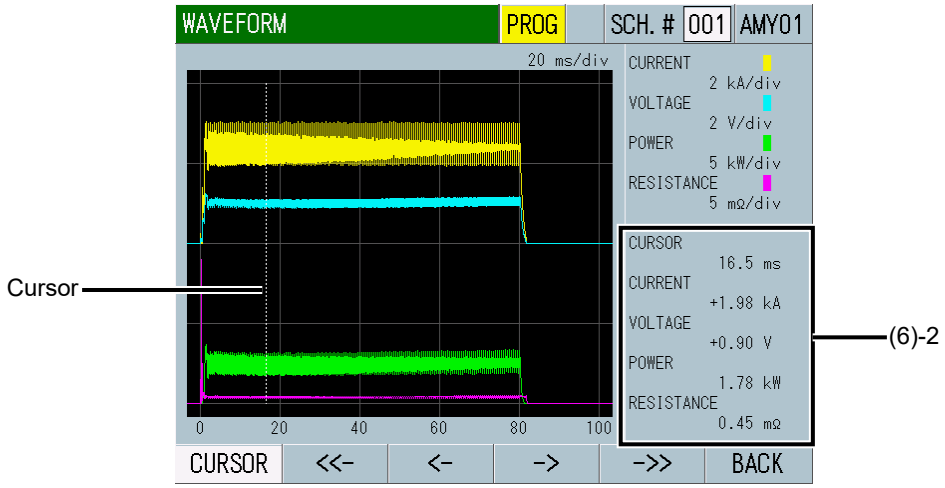
CURR: Touching this makes it possible to adjust the scale of the vertical axis for the current waveform. In this condition, touch + (plus) to enlarge a scale of the vertical axis for the current waveform or - (minus) to reduce it.

VOLT: Touching this makes it possible to adjust the scale of the vertical axis for the voltage waveform.

POWER: Touching this makes it possible to adjust the scale of the vertical axis for the power waveform.

RESIST: Touching this makes it possible to adjust the scale of the vertical axis for the resistance waveform.

(6)-2 Cursor command



Shows the current time axis information of the cursor and the measured values of the waveforms at the point in time indicated by the cursor.

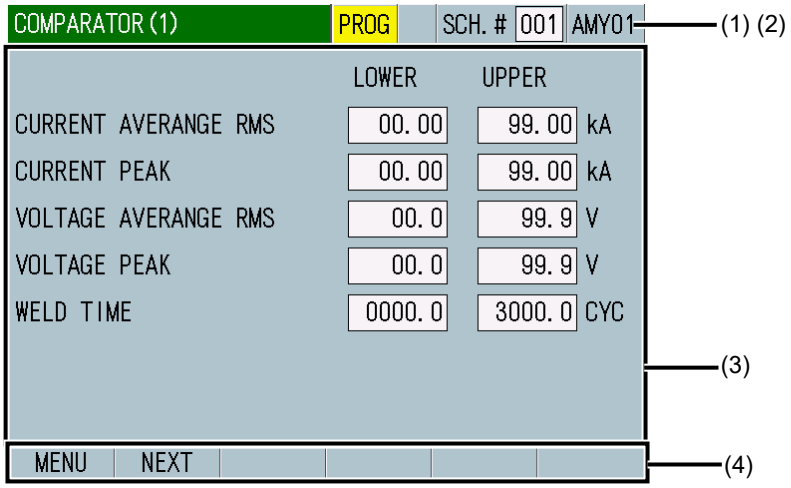
You can move the white line (cursor) on the grid right and left by touching the function keys.

<- ->: Touching this moves the cursor right and left by 1 dot. The cursor moves only while the key is touched.

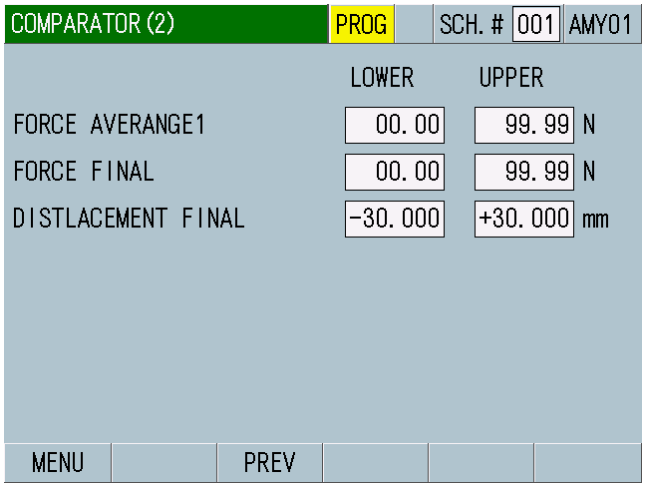
<<- ->>: Touching this moves the cursor right and left by 50 dots.

e. COMPARATOR Screen

e-1. COMPARATOR (1) Screen



e-2. COMPARATOR (2) Screen



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) Parameter setting

Set upper and lower limits for the measurement items selected in the VIEW screen as follows. Items 1 to 5 are on the COMPARATOR (1) screen and items 6 to 10 are on the COMPARATOR (2) screen.

When the measurement item is changed, upper and lower limits for the changed measurement item may be initialized. (Refer to "c. VIEW Screen.")

When the TRIGGER and TIME settings are changed, upper and lower limits for measurement items WELD TIME and FLOW TIME may be initialized. Set upper and lower limits again. (Refer to "l-1. BASIC SETUP (1) Screen.")

- CURRENT (PEAK, RMS, AVERAGE RMS)
  Set upper and lower limits in the following ranges depending on the type of toroidal coil connected and according to the CURR RANGE setting in the BASIC SETUP (1) screen:

When 1x sensitivity coil is used:
2.000 kA range: 0.000 to 9.999 kA
6.00 kA range: 00.00 to 99.99 kA
20.00 kA range: 00.00 to 99.99 kA
60.0 kA range: 000.0 to 999.9 kA
200.0 kA range: 000.0 to 999.9 kA

When 10x sensitivity coil is used:
0.200 kA range: 0.000 to 9.999 kA
0.600 kA range: 0.000 to 9.999 kA
2.000 kA range: 0.000 to 9.999 kA
6.00 kA range: 00.00 to 99.99 kA
20.00 kA range: 00.00 to 99.99 kA

- VOLTAGE (PEAK, RMS, AVERAGE RMS)
  Set upper and lower limits in the following ranges according to the VOLTAGE RANGE setting in the BASIC SETUP (1) screen:

6.00 V range: 0.00 to 9.99 V
20.0 V range: 0.0 to 99.9 V

- WELD TIME
  Set upper and lower limits in the following ranges according to the TIME setting in the BASIC SETUP (1) screen:

CYC-AC, CYC***Hz-AC, CYC-DC, LONG CYC-AC: 0.0 to 3000.0 CYC
ms-DC, ms-AC: 0 to 30000 ms
SHORT ms-DC: 0.00 to 300.00 ms

- POWER AVERAGE
  0.0 to 300.00 kW
- RESISTANCE AVERAGE
  0.0 to 300.00 mΩ
- FORCE (AVERAGE 1, AVERAGE 2, PEAK, INITIAL, FINAL) *1
  Set upper and lower limits in the following ranges according to the SENSOR and UNITS settings in the EXTEND SETUP (5) screen:

MA-520: 0.00 to 99.99 N / 0.00 to 99.99 kgf / 0.00 to 99.99 lbf

MA-521: 0.0 to 999.9 N / 0.0 to 999.9 kgf / 0.0 to 999.9 lbf

MA-522, **MA-770A**, **MA-771A**: 0 to 9999 N / 0 to 9999 kgf / 0 to 9999 lbf

When RATED SETTING1 or RATED SETTING2 is selected for SENSOR, set upper and lower limits in the following ranges according to the DECIMAL RANGE setting in the EXTEND SETUP (5) screen:

.: 0.00 to 99.99 N / 0.00 to 99.99 kgf / 0.00 to 99.99 lbf
***.*: 0.0 to 999.9 N / 0.0 to 999.9 kgf / 0.0 to 999.9 lbf
****: 0 to 9999 N / 0 to 9999 kgf / 0 to 9999 lbf

- EXTERNAL (AVERAGE 1, AVERAGE 2, PEAK, INITIAL, FINAL) *1
  Set upper and lower limits in the following ranges according to the DECIMAL RANGE setting in the EXTEND SETUP (7) screen:

*.***: -9.999 to +9.999
.: -99.99 to +99.99
***.*: -999.9 to +999.9
****: -9999 to +9999

- DISPLACEMENT (INITIAL, PULSE 1, PULSE 2, FINAL) *1
  Set upper and lower limits in the following ranges according to the SENSOR STEP and UNITS settings in the EXTEND SETUP (3) screen:

When a sensor with 1 µm resolution or less is used: -30.000 to +30.000 mm / -3.000 to +3.000 inch
When a sensor with 1.1 µm resolution or more is used: -300.00 to +300.00 mm / -30.000 to +30.000 inch

(4) Function keys

MENU: Touching this displays the MENU screen.

PREV: Touching this displays the COMPARATOR (1) screen.

NEXT: Touching this displays the COMPARATOR (2) screen.

*1: Force/displacement-equipped specification function

f. ENVELOPE Screen

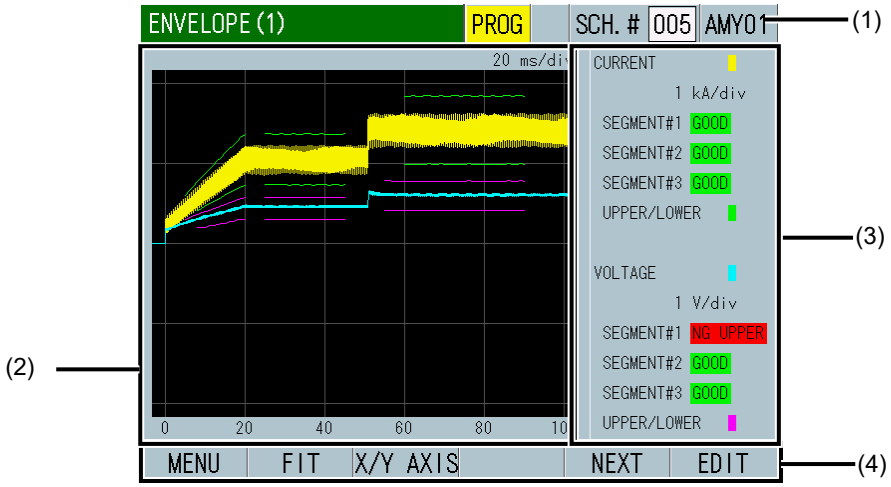
The envelope function is to create an envelope waveform (upper/lower limit threshold) based on the reference waveform to compare the actual measured waveform with envelope waveform.

f-1. ENVELOPE (1) Screen

Shows the measured waveform, upper/lower limit determination threshold and judgment result of items selected for WAVEFORM 1 and WAVEFORM 2.

WAVEFORM 1 and WAVEFORM 2 are WAVEFORM 1 and WAVEFORM 2 set in the VIEW screen. (Refer to “c. VIEW Screen.”)

VIEW	ENVELOPE
WAVEFORM 1	WAVEFORM 1
WAVEFORM 2	WAVEFORM 2



(1) SCH.#

Shows the measurement schedule number used (1 to 20). (The maximum number of schedules is 127 in other screens, but 20 in the ENVELOPE screen.) On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Waveform display

Shows waveforms and upper/lower limit thresholds.

(3) Item name and judgment result of the displayed waveform

Shows the item name and judgment results of WAVEFORM 1 (ENVELOPE#1) at the upper part and WAVEFORM 2 (ENVELOPE#2) at the lower part. Shows the judgment result of three range sections (SEGMENT#1 to #3) for WAVEFORM 1, 2 (ENVELOPE#1, 2) respectively.

Shows GOOD when the waveform is within the range, NG UPPER when it exceeds the upper limit, and NG LOWER when it falls below the lower limit even if 1 point. When it is out of both upper and lower limits at the same time, NG LOWER is preferentially displayed. Also, when there is no measured waveform in the time range of envelope judgment, NG LOWER is displayed.

(4) Function keys

MENU: Touching this displays the MENU screen.

FIT: Touching this redisplays the waveforms by automatically resizing them to fit into the screen.

X/Y AXIS: Touching this displays the cursor command at the function key.

NEXT: Touching this displays the ENVELOPE (3) screen.

EDIT: Touching this displays the ENVELOPE (2) screen.

f-2. ENVELOPE (2) screen

(1) SCH.#

Shows the measurement schedule number used (1 to 20). (The maximum number of schedules is 127 in other screens, but 20 in the ENVELOPE screen.) On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) Envelope judgment section and threshold setting

ENVELOPE#: Specify the waveform to set the threshold in. The name of the specified waveform and the unit of the vertical axis are displayed.

SEGMENT#: Set the judgment level in three range sections (SEGMENT#1 to #3) for each waveform. You can set ON/OFF to display/hide.

OFFSET: Set threshold for the reference waveform by upper limit and lower limit. Setting threshold in value or percentage can be set in the ENVELOPE (3) screen.

UPPER: Set the upper limit.
LOWER: Set the lower limit.

START TIME: Set the start of the time range to judge by threshold.

UPPER: Set the time to start the judgment of upper limit.
LOWER: Set the time to start the judgment of lower limit.

END TIME: Set the end of the time range to judge by threshold.

UPPER: Set the time to end the judgment of upper limit.
LOWER: Set the time to end the judgment of lower limit.

(Note 1) For envelope measurement, depending on the sampling interval (20 us, 50 us, 100 us, 200 us, 500 us, 1000 us) set in the SYSTEM SETUP (2) screen, there is a limit for the envelope measurable time (time from START TIME to END TIME). Set START TIME/END TIME according to the following table. If the measurable time is exceeded, “E06: ENVELOPE ERROR” occurs when the REFER key is touched.

Envelope interval	Measurable time
20 us	100 ms max.
50 us	250 ms max.
100 us	500 ms max.
200 us	1000 ms max.
500 us	2500 ms max.
1000 us	5000 ms max.

(Note 2) Set the judgment of both upper limit and lower limit.

(4) Function keys

REFER: Touching this takes in the reference waveform and displays the set threshold and the reference waveform.

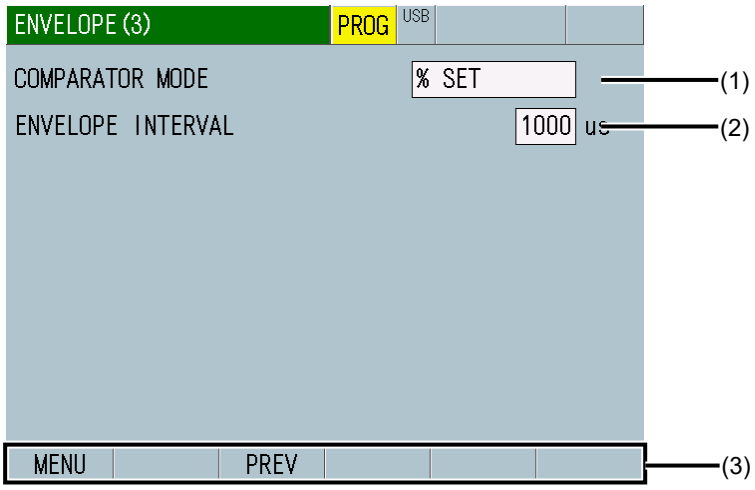
DELETE: Touching this deletes the displayed envelope judgment section and threshold setting.

X/Y AXIS: Touching this displays the cursor command at the function key and checks detailed data of time axis and vertical axis.

SAVE: Touching this displays YES and NO. Touch YES to save.

EXIT: Touching this closes the ENVELOPE (2) screen and returns to the ENVELOPE (1) screen.

f-3. ENVELOPE (3) Screen



(1) COMPARATOR MODE

Select % SET or VALUE SET.

% SET: Set the upper value larger and the lower value smaller by a ratio of a set value from the reference waveform. Set the upper value in the range of +0 to +50% and the lower value in the range of -0 to -50%.

VALUE SET: Set the upper value larger and the lower value smaller by a set value from the reference waveform.

(2) ENVELOPE INTERVAL

Set the sampling interval for envelope measurement.

You can select from among 20 us, 50 us, 100 us, 200 us, 500 us, and 1000 us.

(Note 1) The settable range of ENVELOPE INTERVAL changes depending on the selected waveform or the SAMPLING INTERVAL setting. Therefore, make a setting so as to satisfy all of the followings. If not, “E06: ENVELOPE ERROR” occurs when editing envelope.

When the waveform type used in the WAVEFORM screen is CURRENT, VOLTAGE, POWER, or RESIST and the TIME setting in the BASIC SETUP (1) screen is SHORT ms-DC

CURRENT SAMPLING INTERVAL	ENVELOPE INTERVAL
20us	20us, 100us, 200us, 500us, 1000us
50us	50us, 100us, 200us, 500us, 1000us
100us	100us, 200us, 500us, 1000us

When the waveform type used in the WAVEFORM screen is CURRENT, VOLTAGE, POWER, or RESIST and the TIME setting in the BASIC SETUP (1) screen is a setting other than SHORT ms-DC

CURRENT SAMPLING INTERVAL	ENVELOPE INTERVAL
20us、50us	50us, 100us, 200us, 500us, 1000us
100us	100us, 200us, 500us, 1000us

When the waveform type used in the WAVEFORM screen is DISPLACEMENT

CURRENT SAMPLING INTERVAL	ENVELOPE INTERVAL
20us、50us	50us, 100us, 200us, 500us, 1000us
100us	100us, 200us, 500us, 1000us

When the waveform type used in the WAVEFORM screen is FORCE or EXTERNAL and the waveform type used in ENVELOPE#1 and ENVELOPE#2 is CURRENT, VOLTAGE, POWER, RESIST, or DISPLACEMENT

CURRENT SAMPLING INTERVAL	ENVELOPE INTERVAL
20us、50us	50us, 100us, 200us, 500us, 1000us
100us	100us, 200us, 500us, 1000us

When the waveform type used in ENVELOPE#1 and ENVELOPE#2 is FORCE or EXTERNAL

FORCE SAMPLING INTERVAL	ENVELOPE INTERVAL
100us	100us, 200us, 500us, 1000us
200us	200us, 500us, 1000us
500us	500us, 1000us

For waveform type, refer to Chapter 8, “c. VIEW Screen.”

For TIME, refer to Chapter 8, “l-1. BASIC SETUP (1) Screen.”

For CURRENT SAMPLING INTERVAL and FORCE/ EXTERNAL SAMPLING INTERVAL, refer to Chapter 8, “n-2. SETUP SYSTEM (2) Screen.”

(Note 2) Depending on the setting, there is a limit for the envelope measurable time (time from START TIME to END TIME). Set START TIME/END TIME according to the following table.

Envelope interval	Measurable time
20 us	100 ms max.
50 us	250 ms max.
100 us	500 ms max.
200 us	1000 ms max.
500 us	2500 ms max.
1000 us	5000 ms max.

(3) Function keys

MENU: Touching this displays the MENU screen.

PREV: Touching this displays the ENVELOPE (2) screen.

f-4. How to set the envelope reference waveform and the determination range

There are two ways to create the threshold of the envelope function:

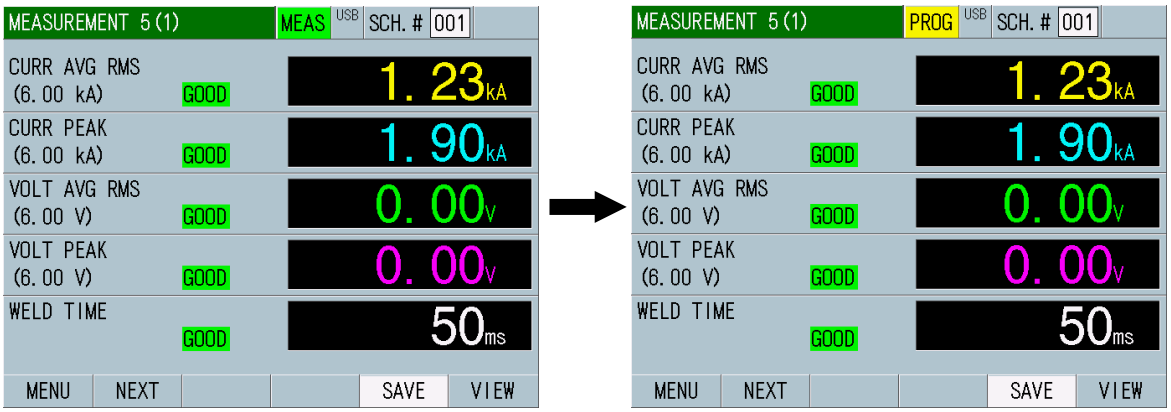
① How to create the upper/lower limit threshold based on the measured waveform

② How to create the upper/lower limit threshold based on the optionally created waveform

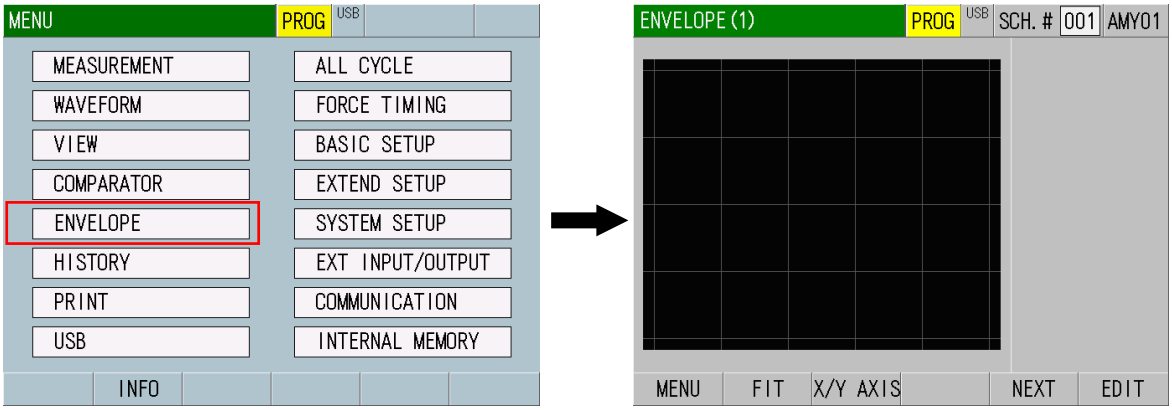
① is generally used, but ② is effective in the line where high dispersion exists in measured values.

① How to create the upper/lower limit threshold based on the measured waveform

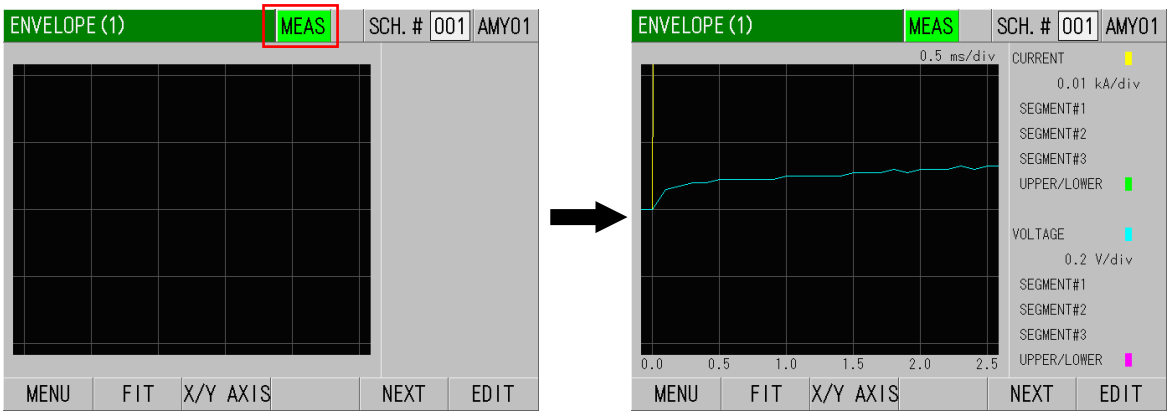
1) When the power is turned on, the MEASUREMENT screen appears. Touch MEAS to change it to PROG.



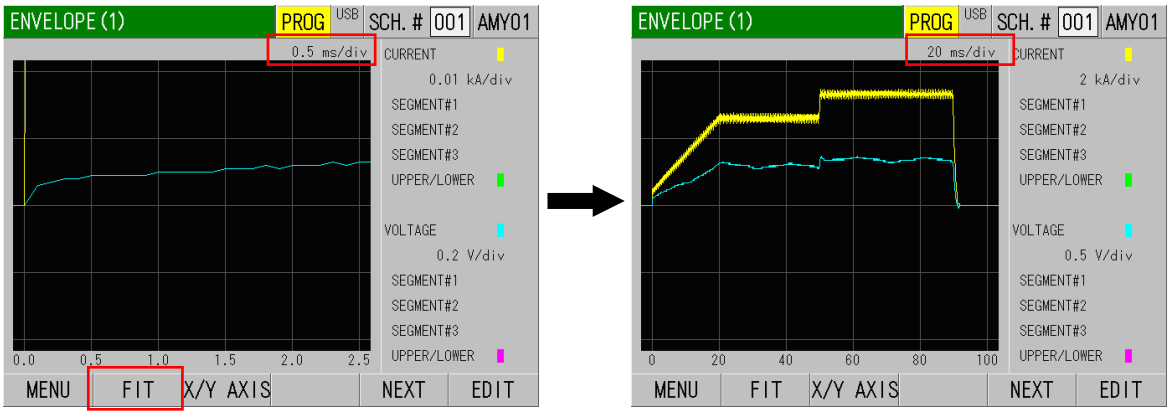
2) Touch the MENU key and select ENVELOPE on the MENU screen.



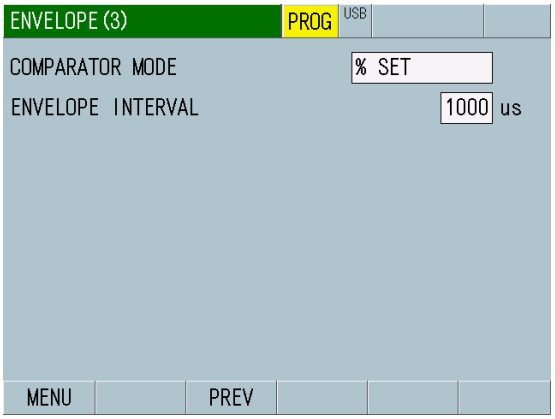
3) Touch PROG to change it to MEAS on the ENVELOPE (1) screen to measure an actual welding waveform.



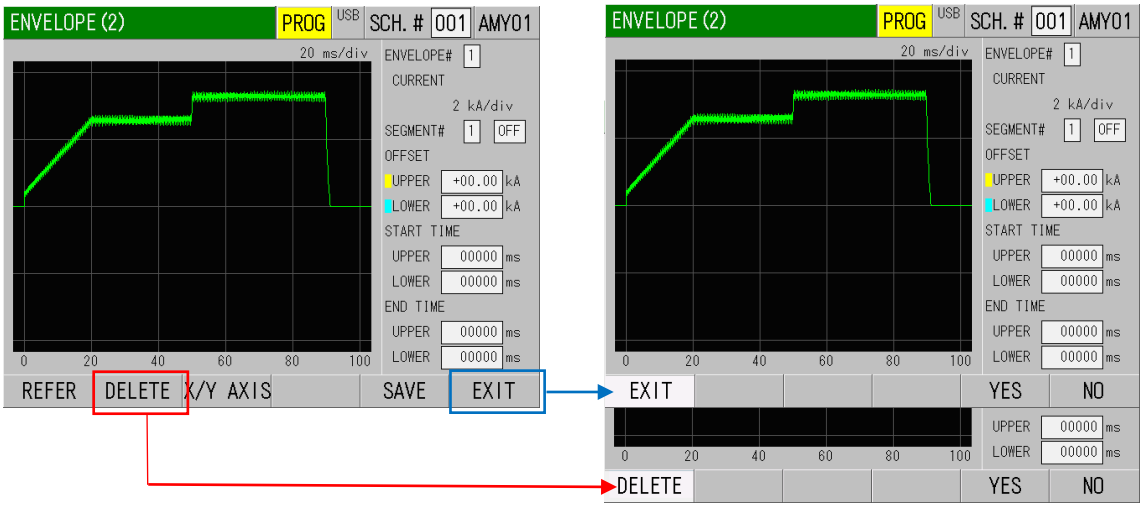
4) Change MEAS to PROG.
When the waveform does not fit in screen size, touch the FIT key. Perform welding actually and measure a median waveform of a good range. (When the power supply is turned on and after the setting item is changed, XY-axis range becomes the initial value.)



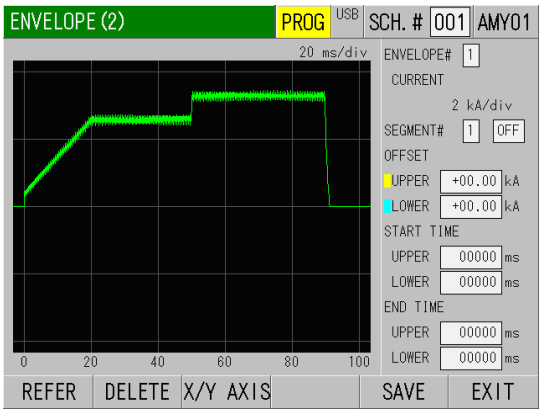
5) Touch the NEXT key to display the ENVELOPE (3) screen. On this screen, select % SET or VALUE SET for COMPARATOR MODE and set ENVELOPE INTERNAL. Touch the PREV key to return to the ENVELOPE (1) screen.



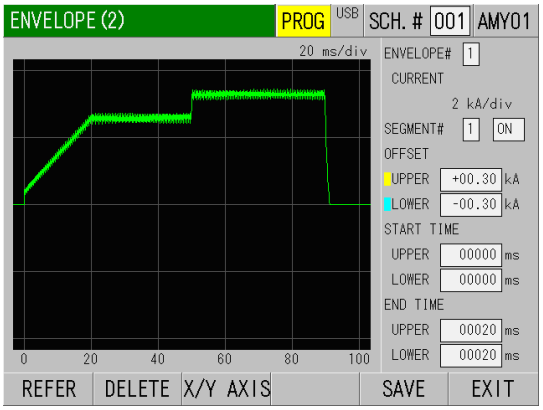
6) Touch the EDIT key to display the ENVELOPE (2) screen.
When the previous envelope data is still displayed, touch DELETE key and touch YES. To modify the envelope setting, touch NO to return. To return to the ENVELOPE (1) screen, touch the EXIT key and select YES.



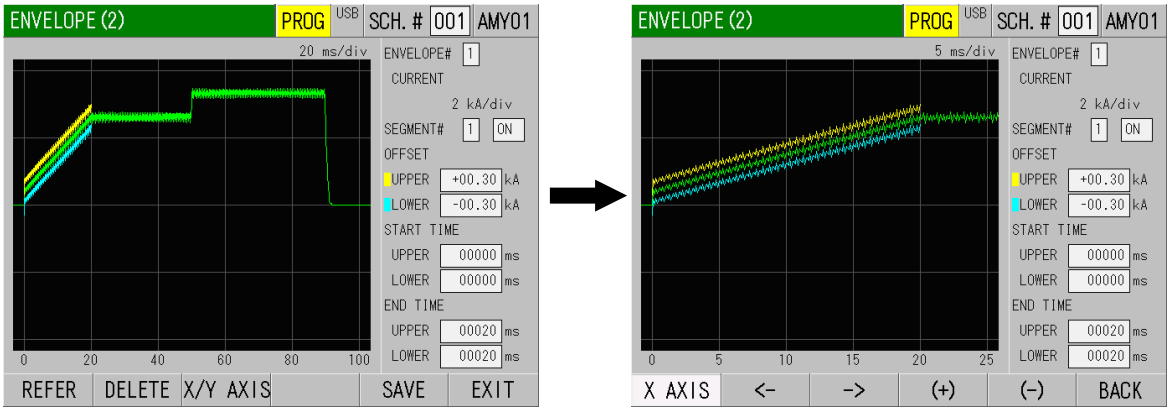
7) Touch the REFER key to take in the reference waveform. The waveform measured in 3) is displayed. Based on this waveform, set the time range for upper and lower limits.



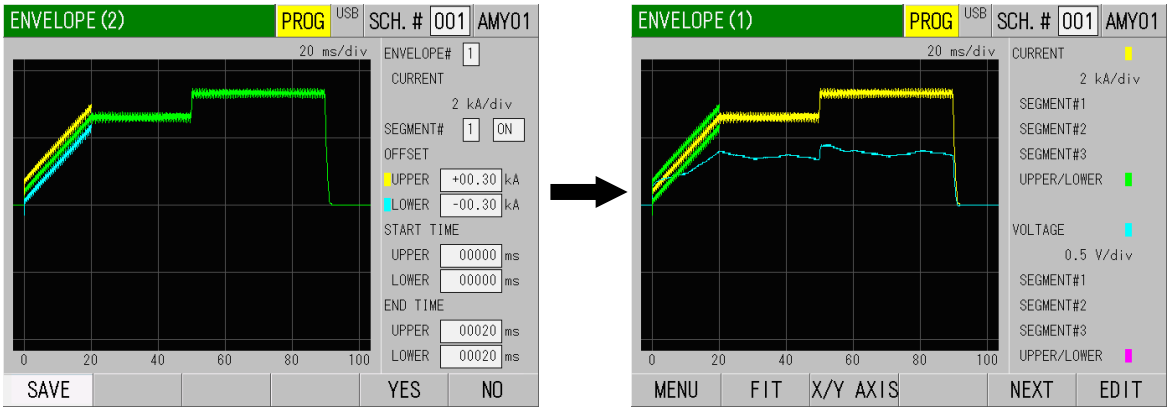
8) Select 1 for ENVELOPE#, select 1 for SEGMENT#, and change OFF to ON. Set upper and lower limit values in UPPER and LOWER of OFFSET. As the time range to judge the upper and lower limit, set from START TIME to END TIME. The time range can be set for UPPER and LOWER respectively.



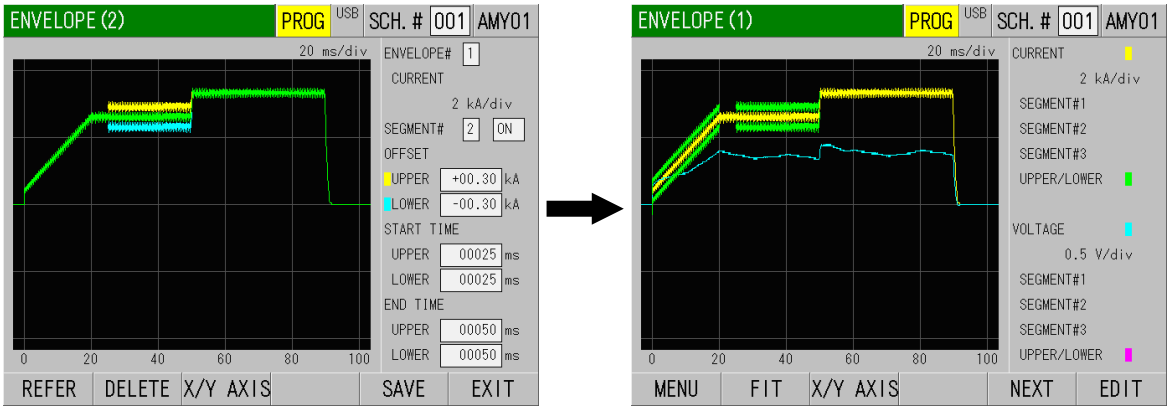
9) Touching the REFER key and selecting YES displays reference waveform and envelope setting. You can also check the detailed data of time axis and vertical axis by touching the X/Y AXIS key. After check, touch the BACK key and return till the REFER key is shown.



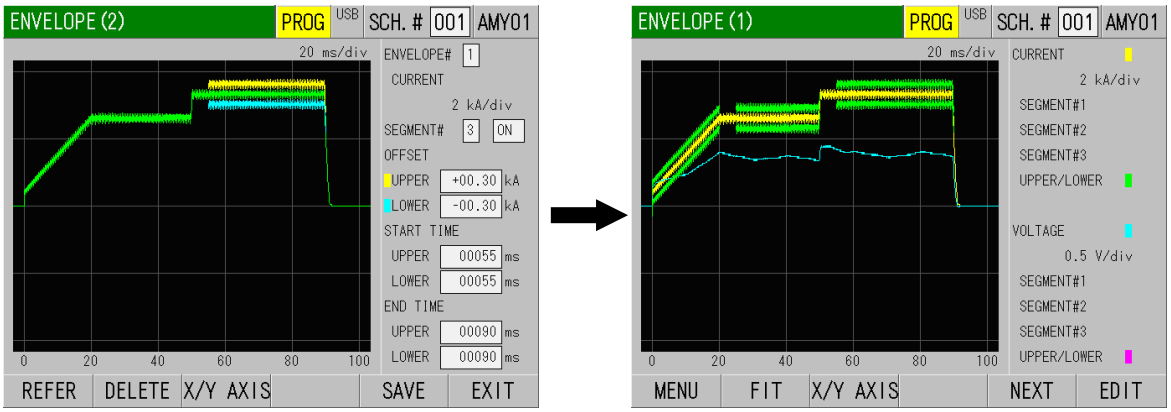
10) Save setting conditions by touching SAVE key. When saved, “SCH” is shown in orange and return to the ENVELOPE (1) screen.



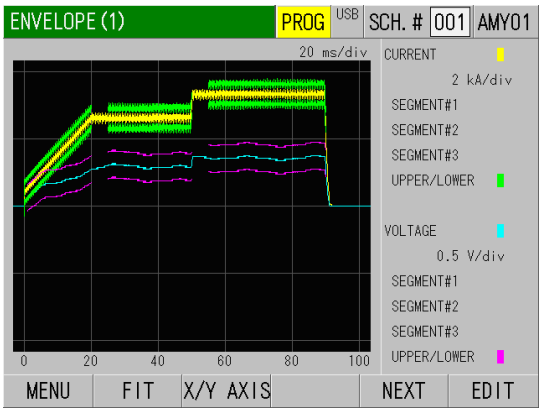
11) Touch the EDIT key again, select 2 for SEGMENT#, and change OFF to ON. Perform steps 6) to 10). Be sure to perform from REFERENCE to SAVE for each setting of SEGMENT.



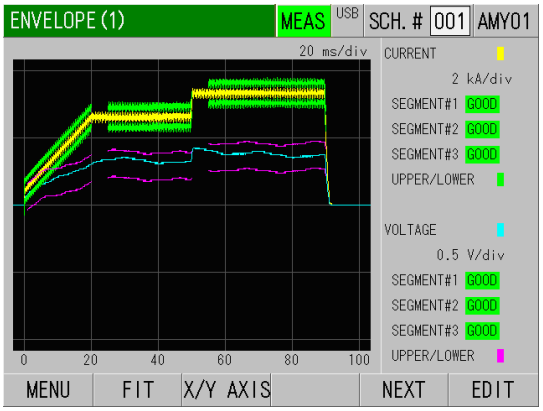
12) Touch the EDIT key again, select 3 for SEGMENT#, and change OFF to ON. Perform steps 6) to 10). Be sure to perform from REFERENCE to SAVE for each setting of SEGMENT.



13) Similarly, select 2 for ENVELOPE# for WAVEFORM 2 and perform settings of SEGMENT#1 to 3. Be sure to perform from REFERENCE to SAVE for each setting of SEGMENT.



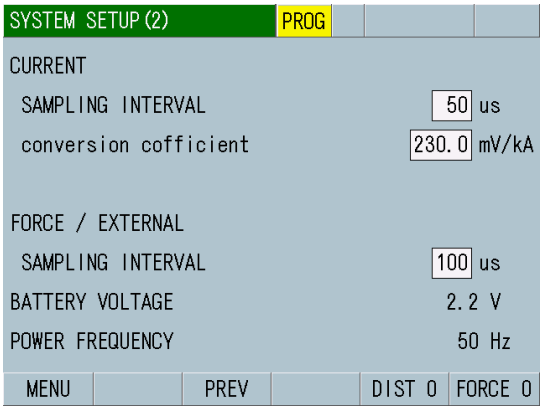
14) The envelope setting is complete.
Make measurements on the ENVELOPE (1) screen and check the setting contents by waveforms.

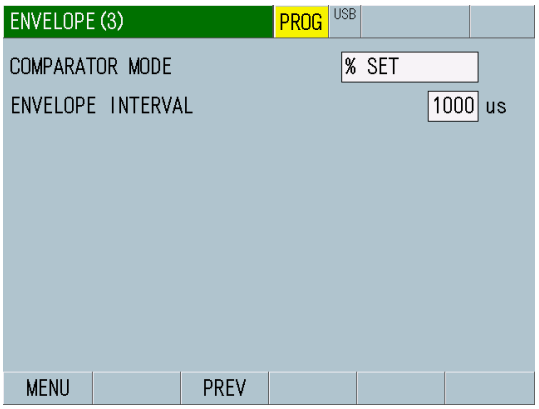


② How to create the upper/lower limit threshold based on the optionally created waveform

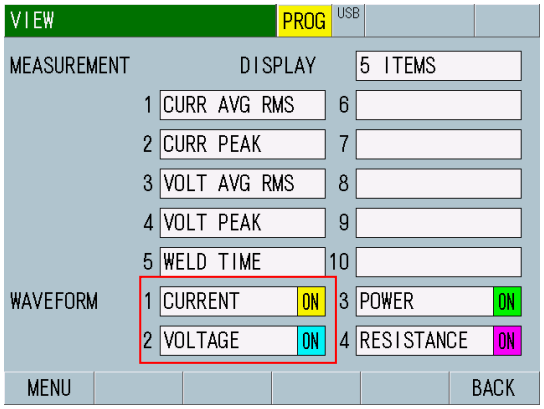
Save the measured waveform data in the USB memory, perform statistical processing on the customer's side, and create the upper/lower limit threshold. Make the **MM-400A** read it in the CSV format again and make an envelope measurement.

1) Set SAMPLING INTERVAL in the SYSTEM SETUP (2) screen and ENVELOPE INTERVAL in the ENVELOPE (3) screen. There is a limit for the envelope measurement. The maximum is 5000 in upper limit and lower limit in each SEGMENT, respectively. Be careful of settings of ENVELOPE INTERVAL and time between START TIME and END TIME in each SEGMENT. (Refer to "f-2. ENVELOPE (2) Screen (Note)".)



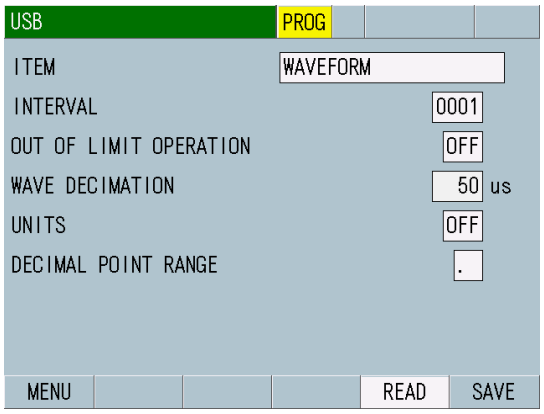


2) Select items to perform envelope upper/lower limit threshold judgment in WAVEFORM 1 and 2 in the VIEW screen and measure them. (Waveforms for reference are obtained.)



3) Insert the USB into the **MM-400A** and select WAVEFORM for ITEM in the USB screen. Set the interval to sample from waveform data in WAVE DECIMATION, and then touch the SAVE key. "¥wav" folder is created in the USB and the waveform's CSV file (any of "wav-0.csv" to "wav-1000.csv") is created in the folder. Confirm that sampled interval time is input in column A and WAVEFORM 1 to 4 data of each sampled interval are input in columns B to E. Item names of waveform in the CSV are as follows.

C: CURRENT, V: VOLTAGE, P: POWER, R: RESIST, D: DISPLACEMENT, F: FORCE, and E: EXTERNAL



	A	B	C	D	E
1	TIME	C	V	P	R
2	0	0	0	0	0
3	0.05	0.329	0.2	0.07	0.61
4	0.1	0.227	0.18	0.04	0.79
5	0.15	0.138	0.12	0.02	0.87
6	0.2	0.061	0.05	0	0.82
7	0.25	0.005	-0.01	0	2
8	0.3	0	-0.05	0	0
9	0.35	0	-0.07	0	0
10	0.4	-0.001	-0.08	0	80
11	0.45	0.018	-0.06	0	3.33
12	0.5	0.681	0.19	0.13	0.28
13	0.55	1.376	0.58	0.8	0.42
14	0.6	1.301	0.77	1	0.59
15	0.65	1.11	0.76	0.84	0.68
16	0.7	0.942	0.64	0.6	0.68
17	0.75	0.795	0.48	0.38	0.6
18	0.8	0.663	0.3	0.2	0.45
19	⋮	⋮	⋮	⋮	⋮

4) Among columns B to E, B: WAVEFORM 1 and C: WAVEFORM 2 are data for envelope judgment. Since D: WAVEFORM 3 and E: WAVEFORM 4 are not used, delete them. Perform statistical processing for waveform data obtained in each measurement and create the reference data.

Data 1

	A	B	C
1	TIME	C	V
2	0	0.01	0.01
3	0.05	0.339	0.21
4	0.1	0.237	0.19
5	0.15	0.148	0.13
6	0.2	0.071	0.06
7	0.25	0.015	0
8	0.3	0.01	-0.04
9	0.35	0.01	-0.06
10	0.4	0.009	-0.07
11	0.45	0.028	-0.05
12	0.5	0.691	0.2
13	0.55	1.386	0.59
14	0.6	1.311	0.78
15	0.65	1.12	0.77
16	0.7	0.952	0.65
17	0.75	0.805	0.49
18	0.8	0.673	0.31
19	⋮	⋮	⋮

Data 2

	A	B	C
1	TIME	C	V
2	0	0.03	0.03
3	0.05	0.359	0.23
4	0.1	0.257	0.21
5	0.15	0.168	0.15
6	0.2	0.091	0.08
7	0.25	0.035	0.02
8	0.3	0.03	-0.02
9	0.35	0.03	-0.04
10	0.4	0.029	-0.05
11	0.45	0.048	-0.03
12	0.5	0.711	0.22
13	0.55	1.406	0.61
14	0.6	1.331	0.8
15	0.65	1.14	0.79
16	0.7	0.972	0.67
17	0.75	0.825	0.51
18	0.8	0.693	0.33
19	⋮	⋮	⋮

...

Statistically processed data

	A	B	C
1	TIME	C	V
2	0	0.02	0.02
3	0.05	0.349	0.22
4	0.1	0.247	0.2
5	0.15	0.158	0.14
6	0.2	0.081	0.07
7	0.25	0.025	0.01
8	0.3	0.02	-0.03
9	0.35	0.02	-0.05
10	0.4	0.019	-0.06
11	0.45	0.038	-0.04
12	0.5	0.701	0.21
13	0.55	1.396	0.6
14	0.6	1.321	0.79
15	0.65	1.13	0.78
16	0.7	0.962	0.66
17	0.75	0.815	0.5
18	0.8	0.683	0.32
19	⋮	⋮	⋮

(Note) When saving the calculated value in CSV data, save a decimal point with a correct digit number.

5) When creating upper/lower limit thresholds of two waveforms based on the created reference waveform data, create two CSV files for each waveform. Create data as follows:

① Data array (entire arrangement)

	A	B
1	H	SEG1
2	E	
3	L	
4	E	
5	H	SEG2
6	E	
7	L	
8	E	
9	H	SEG3
10	E	
11	L	
12	E	
13		

SEGMENT1

SEGMENT2

SEGMENT3

Characters in Column A
H: Start position of upper limit
E: End position of upper limit
L: Start position of lower limit
E: End position of lower limit

Characters in Column B
SEG1: SEGMENT#1 start
SEG2: SEGMENT#2 start
SEG3: SEGMENT#3 start

When the ENVELOPE is selected for ITEM and touch the SAVE key without the envelope setting, the above data is created.

The order is the upper limit of SEGMENT#1, the lower limit of SEGMENT#1, the upper limit of SEGMENT#2, the lower limit of SEGMENT#2, the upper limit of SEGMENT#3, and the lower limit of SEGMENT#3.

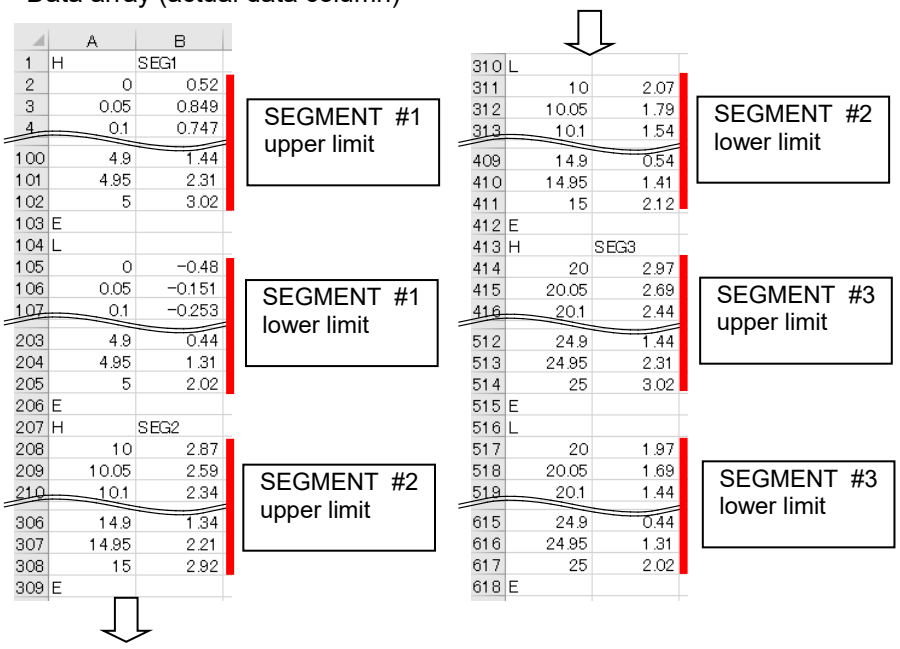
② Data array (time and waveform data)

	A	B
1	H	SEG1
2	0	0.52
3	0.05	0.849
4	0.1	0.747
5	0.15	0.646
99	4.85	1.32
100	4.9	1.44
101	4.95	2.31
102	5	3.02
103	E	

Time interval

Waveform data

③ Data array (actual data column)



Delete “TIME” at the beginning and each item name, and input sampled interval time in column A and WAVEFORM 1 or 2 data in column B. Do not input anything in other columns.

- Insert the upper limit threshold waveform between "H-E", and the lower limit threshold waveform between "L-E." Input "H" at the beginning of upper limit of SEGMENT, "E" at the end of upper limit, "L" at the beginning of lower limit, and "E" at the end of lower limit. (Do not delete characters "H", "L", "E", "SEG1", "SEG2", and "SEG3.")
- Make the time interval the same as ENVELOPE INTERVAL in the ENVELOPE (3) screen.
- Create the envelope data in the order of the upper limit of SEGMENT#1, the lower limit of SEGMENT#1, the upper limit of SEGMENT#2, the lower limit of SEGMENT#2, the upper limit of SEGMENT#3, the lower limit of SEGMENT#3.
- Set both upper limit value and lower limit value for SEGMENT.
- For unused SEGMENT, input "H" and "E" for upper limit, and "L" and "E" for lower limit.
- Make sure that the number of data does not exceed 5000 in upper limit and lower limit in each SEGMENT, respectively.

④ Name of folder and CSV file in the USB

Create a folder named ¥env_set in the USB to save data.

The name of CSV file saved in the folder is as shown below. Upper/lower limit threshold data of WAVEFORM 1 and 2 becomes ENVELOPE# 1 and 2, respectively.

Saved filename: Env01_1_C.csv

a b c

a: Schedule number (01 to 20)
b: ENVELOPE# (1 to 2)
c: Waveform type (C: CURRENT, V: VOLTAGE, P: POWER, R: RESIST, D: DISPLACEMENT, F: FORCE, and E: EXTERNAL)

- For schedule number, use two-digit 01 to 20 for filename.

- Make the waveform type the same as that in the WAVEFORM screen and the ENVELOPE screen.

6) Insert the USB which contains data in the **MM-400A** and select ENVELOPE for ITEM in the USB screen. Select a file by setting SCHEDULE# (1 to 20) and ENVELOPE# (1 to 2) and touch the READ key.

In the following example, insert the USB which contains CSV data (Env01_1_C.csv, Env01_2_V.csv) created in advance into the **MM-400A**, set SCHEDULE# to “01” and ENVELOPE# to “1”, and touch the READ key.

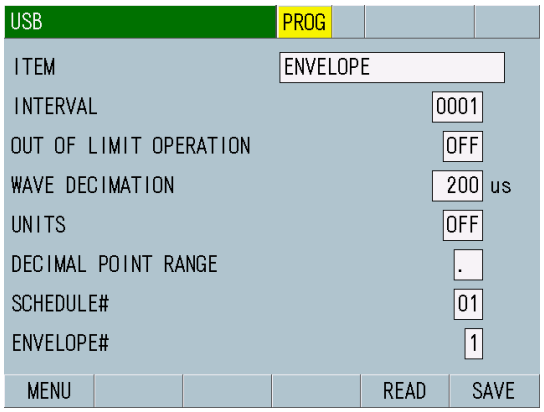
After the completion of reading, change ENVELOPE# to “2” and touch the READ key again.

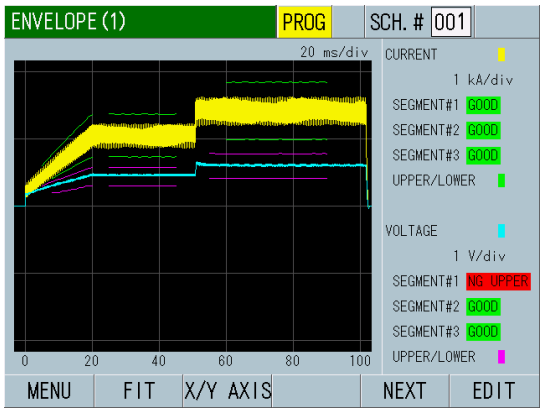
When moving to the ENVELOPE (1) screen after the completion of reading and performing measurement, the upper/lower limit threshold data read from the USB, measured waveform, and envelope judgment result are displayed.

When the specified folder or CSV file does not exist in the USB or the envelope data to be read is not as specified, “E14: USB ERROR” occurs.

Since the envelope data is not reflected in the settings of OFFSET, START TIME and END TIME in the ENVELOPE (2) screen when read from the USB, it may be different from the set contents.

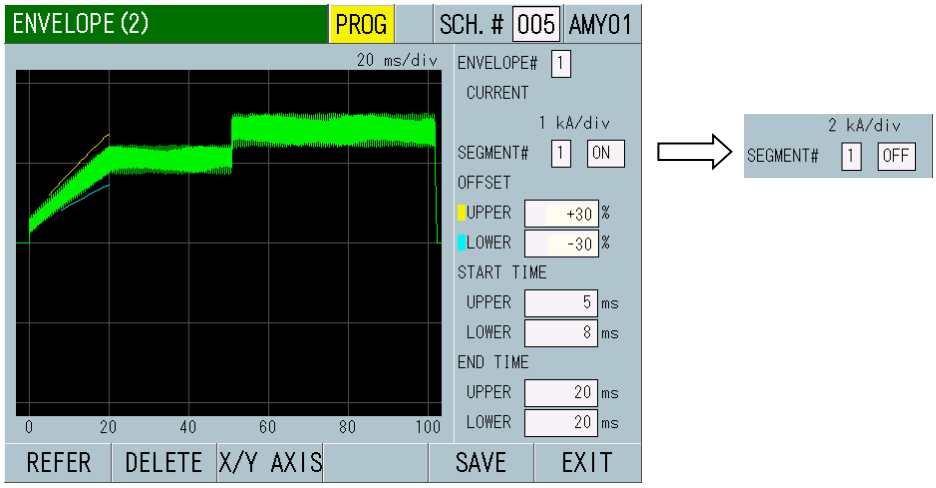
When reading the envelope data from the USB (READ key) or writing the envelope data in the USB (SAVE key), select OFF for UNITS. When saved with ON, the envelope data is recognized as character string and cannot be edited as a numerical value.





(Caution) Cautions for envelope function setting

[When any of the following operations is performed after setting the envelope threshold, the envelope function is forcedly turned off, threshold data is deleted, and the envelope judgment is not performed.]



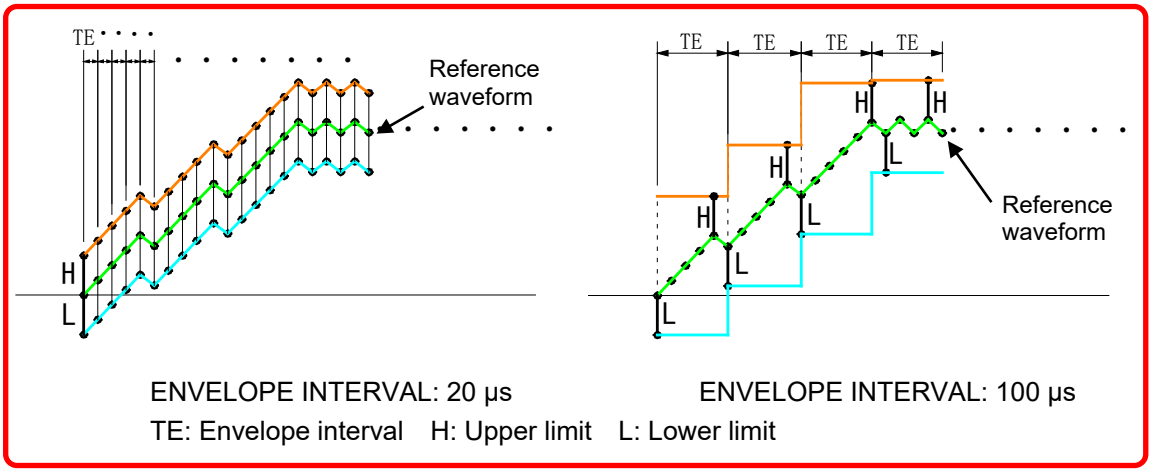
- When items of WAVEFORM 1 and 2 are changed in the VIEW screen
- When the digit number of the decimal point changes by changing range (current / voltage / displacement / force / external)
- When the unit of displacement / force / external is changed
- When SAMPLING INTERVAL is changed

[Upper/lower limit threshold by difference sampling/envelope intervals with the measured waveform as a reference]

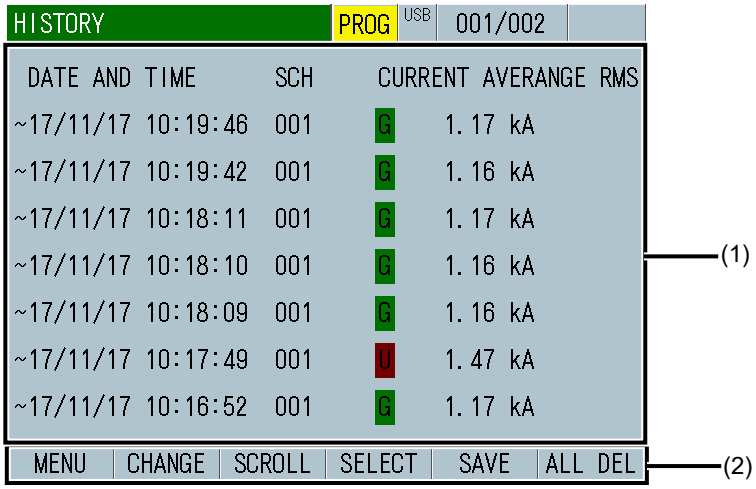
In ENVELOPE INTERVAL, the value above the maximum sampling value becomes the upper limit level, and the value below the minimum sampling value becomes the lower limit level.

In the following example, VALUE SET is selected for COMPARATOR MODE. In case of % SET, the upper limit/lower limit value becomes higher as waveform becomes bigger.

(Example) Difference between upper/lower limit thresholds with “SAMPLING INTERVAL 20 µs and ENVELOPE INTERVAL 20 µs” and “SAMPLING INTERVAL 20 µs and ENVELOPE INTERVAL 100 µs”



g. HISTORY Screen



(1) History display

The HISTORY screen shows a list of measured values (presence/absence of waveforms, date, time, schedule No., judgment result, and measured value) obtained until now. This screen allows you to load past measured values and save new ones to the built-in flash memory.

"~" on the left side of the screen indicates the save state of waveforms. When you load the history of the item with "~", waveforms can be displayed on the WAVEFORM screen.

The **MM-400A** has three types of built-in memory.

- Built-in memory 1: The backup power supply holds data when the power is turned off.
- Built-in memory 2: When the power supply is turned off without performing backup, data is cleared.
- Built-in flash memory: Holds data even when the power is turned off. It has a write limit (100,000).

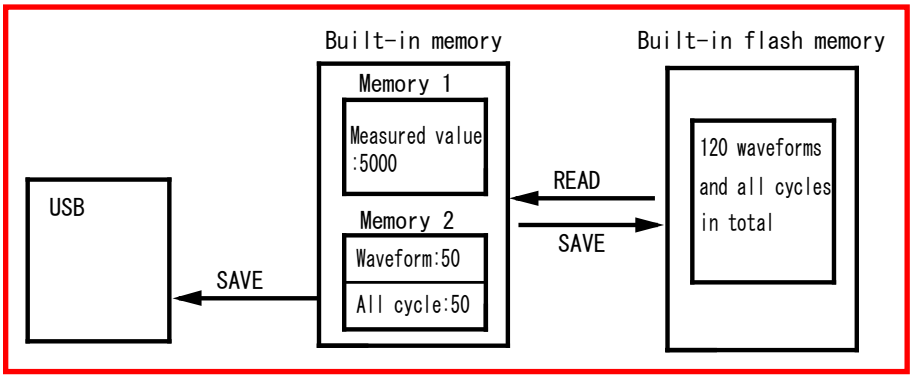
The measured value (10 selected items in the VIEW screen) data uses the built-in memory 1. The number of storable pieces of data is 5,000 and older data is deleted as it exceeds 5,000 and overwrites new data. Data is held even when the power is turned off.

All cycles and waveforms (4 selected waveforms in the VIEW screen) uses the built-in memory 2. The maximum number of storable pieces of data is **50** for all cycles and waveforms **respectively**. (The number of storable pieces of data varies depending on the waveform measurement time. 50 is just a guide.) Older data is deleted as the number of pieces of data is exceeded and overwrites new data. When the power supply is turned off, data is cleared.

For measured value, all cycles and waveforms, older data is deleted as the number of pieces of data is exceeded. Take out data via USB or communication accordingly.

The built-in flash memory (internal memory) can be used as backup of the built-in memory. (Refer to “q. INTERNAL MEMORY Screen.”) The standard number of storable pieces of data is **120** for all cycles and waveforms **in total**. (The number of storable pieces of data varies depending on the waveform measurement time. 120 is just a guide.) An error message “E15: INTERNAL MEMORY ERROR” appears if the write limit is exceeded. If an error occurs, save the internal memory data into the USB, and then touch ALL DEL key on the READ FLASH MEMORY screen to clear the built-in flash memory data. Even if you save data in a state that an error is occurring, new data is not written. Data is held even when the power is turned off.

When reading the built-in flash memory (internal memory), the history of measured value, waveforms and all cycles is deleted. Take out data via USB or communication accordingly before reading.



(2) Function keys

MENU: Touching this displays the MENU screen.

CHANGE: Touching this displays the arrow key (← →). Touching the arrow key switches between measured values of ten measurement items.

SCROLL: Touching this displays the arrow key (↑↓). Touching the arrow key moves a page of the screen.

SELECT: First select an item to load, and then touch this.

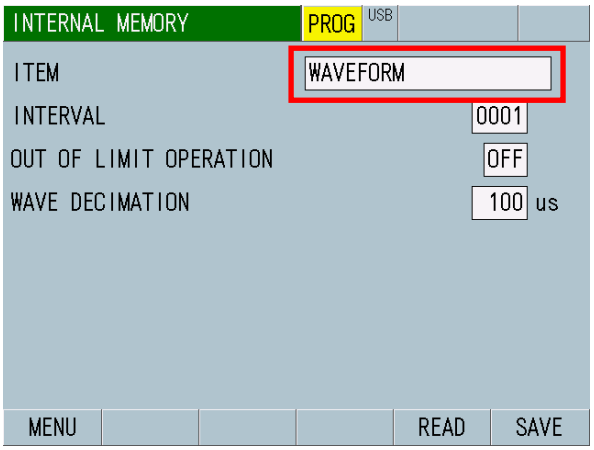
SAVE: Directly touching the displayed history displays a line-based cursor. In this condition, touch the SAVE key in the built-in flash memory to save current, force all cycle or waveform in the built-in flash memory. However, you need to select an item to save in the INTERNAL MEMORY screen in advance. Touching SELECT again deselects measured values.

ALL DEL: Clears all history data from the built-in flash memory.

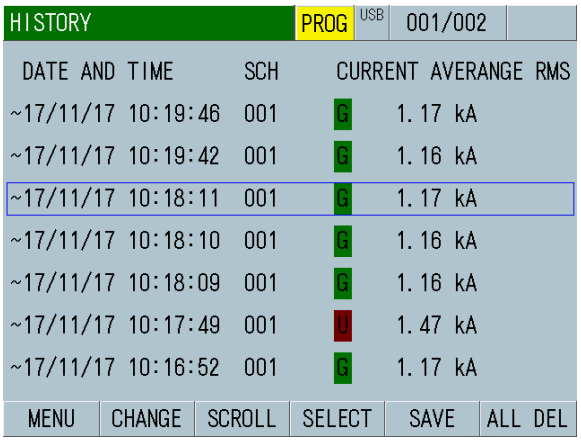
[How to load data saved earlier than data in the HISTORY screen (waveform, all cycle)]

1) Select an item (WAVEFORM, CURRENT ALL CYCLE and FORCE ALL CYCLE) to load in the INTERNAL MEMORY screen in advance.

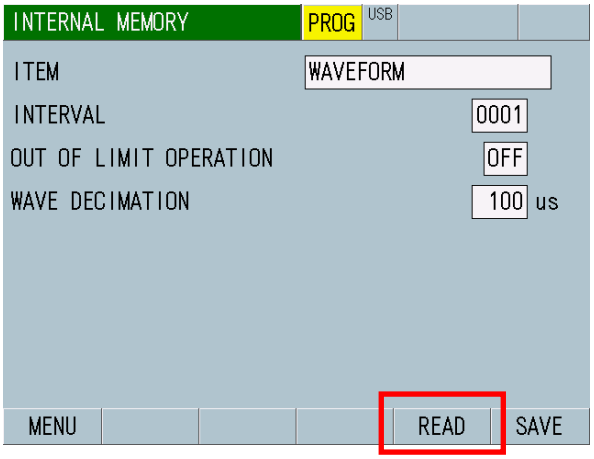
(Note) WAVEFORM, CURRENT ALL CYCLE and FORCE ALL CYCLE cannot be loaded simultaneously from a history data.



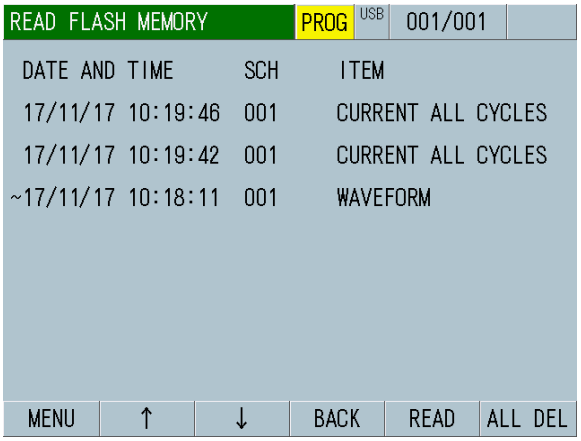
2) Select one to load among data with "~" on the left side of the HISTORY screen. The selected data is surrounded with a blue frame. Touch the SAVE key to save it in the internal memory.



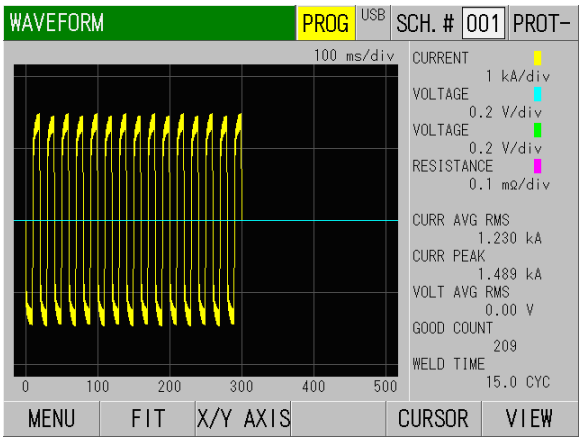
3) Move to the INTERNAL MEMORY screen and touch the READ key, the READ FLASH MEMORY screen (saved data list) is displayed.
Return to 2) to load other history data or return to 1) to change the item and set WAVEFORM, CURRENT ALL CYCLE or FORCE ALL CYCLE again.



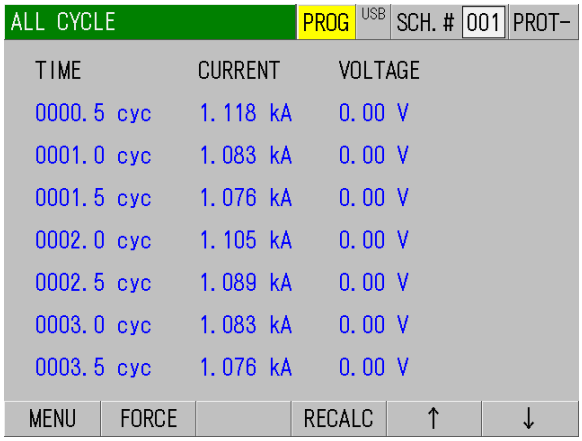
4) Select data by touching directly on the list and touch the READ key. Once the READ key is touched, other history data are all deleted.



5) Move to the screen of the loaded item (WAVEFORM or ALL CYCLE screen) to check data.



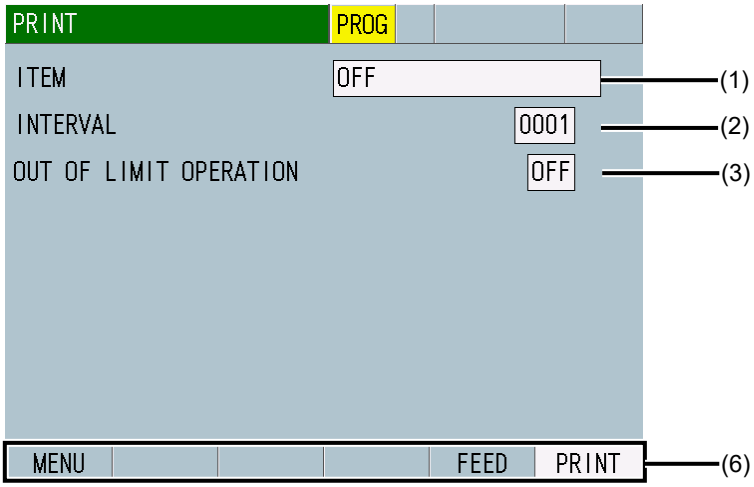
Waveform data loaded by 17/11/17 10:18:11



All cycle data loaded by 17/11/17 10:18:11

(Caution) Items to load cannot be checked simultaneously. For example, even when you move to the ALL CYCLE screen after loading the waveform, data is not shown. Select CURRENT or FORCE ALL CYCLE in step 1) again and perform steps 2) to 5).

h. PRINT Screen

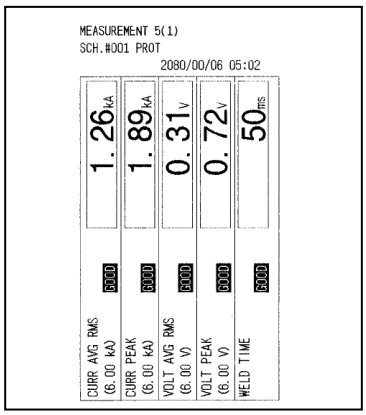


(1) ITEM

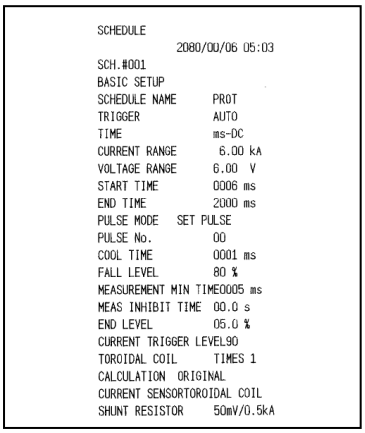
Select an item to print from the following:

- OFF
  No printing
- MEASUREMENT
  Prints the measured values of ten items selected in the VIEW screen. Prints after the end of measurement or when PRINT is touched. Print timing changes depending on the Print Interval and Error Print conditions.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no printing is made.
- WAVEFORM
  Prints the waveforms of four items selected in the VIEW screen. The vertical and horizontal scales applied to the printed waveforms are those set in the WAVEFORM screen. You can select the waveforms to print with waveform ON/OFF in the VIEW screen. Prints after the end of measurement or when PRINT is touched. Print timing changes depending on the Print Interval and Error Print conditions.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no printing is made.
- CURR ALL CYCLE
  Prints current all cycles. Prints after the end of measurement or when PRINT is touched. Print timing changes depending on the Print Interval and Error Print conditions.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen or ISO17657 is selected for CALCULATION in the BASIC SETUP (3) screen, no printing is made.
- FORCE ALL CYCLE
  Prints force all cycles. Available only for the force/displacement-equipped specification. Prints after the end of measurement or when PRINT is touched. Print timing changes depending on the Print Interval and Error Print conditions.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no printing is made.
- HISTORY
  Prints history selected in HISTORY AREA (20**/**/** to 20**/**/**) among measured values saved in the HISTORY screen. To print, first select this item, and then touch PRINT.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no printing is made.

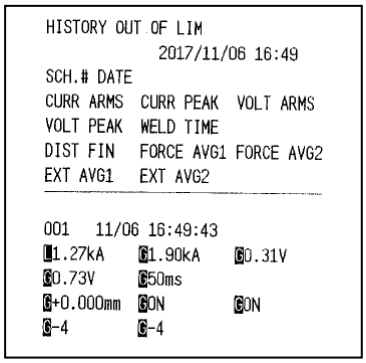
- HISTORY OUT OF LIM
  Prints history selected in HISTORY AREA (20**/**/** to 20**/**/**) among measured values with Upper limit error, Lower limit error, Overrange error, Impulse error, or Parity error saved in the HISTORY screen. To print, first select this item and touch PRINT.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no printing is made.
- SCHEDULE
  Prints schedule data whose range is set in SCHEDULE AREA. To print, first select this item, and then touch PRINT.
- DISPLAY
  Prints screen image prior to the PRINT screen. To print, first display the screen to print. Then, return to the PRINT screen by MENU and touch PRINT.



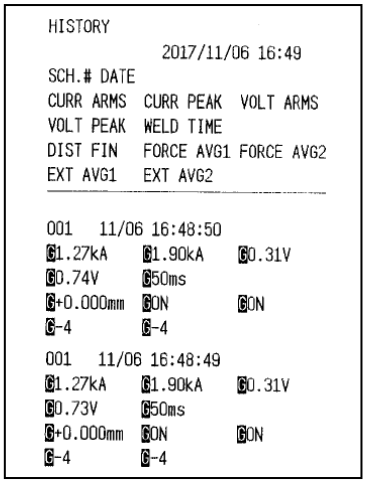
Print example of DISPLAY



Print example of SCHEDULE



Print example of
HISTORY OUT OF LIM



Print example of HISTORY

(2) INTERVAL (*)

You can set a print interval (1 to 1,000). Prints irrespective of a print interval in the event of Upper limit error, Lower limit error (excluding Upper/lower limit error at envelope), Overrange error, Impulse error, or Parity error. The setting of print interval is valid only when MEASUREMENT, WAVEFORM, CURR ALL CYCLE, or FORCE ALL CYCLE is selected for ITEM. When OUT OF LIMIT OPERATION is set to ON, a print interval does not work.

(*) About interval

The interval corresponds to the number of weldings. Since it depends on the number from the last print, the number of prints changes depending on the OUT OF LIMIT OPERATION setting.

INTERVAL setting		1	1	3	3
OUT OF LIMIT OPERATION setting		ON	OFF	ON	OFF
1st welding	OK	-	Print	-	-
2nd welding	OK	-	Print	-	-
3rd welding	OK	-	Print	Print	Print
4th welding	OK	-	Print	-	-
5th welding	NG	Print	Print	Print	-
6th welding	OK	-	Print	-	Print
7th welding	OK	-	Print	-	-
8th welding	OK	-	Print	Print	-

(3) OUT OF LIMIT OPERATION

Select ON/OFF to specify whether to print only in the event of Upper limit error, Lower limit error (excluding Upper/lower limit error at envelope), Overrange error, Impulse error, or Parity error.

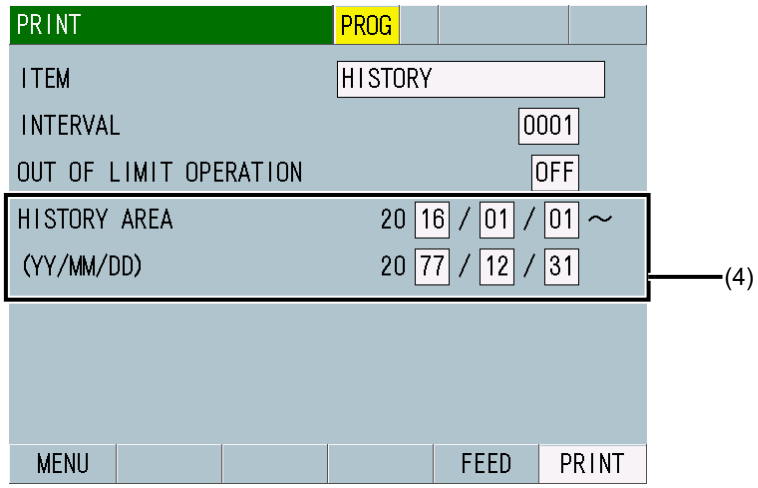
ON: Prints in the event of an error.
OFF: Prints irrespective of errors.

Prints at intervals set for INTERVAL when normal. Prints at the time of an error occurrence when abnormal. The setting of error print is valid only when MEASUREMENT, WAVEFORM, CURR ALL CYCLE, or FORCE ALL CYCLE is selected for ITEM.

(4) HISTORY AREA

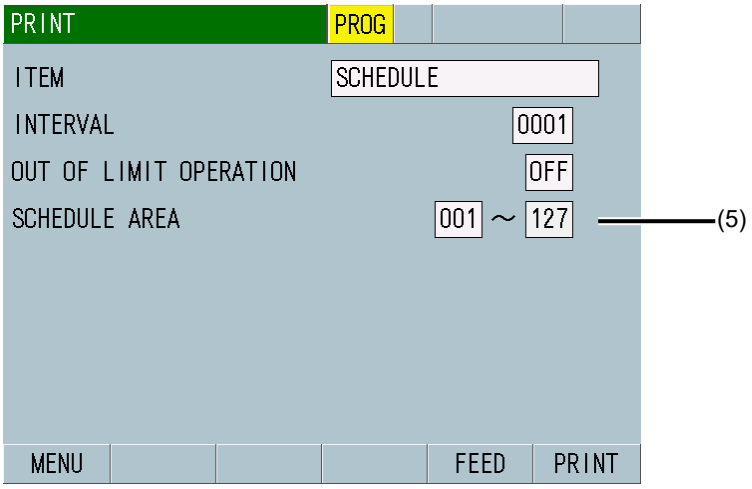
Shown when you have selected HISTORY or HISTORY OUT OF LIM for ITEM. Set a print range with year, month and day.

(Note) The start date should be before the end date.



(5) SCHEDULE AREA

Shown when you have selected SCHEDULE for ITEM. Set the range of schedule numbers to print schedule data from 001 to 127. The setting of schedule data range is valid only when schedule data is printed.



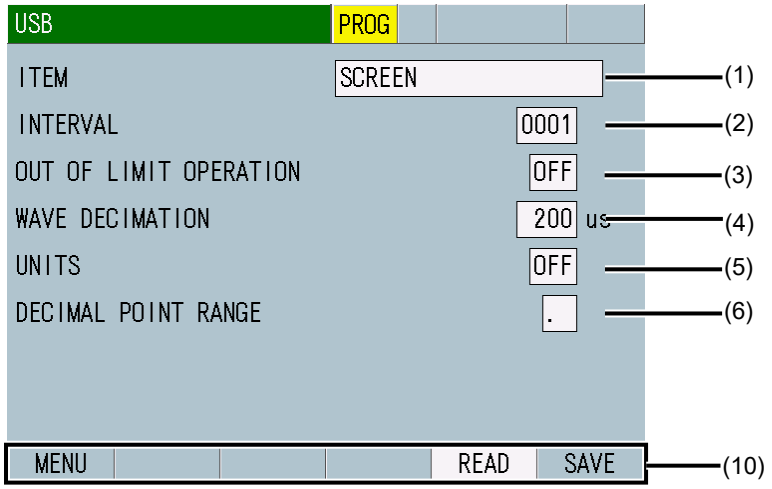
(6) Function keys

MENU: Touching this displays the MENU screen.

FEED: Touching this feeds paper.

PRINT: Touching this prints the item selected for ITEM. To pause printing, press the [RESET] button. Printing will stop after the data stored in the printer is printed.

i. USB Screen



(1) ITEM

Select the data to read from or write in the USB memory from the following:

- OFF
  No writing and reading in/from the USB memory.
- MEASUREMENT
  Writes the measured values of ten items selected in the VIEW screen in the USB memory.
  The filenames are “measure-0.CSV” to “measure-1000.CSV.” After 1000, the filename returns to 0. The file is overwritten. A thousand of measured values are written in a file.
  In saving by the SAVE key, a measured value is written and “¥measure” folder is created.
  In automatic saving for every interval, up to 1000 measured values are written in a file and “¥measure_in_meas” folder is created.
  When **MM-400A** is powered off, USB memory is removed, or “E14: USB ERROR” occurs, the measured value is written with a new filename.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no writing in the USB memory is made.
- WAVEFORM
  Writes the waveforms of four items selected in the VIEW screen in the USB memory.
  The filenames are “wav-0.csv” to “wav-1000.csv.” After 1000, the filename returns to 0. The file is overwritten.
  “¥wav” folder is created by the SAVE key and “¥wav_in_meas” folder is created by automatic saving for every interval.
  Waveforms are not saved in the seam measurement.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no writing in the USB memory is made.
- CURR ALL CYCLE
  Writes current all cycles in the USB memory.
  The filenames are “curr_allcycle-0.csv” to “curr_allcycle-1000.csv.” After 1000, the filename returns to 0. The file is overwritten.
  “¥curr_allcycle” folder is created by the SAVE key and “¥cur_allcycle_in_meas” folder is created by automatic saving for every interval.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen or ISO17657 is selected for CALCULATION in the BASIC SETUP (3) screen, no writing in the USB memory is made.

- FORCE ALL CYCLE
  Writes force all cycles in the USB memory. Available only for the force/displacement-equipped specification.
  The filenames are “force_allcycle-0.csv” to “force_allcycle-1000.csv.” After 1000, the filename returns to 0. The file is overwritten.
  “¥force_allcycle” folder is created by the SAVE key and “¥force_allcycle_in_meas” folder is created by automatic saving for every interval.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no writing in the USB memory is made.
- HISTORY
  Writes history selected in HISTORY AREA (20**/**/** to 20**/**/**) among measured values saved in the HISTORY screen in the USB memory. To save, first select this item, and then touch SAVE.
  The filenames are “hist_measure-0.csv” to “hist_measure-1000.csv.” After 1000, the filename returns to 0. The file is overwritten. “¥hist_measure” folder is created.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no writing in the USB memory is made.
- HISTORY OUT OF LIM
  Writes history selected in HISTORY AREA (20**/**/** to 20**/**/**) among measured values with Upper limit error, Lower limit error, Overrange error, Impulse error, or Parity error saved in the HISTORY screen in the USB memory. To save, first select this item and touch SAVE.
  The filenames are “hist_error-0.csv” to “hist_error-1000.csv.” After 1000, the filename returns to 0. The file is overwritten. “¥hist_error” folder is created.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no writing in the USB memory is made.
- SCHEDULE
  Writes/Reads the schedule data in/from the USB memory. At writing, the information selected among schedules 1 to 127 is written. At reading, only the selected schedule is read. Also, set the file number (01 to 10) to read from or write in the schedule data. The schedule data can be backed up and copied to other **MM-400A**.
  “¥sch_set” folder is created, and “¥FileNo_01” to “¥FileNo_10” folders are created in a lower hierarchy for each file number.

  (Note) Before reading the schedule data, change the decimal point setting to the same setting as that set when saved it. (Refer to “(6) DECIMAL POINT RANGE.”) When the decimal point has not been changed from the initial setting, it can be read with the present setting. The initial setting of decimal point is “.”.
- SCREEN
  Writes screen image prior to the USB screen in the USB memory. To write in the USB memory, first display the screen to write. Then, return to the USB screen by MENU and touch SAVE.
  The data format is BITMAP. The filenames are “screen_bmp-0.bmp” to “screen_bmp-1000.bmp.” After 1000, the filename returns to 0. The file is overwritten.
  “¥screen_bmp” folder is created.
- ENVELOPE
  Writes the envelope data from the USB memory or reads an optionally created envelope data from the USB memory. Create a folder named “¥env_set” in the USB memory and store the envelope data in the folder. The filename depends on schedule number, envelope number and waveform type, for example, “Env01_1_C.csv.” Refer to “f-4. How to set the envelope reference waveform and the determination range, ②.”
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no writing in the USB memory is made.

(2) INTERVAL (*)

You can set an interval (1 to 1,000) to save each measurement data automatically in the USB. Saves irrespective of a save interval in the event of Upper limit error, Lower limit error (excluding Upper/lower limit error at envelope), Overrange error, Impulse error, or Parity error. The setting of interval is valid only when MEASUREMENT, WAVEFORM, CURR ALL CYCLE, or FORCE ALL CYCLE is selected for ITEM. When OUT OF LIMIT OPERATION is set to ON, an interval does not work.

(*) About interval

The interval corresponds to the number of weldings. Since it depends on the number from the last save, the number of saves changes depending on the OUT OF LIMIT OPERATION setting.

INTERVAL setting		1	1	3	3
OUT OF LIMIT OPERATION setting		ON	OFF	ON	OFF
1st welding	OK	-	Save	-	-
2nd welding	OK	-	Save	-	-
3rd welding	OK	-	Save	Save	Save
4th welding	OK	-	Save	-	-
5th welding	NG	Save	Save	Save	-
6th welding	OK	-	Save	-	Save
7th welding	OK	-	Save	-	-
8th welding	OK	-	Save	Save	-

(3) OUT OF LIMIT OPERATION

Select ON/OFF to specify whether to save only in the event of Upper limit error, Lower limit error, Overrange error, Impulse error, or Parity error.

ON: Saves in the event of an error.
OFF: Saves irrespective of errors.

Saves at intervals set for INTERVAL when normal. Saves at the time of an error occurrence when abnormal. The setting of error save is valid only when MEASUREMENT, WAVEFORM, CURR ALL CYCLE, or FORCE ALL CYCLE is selected for ITEM.

(4) WAVE DECIMATION

Set a waveform decimation. You can select from among 20 us, 50 us, 100 us, 200 us, 500 us, and 1000 us. If you set a decimation smaller than the data sampling interval stored in the instrument, the data will be output at the internally stored interval. The setting of waveform decimation is valid only when WAVEFORM is selected for ITEM.

WAVE DECIMATION is reflected when the followings are satisfied.

<table>
<tr><th>CURRENT SAMPLING INTERVAL</th><th>FORCE SAMPLING INTERVAL</th><th>Current measure-ment</th><th>Displace-ment measure-ment</th><th>Force/ external measure-ment</th><th>TIME</th><th>WAVE DECIMATION</th></tr>
<tr><td>20us</td><td>100us
200us
500us</td><td rowspan="8">Yes</td><td>No</td><td rowspan="5">No</td><td>SHORT
ms-DC</td><td>20us, 100us, 200us, 500us, and 1000us are the same as setting. 50us becomes 20us.</td></tr>
<tr><td>20us*1</td><td rowspan="3">100us
200us
500us</td><td rowspan="6">Yes/No</td><td rowspan="6">All settings</td><td rowspan="2">50us, 100us, 200us, 500us, and 1000us are the same as setting. 20us becomes 50us.</td></tr>
<tr><td>50us</td></tr>
<tr><td>100us</td><td>100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.</td></tr>
<tr><td>200us*1</td><td>200us, 500us and 1000us are the same as setting. 20us, 50us and 100us become 200us.</td></tr>
<tr><td rowspan="3">20us*1
50us*1
100us</td><td>100us</td><td rowspan="3">No</td><td>100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.</td></tr>
<tr><td>200us</td><td>100us, 200us and 1000us are the same as setting. 20us, 50us and 500us become 100us.</td></tr>
<tr><td>500us</td><td>100us, 500us and 1000us are the same as setting. 20us, 50us and 200us become 100us.</td></tr>
</table>

CURRENT SAMPLING INTERVAL	FORCE SAMPLING INTERVAL	Current measure-ment	Displace-ment measure-ment	Force/ external measure-ment	TIME	WAVE DECIMATION
200us*1	100us*1	Yes	Yes/No	No	All settings	100us, 200us and 1000us are the same as setting. 20us, 50us and 500us become 100us.
	200us					
	500us					100us, 500us and 1000us are the same as setting. 20us, 50us and 200us become 100us.
20us*1 50us*1 100us	100us	No	No		-	100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.
	200us					200us and 1000us are the same as setting. 20us, 50us, 100us, and 500us become 200us.
	500us					500us and 1000us are the same as setting. 20us, 50us, 100us, and 200us become 500us.
200us*1	100us*1					200us and 1000us are the same as setting. 20us, 50us, 100us, and 500us become 200us.
	200us					
	500us					500us and 1000us are the same as setting. 20us, 50us, 100us, and 200us become 500us.

*1: Also refer to CURRENT SAMPLING INTERVAL and FORCE/ EXTERNAL SAMPLING INTERVAL in Chapter 8, “n-2. SETUP SYSTEM (2) Screen.”

(5) UNITS

Select whether to add a unit to the save data or not.

OFF: Not added
ON: Added

(6) DECIMAL POINT RANGE

"." (period) or "," (comma) for DECIMAL POINT RANGE is switched, the measurement data saved in the CSV file changes as shown below.

- Example of "." (period) (partly omitted measurement data)
  (snip)01.00kA,00,G,01.10kA,05,G,02(snip)[CR][LF]
- Example of "," (comma) (partly omitted measurement data)
  (snip)01,00kA;00;G;01,10kA;05;G;02(snip)[CR][LF]

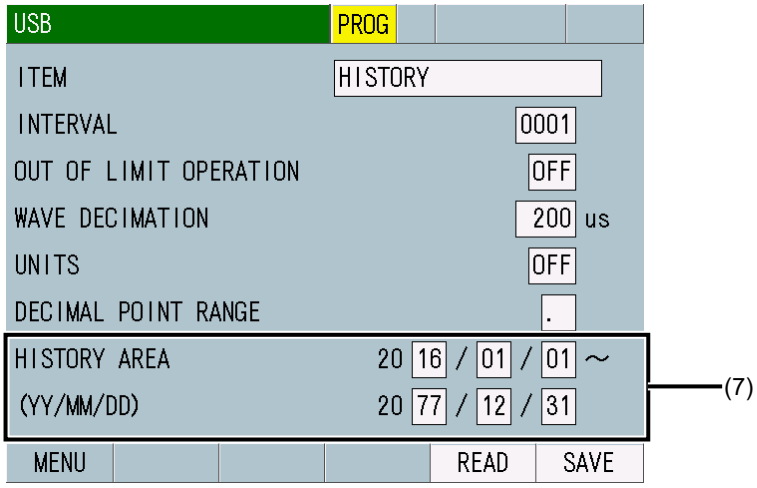
In the "." (period) setting, period is used for decimal point and comma is used for delimiter. On the other hand, in the "," (comma) setting, comma is used for decimal point and semicolon is used for delimiter.

When the language setting of Excel is Japanese, select "." (period) for DECIMAL POINT RANGE. When European language such as German is set, select "," (comma).

(7) HISTORY AREA

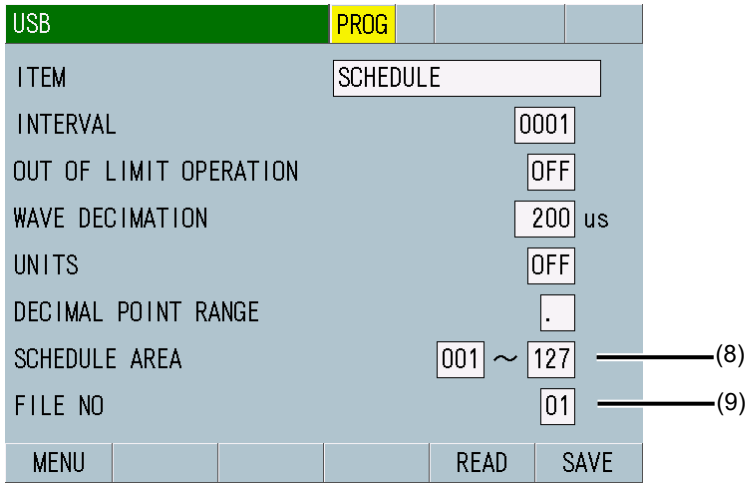
Shown when you have selected HISTORY or HISTORY OUT OF LIM for ITEM. Set a save range with year, month and day.

(Note) The start date should be before the end date.



(8) SCHEDULE AREA

Shown when you have selected SCHEDULE for ITEM. Set the range of schedule numbers to save schedule data from 001 to 127. The setting of schedule data range is valid only when schedule data is saved.



(9) FILE NO

When you have selected SCHEDULE for ITEM, FILE NO is displayed.

Set the file number (01 to 10) to read from or write in the schedule data.

"¥sch_set" folder is created, and "¥FileNo_01" to "¥FileNo_10" folders are created in a lower hierarchy for each file number. Further, the following files are created in a lower hierarchy for each screen.

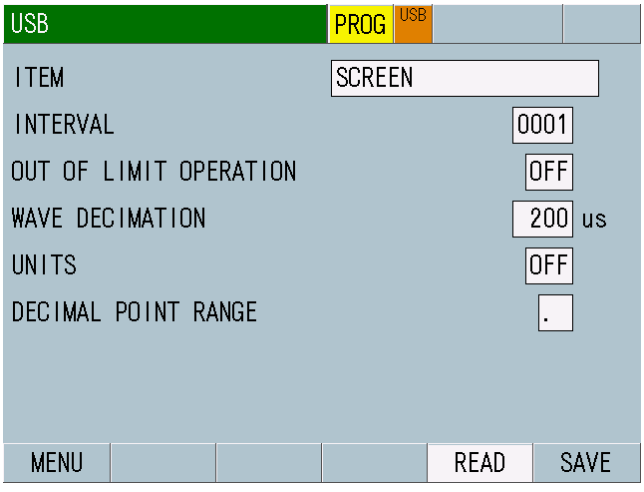
Screen	Filename
VIEW screen	View.csv
ENVELOPE (2) screen	Env2.csv
ENVELOPE (3) screen	Env3.csv
COMPARATOR screen	HiLoComp.csv
PRINT screen	Printer.csv
USB screen	Usb.csv
BASIC SETUP (1), (2) screens	Base12.csv
BASIC SETUP (3) screen	Base3.csv
EXTEND SETUP (1), (4), (6) screens	Extend146.csv
EXTEND SETUP (2), (3), (5), (7) screens	Extend2357.csv
SYSTEM SETUP (1), (2) screens	System.csv
EXT INPUT/OUTPUT (1) to (4) screens	ExtIO.csv
COMMUNICATION (1), (2) screens	Comm.csv
INTERNAL MEMORY screen	InternalMem.csv
SEAM SETUP (1), (2) screens	Seam12.csv
SEAM SETUP (3) screen	Seam3.csv

(10) Function keys

MENU: Touching this displays the MENU screen.

READ: Touching this performs reading schedule setting data or envelope data from the USB memory. Valid when SCHEDULE or ENVELOPE is selected for ITEM.

SAVE: Touching this performs writing the item selected for ITEM in the USB memory. When the USB memory works, "USB" is shown in orange.



CAUTION

Do not turn off the power supply while reading from or writing in the USB. If not, it results in malfunction.

(Note 1) Contents of USB data

- The data contents of measured value “measure-*.csv” (* indicates 0 to 1000), measured value history “hist_measure-*.csv” (* indicates 0 to 1000), and error history “hist_error-*.csv” (* indicates 0 to 1000) are as follows. For item code table, refer to “Chapter 12, (5) Code Table of Communication and USB Data.”

Column	Item	Display/contents
A	Schedule number	1 to 127
B	Year / month / day hour : minute: second	
C	Measurement item code 1	Refer to the Measurement code table.
D	Judgment item code 1	Refer to the Judgment code table.
E	Measured value 1	
F	Measurement item code 2	Refer to the Measurement code table.
G	Judgment item code 2	Refer to the Judgment code table.
H	Measured value 2	
I	Measurement item code 3	Refer to the Measurement code table.
J	Judgment item code 3	Refer to the Judgment code table.
K	Measured value 3	
L	Measurement item code 4	Refer to the Measurement code table.
M	Judgment item code 4	Refer to the Judgment code table.
N	Measured value 4	
O	Measurement item code 5	Refer to the Measurement code table.
P	Judgment item code 5	Refer to the Judgment code table.
Q	Measured value 5	
R	Measurement item code 6	Refer to the Measurement code table.
S	Judgment item code 6	Refer to the Judgment code table.
T	Measured value 6	
U	Measurement item code 7	Refer to the Measurement code table.
V	Judgment item code 7	Refer to the Judgment code table.
W	Measured value 7	
X	Measurement item code 8	Refer to the Measurement code table.
Y	Judgment item code 8	Refer to the Judgment code table.
Z	Measured value 8	
AA	Measurement item code 9	Refer to the Measurement code table.
AB	Judgment item code 9	Refer to the Judgment code table.
AC	Measured value 9	
AD	Measurement item code 10	Refer to the Measurement code table.

Column	Item	Display/contents
AE	Judgment item code 10	Refer to the Judgment code table.
AF	Measured value 10	
AG	ENVELOPE#1 Waveform item code	Refer to the Waveform code table (Item code).
AH	ENVELOPE#1 SEGMENT#1 Judgment	Refer to the Judgment code table.
AI	ENVELOPE#1 SEGMENT#2 Judgment	Refer to the Judgment code table.
AJ	ENVELOPE#1 SEGMENT#3 Judgment	Refer to the Judgment code table.
AK	ENVELOPE#2 Waveform item code	Refer to the Waveform code table (Item code).
AL	ENVELOPE#2 SEGMENT#1 Judgment	Refer to the Judgment code table.
AM	ENVELOPE#2 SEGMENT#2 Judgment	Refer to the Judgment code table.
AN	ENVELOPE#2 SEGMENT#3 Judgment	Refer to the Judgment code table.

- The data contents of CURRENT ALL CYCLE “curr_allcycle_*.csv” (* indicates 0 to 1000) are as follows.

Column/Cell	Item	Display/range
A	Current flow time	In unit(s) of 1 ms or 0.5 CYC
B	Measurement range	Shows * for measurement range and space for non-measurement range.
C	Current value	Shows current value for every current flow time.
D	Voltage value	Shows voltage value for every current flow time.
C1	Number of measurements	Shows the number of all cycle data.

- The data contents of FORCE ALL CYCLE “force_allcycle_*.csv” (* indicates 0 to 1000) are as follows.

Column/Cell	Item	Display/range
A	Current flow time	In units of 10 ms
B	Measurement range	Shows * for force measurement range and space for non-measurement range.
C	Force value	Shows force value for every 10 ms.
D	Measurement range	Shows * for external output measurement range and space for non-measurement range.
E	External output value	Shows external output value for every 10 ms.
C1	Number of measurements	Shows the number of all cycle data.

- The data contents of WAVEFORM “wav_*.csv” (* indicates 0 to 1000) are as follows.

Column/Cell	Item	Display/range
A	Current flow time	In unit of sampling interval
B	Waveform 1	WAVEFORM 1 in the VIEW screen
C	Waveform 2	WAVEFORM 2 in the VIEW screen
D	Waveform 3	WAVEFORM 3 in the VIEW screen
E	Waveform 4	WAVEFORM 4 in the VIEW screen

(Note 2) About the USB memory

USB memories formatted as FAT16 or FAT32 are supported. Those formatted as exFAT or NTFS are not supported. (*)

We have confirmed the operations of the following USB memories (as of August 2017).

Manufacturer	Model	Capacity
ELECOM	MF-SU308GSV	8 GB
	MF-KSU2A16GSV	16 GB
	MF-PSU316G* *1	16 GB
	MF-KSU2A32GSV	32 GB
	MF-MSU3A04G* *1	4 GB
I/O DATA	U3-CPSL8G/* *1	8 GB
BUFFALO	RUF3-K8GA-* *1	8 GB
	RUF3-PS8G-* *1	8 GB
	RUF3-SMA8G-* *1	8 GB
	RUF3-SMA32G-* *1	32 GB
SONY	USM8GR* *1	8 GB
SanDisk	SDCZ33-016G-J57	16 GB
Transcend	TS16GJF700PE	16 GB

1: “” indicates color.

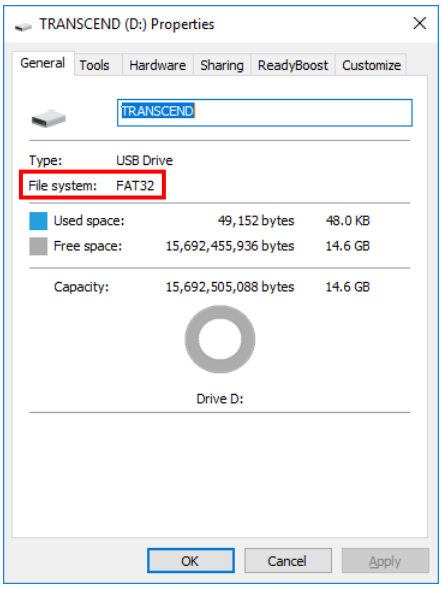
The operations of USB memories were confirmed by us and are not guaranteed. Please note that we do not take responsibility for any damage caused by using them.

Due to the circumstances of manufactures, specifications of USB memories may be changed. Please note that USB memories may not work normally depending on the changes.

(*) About the USB memory format (FAT16, FAT32, NTFS, and exFAT)

- FAT16: A format used in MS-DOS or later, and it can’t be over 4 GB.
- FAT32: A format used in Windows 98 and later, and it can’t be over 32 GB.
- NTFS: A format used as system drive such as HDD and SSD to install Windows NT and later, and it supports up to 256 TB almost limitlessly.
- exFAT: A format used in a large capacity SD memory card (SDXC etc.) mainly used in digital camera and digital video camera, and it supports up to 256 TB almost limitlessly.

In advance, point a mouse cursor to the USB drive in the Explorer on a Windows computer etc. and right-click [Properties (R)] to check the USB in use by the file system.



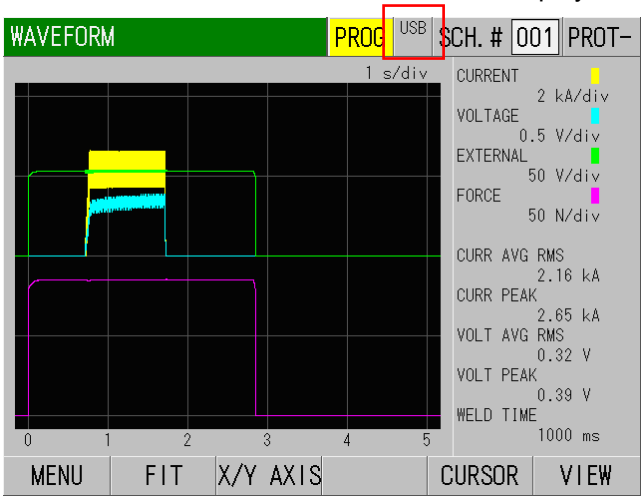
(Note 3) About using a brand-new USB memory

Before using a brand-new or freshly-formatted USB memory on the **MM-400A**, create a file in advance on a Windows computer, etc. and save it in USB.

If there is not file to save, an empty text file doesn't matter. It can be created by right-clicking in the Explorer to execute "New" – "Text Document." Create a text file and change the filename.

(Note 4) About the display of USB memory

When a usable USB is inserted in the **MM-400A**, "USB" is shown at the upper portion of the screen. To save data, be sure to confirm this display.



(Note 5) About the use of USB memory

Store data saved in the USB memory into a computer periodically without leaving the saved data. When deleting all files after storing data, perform (Note 3).

Also, the USB memory has a write-in life, so when it takes time to write-in longer than before or garbled character is generated in the written file, replace it.

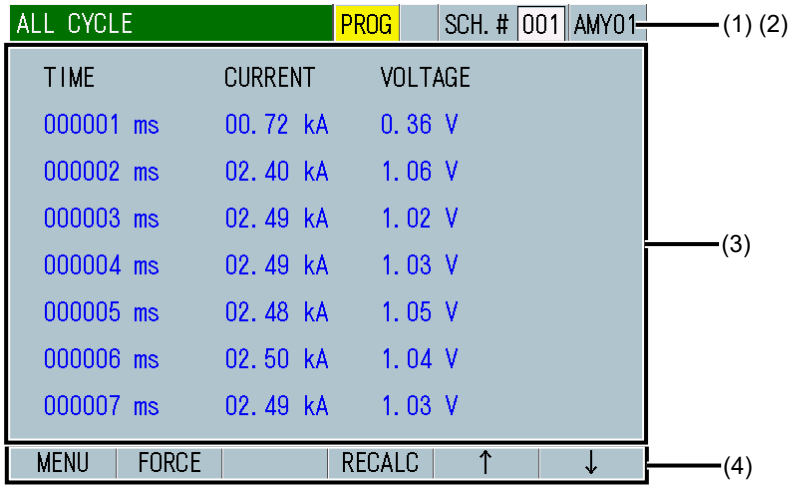
The life of the USB memory can be extended by moving data at short intervals without leaving the saved data and using it with large free space.

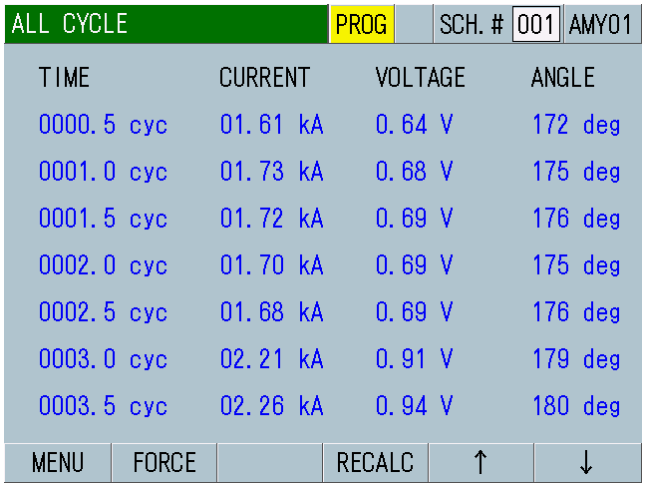
j. ALL CYCLE Screen

Can not be used in the ISO17657 mode, but in the original mode.

With this function, current flow result after measurement every half cycle or 1 ms and measurement result of force/external input every 10 ms can be analyzed in detail.

j-1. ALL CYCLE Screen (Current)





(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) RMS per cycle[*2]

Shows the RMS current, voltage and conduction angle[*1] every half cycle in AC mode and every 1 ms in DC mode. The area with values shown in blue represents the calculation interval.

(4) Function keys

MENU: Touching this displays the MENU screen.

FORCE: Touching this displays the ALL CYCLE screen (Force).

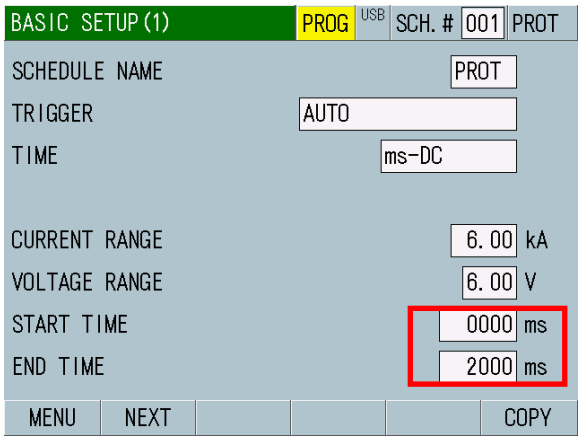
RECALC: Touching this recalculates the measured current and voltage. Use this function to redo the calculation of the arithmetic mean over a new calculation interval after changing the start and end cycle (MEAS START, MEAS END) settings in the BASIC SETUP (1) screen.

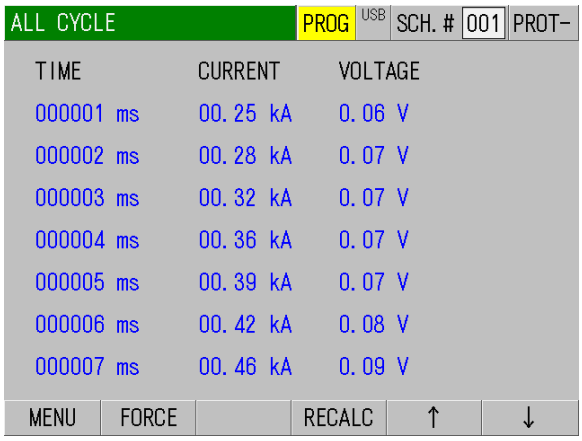
↑↓: Touching this moves a page of the screen.

*1: Conduction angle appears only when CYC-AC, CYC***Hz-AC or LONG CYC-AC is selected for TIME in the BASIC SETUP (1) screen.
*2: The measured value does not appear in the ALL CYCLE screen if SHORT ms-DC is selected for TIME in the BASIC SETUP (1) screen.

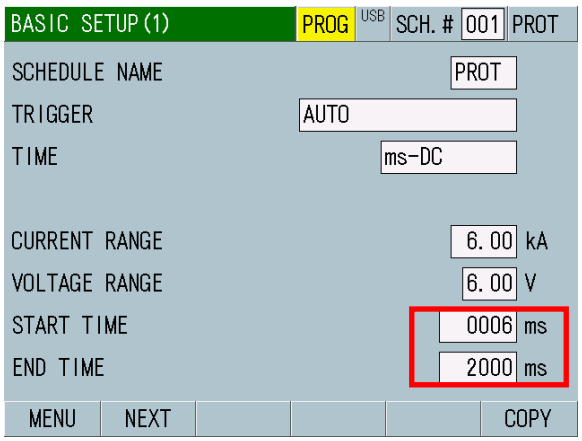
(*) How to execute RECALC of current, voltage and conduction angle

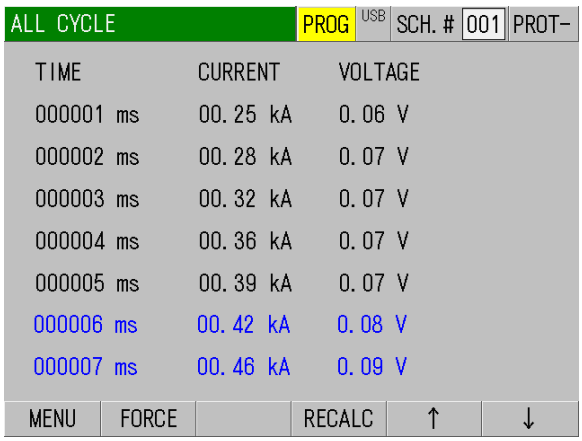
1) Before executing RECALC: Measurement range 0 to 2000 ms





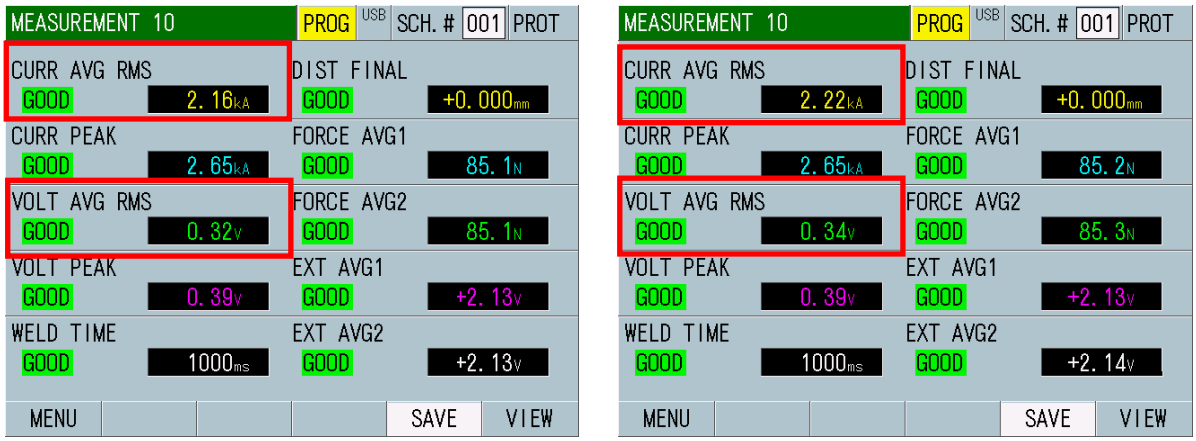
2) Change the measurement start to 6 ms and touch the RECALC key. The color of range omitted from calculation (1 to 5 ms) changes from blue to black.



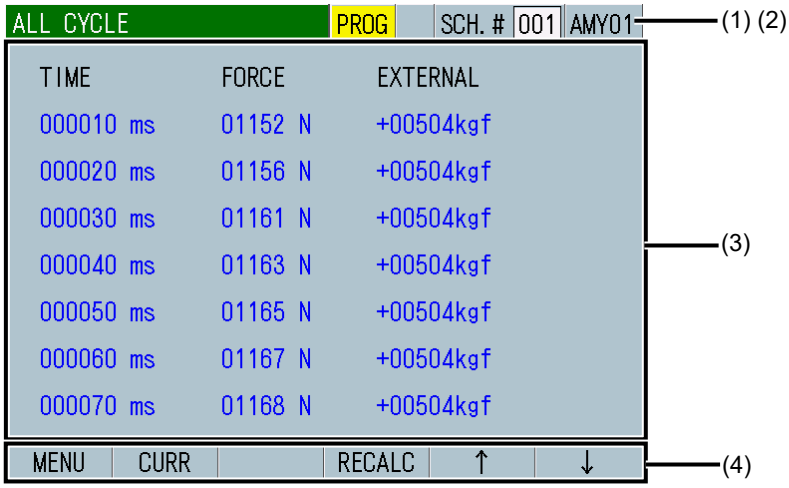


3) Left: Measured value before recalculation Right: After recalculation

Since the RMS calculation starts from 6 ms, the rising part is omitted from the measured value.



j-2. ALL CYCLE Screen (Force)



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) RMS per cycle

Shows the RMS FORCE and EXTERNAL every 10 ms. The area with values shown in blue represents the calculation interval.

(4) Function keys

MENU: Touching this displays the MENU screen.

CURR: Touching this displays the ALL CYCLE screen (Current).

RECALC: Touching this recalculates the measured force and external input. Use this function to redo the calculation of the mean over a new calculation interval after changing the force start and end cycle (START TIME, END TIME) settings in the EXTEND SETUP (4) screen and changing the external input start and end cycle (START TIME, END TIME) settings in the EXTEND SETUP (6) screen.

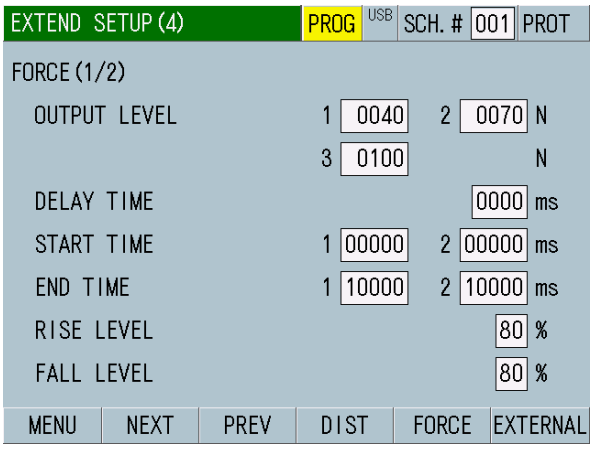
↑↓: Touching this moves a page of the screen.

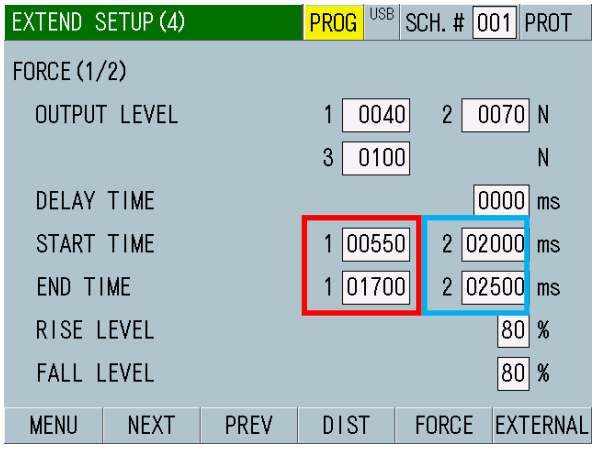
*1: Force/displacement-equipped specification function

(*) How to execute RECALC of force and external

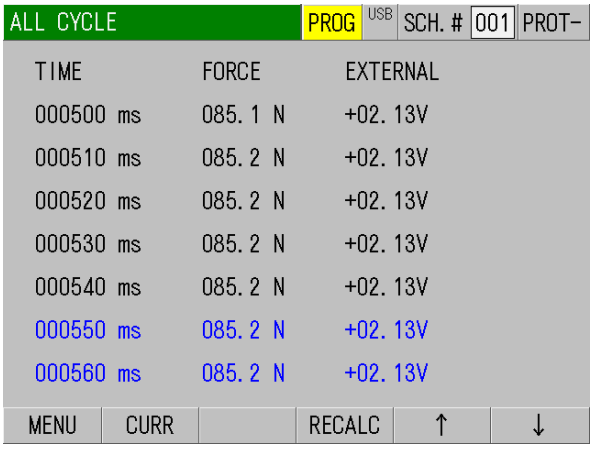
1) Just like RECALC of current/voltage/conduction angle, change start time and end time of force to recalculate after measurement. The external input is are also similar.

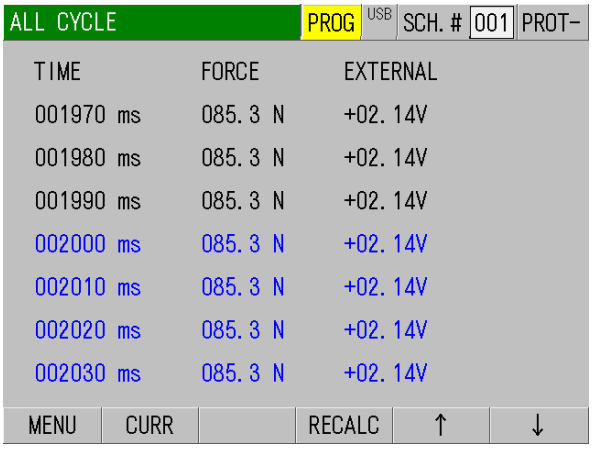
Left: Schedule of measurement before recalculation Right: Schedule of recalculation



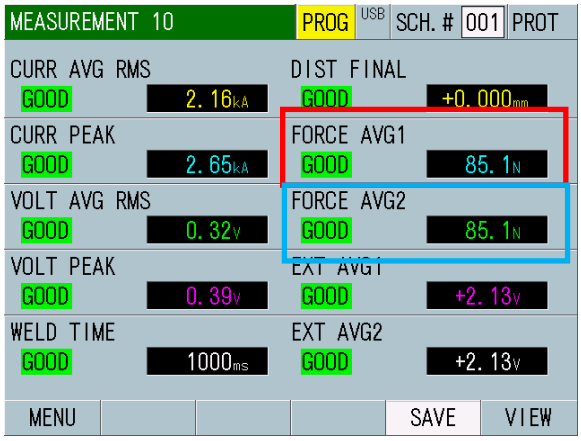


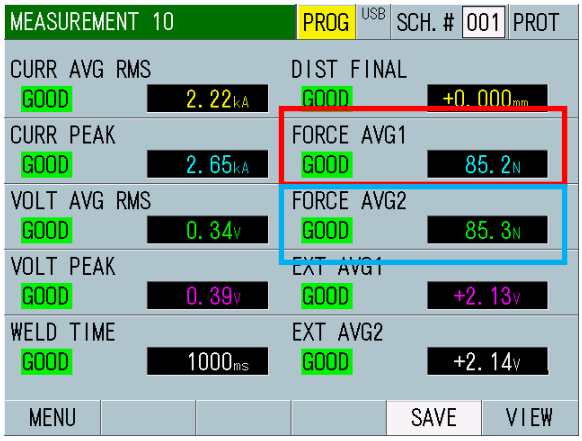
2) Touching the RECALC key changes the color of range omitted from calculation from blue to black. Left: Force average 1 Right: Force average 2





3) Left: Measured value before recalculation Right: After recalculation





k. FORCE TIMING Screen

The FORCE TIMING screen is for checking the timing from when the force starts, the current flows, until when the force ends. Displays waveforms and measured values.

Note: This function is used on the **MM-400A**'s force/displacement-equipped specification only.

Note1: Set the followings in advance.
Set TRIGGER to FORCE in the BASIC SETUP (1) screen and MODE to NORMAL in the SYSTEM SETUP (1) Screen.
Also, the force waveform can be displayed when the force reaches the preset force trigger level and the current reaches the current trigger level, and then both force and current are measured.

Note2: This screen is shown only when the FORCE TIMING screen is selected from the MENU screen. To display the next force timing, go to the MEASUREMENT, WAVEFORM or ALL CYCLE screen and display the FORCE TIMING screen after measurement.

(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) Waveform display

Shows the current[*2], force[*2] and force external trigger[*1] waveforms.

(4) Force time

Shows the following items: ((1) to (6) correspond to the numbers in the figure on the next page.)

Force 1 (FORCE1)[*3]: Mean force over force calculation interval 1

Force 2 (FORCE2)[*3]: Mean force over force calculation interval 2

Force Time (TIME)[*3]: Time from when the force signal exceeds the force trigger level to when the signal reaches the force end level

Force Start Time (ELECTRODE START TIME)*1 (1): Time from the external input signal “FORCE TRIGGER” input to when the force signal exceeds TRIGGER LEVEL

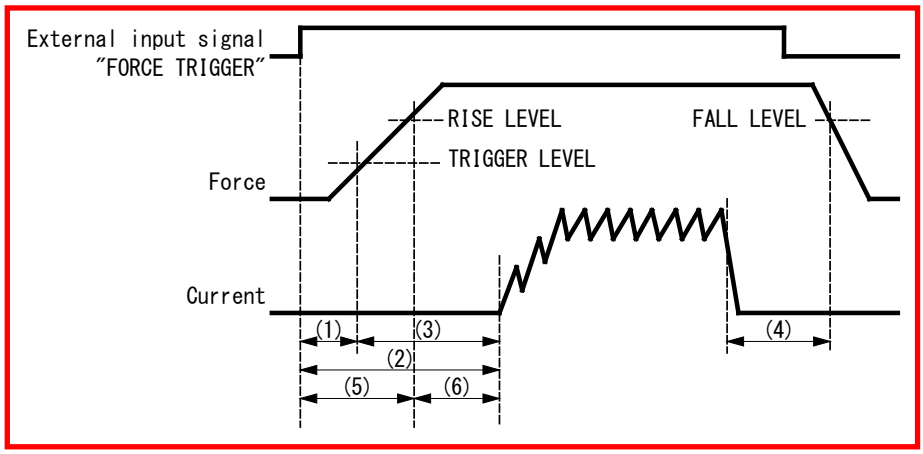
Squeeze Time (SQUEEZE TIME)*1 (2): Time from the external input signal “FORCE TRIGGER” input to the start of current flow

Force Stabilization Time (SQZ DELAY TIME)*2 (3): Time from when the force signal exceeds TRIGGER LEVEL to the start of current flow

Hold Time (HOLD TIME)*2 (4): Time from the end of current flow to when the force signal falls below FALL LEVEL

Force Completion Time (TIME TO FORCE)*1 (5): Time from the external input signal “FORCE TRIGGER” input to when the force signal becomes RISE LEVEL

Current Start Time (SQUEEZE START TIME)*2 (6): Time from when the force signal exceeds RISE LEVEL to the start of current flow



(5) Function keys

MENU: Touching this displays the MENU screen.

FIT: Touching this redisplays the waveforms by automatically resizing them to fit into the screen.

X/Y AXIS: Touching this displays the scale command of XY axis at the function key. For the scale command of XY axis, refer to (2) d (7) in Chapter 8.

*1: Shown when force and current are measured using the force trigger.
*2: Shown when force and current are measured.
*3: Not shown if FORCE1, FORCE2 or FORCE TIME is not selected in the VIEW screen.

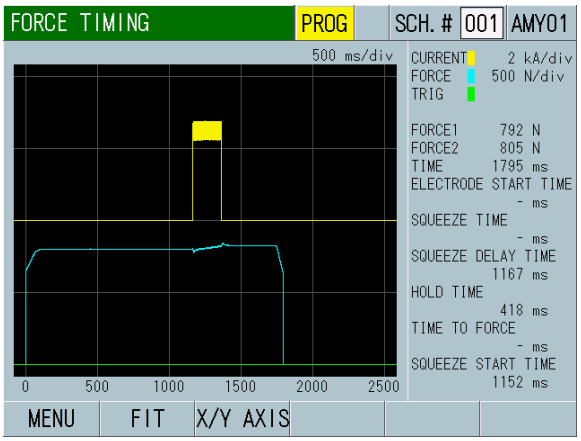
[Force measurement start timing]

There are two ways for measurement, a way to start when the weld force reaches the preset TRIGGER LEVEL without using the external input signal “FORCE TRIGGER” and a way to start measurement using the external input signal “FORCE TRIGGER” (force valve driving signal) together.

In the first case, Force start time, Squeeze time and Force completion time cannot be measured, but in the latter case, all items can be measured by inputting the external input signal “FORCE TRIGGER.”

- Way to start when the weld force reaches the preset TRIGGER LEVEL

The timing from when the force starts, the current flows, until when the force ends is measured. When the weld force exceeds TRIGGER LEVEL, the measurement starts. For the force trigger level, refer to “m-5. EXTEND SETUP (5) Screen.” Taking the force start point as the reference point of time axis (horizontal axis), force and current waveforms are displayed and each timing can be observed. The unit of horizontal axis is ms. Force 1, Force 2, Force time, Current stabilization time, Hold time, and Current start time are displayed in the area of displaying measured values.

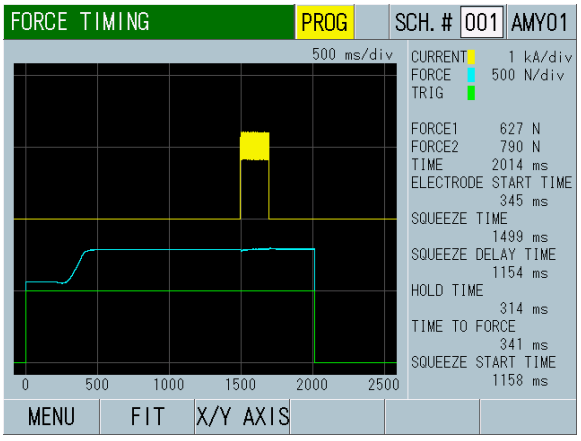


- Way to start measurement using the external input signal “FORCE TRIGGER” (force valve driving signal) together

The timing from when the force valve driving signal of Head is input, the Head starts applying force, the welding current flows, the force valve driving signal is turned off, until when the force ends is measured.

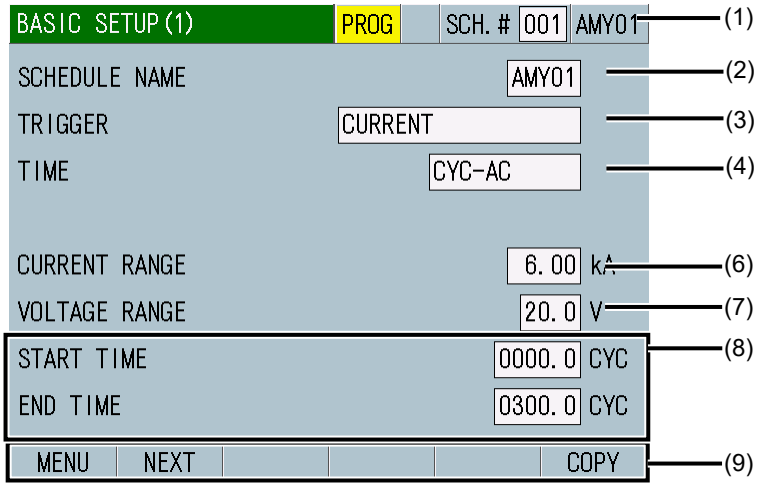
Turn off 24 V DC by inputting the external input signal “FORCE TRIGGER” simultaneously with the force valve driving signal of Head. When the force valve uses the Head with 24 V DC specification, you can divide the force valve driving signal to input. The input terminal of the external input signal “FORCE TRIGGER” does not have polarity.

Taking the timing of the external input signal “FORCE TRIGGER” input as the reference point of time axis (horizontal axis), force external trigger, force and current waveforms are displayed on the screen and each timing can be observed. The unit of horizontal axis is ms. Since the screen is for measuring the timing, the vertical axis has no unit. Force 1, Force 2, Force time, Force start time, Squeeze time, Force stabilization time, Hold time, Force completion time, and Current start time are displayed in the area of displaying measured values.



I. BASIC SETUP Screen

I-1. BASIC SETUP (1) Screen



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) SCHEDULE NAME

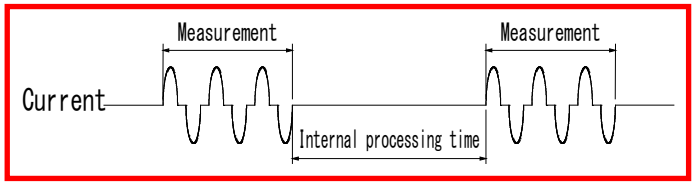
Inputs the name for the set schedule. Up to five alphanumeric characters can be input.

(3) TRIGGER

Select an input signal required to start measurement. In the standard specification (force/displacement not equipped), only CURRENT can be selected.

When the TRIGGER setting is changed, upper and lower limits for measurement items WELD TIME and FLOW TIME and TIME, START TIME, END TIME, COOL TIME, and MEASUREMENT MIN TIME on the BASIC SETUP screens may be initialized. Set upper and lower limits and TIME, START TIME, END TIME, COOL TIME, and MEASUREMENT MIN TIME on the BASIC SETUP screens again. (Refer to "e. COMPARATOR Screen" and "I-2. BASIC SETUP (2) Screen.")

- CURRENT
  Force and external voltage/current input are not measured.
  The instrument performs measurement each time a current signal is input, showing the measured values, waveforms and all cycles. The internal processing time varies depending on the current flow time. As a result, the internal processing may not be complete before next measurement. To pass multiple current pulses, refer to PULSE MODE in the BASIC SETUP (2) screen.



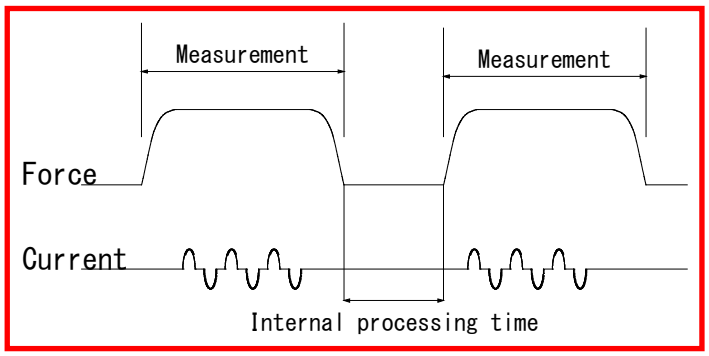
- AUTO
  The first input among 1) current, 2) force or external input (±10 V voltage or 4 to 20 mA current), and 3) force trigger or external force trigger triggers measurement.

1) When current is a trigger, the instrument operates in the same manner as in the CURRENT setting for TRIGGER.

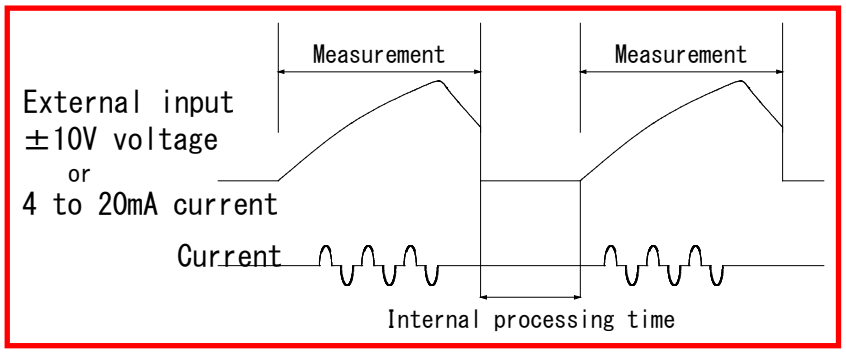
2) When force or external input is a trigger, the instrument operates in the same manner as in the FORCE or EXTERNAL setting for TRIGGER.

3) When force trigger or external trigger is a trigger, the instrument operates in the same manner as in the FORCE (EXT) or EXTERNAL (EXT) setting for TRIGGER. Note, however, that the instrument starts measurement only upon input of current or force (or external input).

- FORCE
  The instrument performs measurement each time a force signal is input, showing the measured values and waveforms.
  The internal processing time varies depending on the force and current flow time. As a result, the internal processing may not be complete before next measurement. To pass multiple current pulses, refer to PULSE MODE in the BASIC SETUP (2) screen.

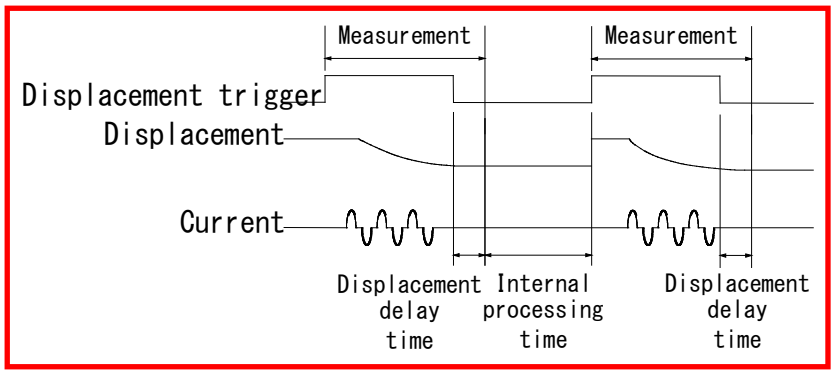


- EXTERNAL
  The instrument starts measurement each time an external input voltage (±10 V) or external input current (4 to 20 mA) is input, making an OK/NG judgment and showing the measured value and waveform.
  The internal processing time varies depending on the external input and current flow time. As a result, the internal processing may not be complete before next measurement. To pass multiple current pulses, refer to PULSE MODE in the BASIC SETUP (2) screen.

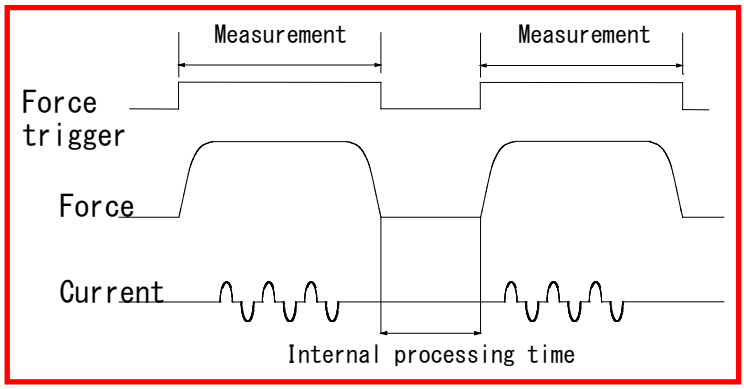


- REAL TIME
  The instrument makes measurement constantly. Force, external input or displacement is measured at intervals of half a second. To perform measurement, select FORCE REAL TIME, EXT REAL TIME or DIST REAL TIME in the VIEW screen. Measurement stops when MEAS is changed to PROG.
- DISPLACEMENT (EXT) [*1]
  The instrument measures displacement each time a displacement trigger of the external input signal is input. The internal processing time varies depending on the current flow and displacement measurement time. As a result, the internal processing may not be complete before next

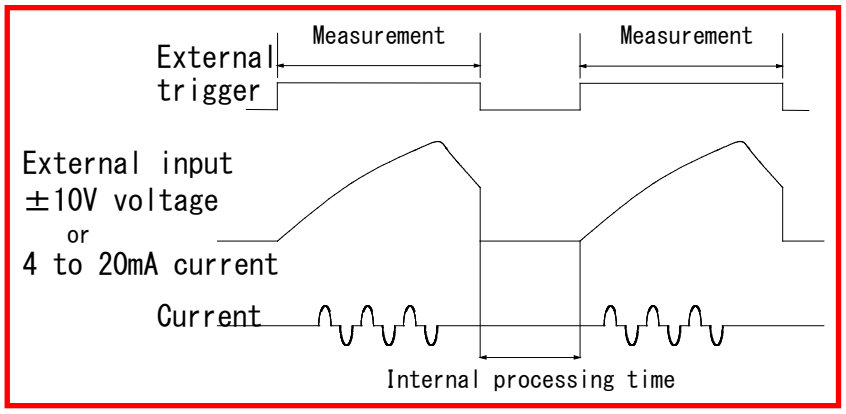
measurement. To pass multiple current pulses, refer to PULSE MODE in the BASIC SETUP (2) screen.



- FORCE (EXT) *1
  The instrument measures force each time a force trigger of the external input signal is input. The internal processing time varies depending on the current flow and force measurement time. As a result, the internal processing may not be complete before next measurement. To pass multiple current pulses, refer to PULSE MODE in the BASIC SETUP (2) screen.



- EXTERNAL (EXT) *1
  The instrument measures external input voltage (±10 V) or external input current (4 to 20 mA) each time an external trigger of the external input signal is input. The internal processing time varies depending on the current flow and external input measurement time. As a result, the internal processing may not be complete before next measurement. To pass multiple current pulses, refer to PULSE MODE in the BASIC SETUP (2) screen.



*1: Refer to (2) INPUT 7 to 8 in “o-1. EXT INPUT/OUTPUT (1) Screen.”

(Reference) TRIGGER setting and measurement

Measurement start item varies depending on the TRIGGER setting.

TRIGGER setting and measurement start item

		Measurement start item							
		CURRENT *1	VOLTAGE	DISPLACEMENT	FORCE *1	EXTERNAL *1	DISPLACEMENT *2 (EXTERNAL INPUT)	FORCE *2 (EXTERNAL INPUT)	EXTERNAL *2 (EXTERNAL INPUT)
TRIGGER setting	CURRENT	○	×	×	×	×	×	×	×
	AUTO	○	×	×	○	○	×	○	○
	FORCE	×	×	×	○	×	×	×	×
	EXTERNAL	×	×	×	×	○	×	×	×
	DISPLACEMENT (EXT)	×	×	×	×	×	○	×	×
	FORCE (EXT)	×	×	×	×	×	×	○	×
	EXTERNAL (EXT)	×	×	×	×	×	×	×	○

*1: Measurement starts when the set threshold is exceeded.
*2: Measurement starts when IN7/IN8 (specified by setting) of the external input is closed.

TRIGGER setting and measurement item

		Measurement item						
		CURRENT	VOLTAGE	POWER	RESIST	DISPLACEMENT	FORCE	EXTERNAL
TRIGGER setting	CURRENT *3	○	○	○	○	○	×	×
	AUTO *4 *5	○	○	○	○	○	○	○
	FORCE *6	○	○	○	○	○	○	○
	EXTERNAL *7	○	○	○	○	○	○	○
	DISPLACEMENT (EXT) *8	○	○	○	○	○	×	×
	FORCE (EXT) *9	○	○	○	○	○	○	○
	EXTERNAL (EXT) *10	○	○	○	○	○	○	○

*3: Measurement of CURRENT/VOLTAGE/POWER/RESIST/DISPLACEMENT is performed when current measurement starts.
*4: Measurement of CURRENT/VOLTAGE/POWER/RESIST/DISPLACEMENT/FORCE/EXTERNAL is performed when current measurement starts.

*5: Measurement of FORCE/EXTERNAL is performed when any measurement of FORCE/EXTERNAL/FORCE (EXTERNAL INPUT)/EXTERNAL (EXTERNAL INPUT) starts, and then measurement of CURRENT/VOLTAGE/POWER/RESIST/DISPLACEMENT is performed when current measurement starts.
*6: Measurement of FORCE/EXTERNAL is performed when force measurement starts, and then measurement of CURRENT/VOLTAGE/POWER/RESIST/DISPLACEMENT is performed when current measurement starts.
*7: Measurement of FORCE/EXTERNAL is performed when external measurement starts, and then measurement of CURRENT/VOLTAGE/POWER/RESIST/DISPLACEMENT is performed when current measurement starts.
*8: Measurement of DISPLACEMENT is performed when displacement (external input) measurement starts, and then measurement of CURRENT/VOLTAGE/POWER/RESIST is performed when current measurement starts.
*9: Measurement of FORCE/EXTERNAL is performed when force (external input) measurement starts, and then measurement of CURRENT/VOLTAGE/POWER/RESIST/DISPLACEMENT is performed when current measurement starts.
*10: Measurement of FORCE/EXTERNAL is performed when external (external input) measurement starts, and then measurement of CURRENT/VOLTAGE/POWER/RESIST/DISPLACEMENT is performed when current measurement starts.

Since MEASUREMENT and WAVEFORM set in the VIEW screen are measured, it is necessary to set above TRIGGER setting and measurement item in the VIEW screen.

DISPLACEMENT (EXT), FORCE (EXT), and EXTERNAL (EXT) operate by the input trigger signal of interface.

Ex.)

- When measuring current:
  Select CURRENT for TRIGGER.
- When measuring displacement according to the current measurement start:
  Select CURRENT for TRIGGER.
- When measuring displacement in an optional timing:
  Select DISPLACEMENT (EXT) for TRIGGER.
- When measuring current/force with a current/force sensor (**MA-770A/771A**):
  Select FORCE for TRIGGER.
- When measuring force with a force sensor (**MA-520B/521B/522B**):
  Select FORCE for TRIGGER.
- When measuring force with a force sensor built in a head:
  Select FORCE (EXT) or FORCE for TRIGGER.

* The same setting is applied when measuring current/displacement.

* Since difference between the times when the head is released and when forced is small with a force sensor built in a head and the trigger level setting is difficult, it is recommended to use the external input trigger.

- When switching measurement of current/voltage with a toroidal coil and measurement of current/voltage/force with a force sensor (**MA-520B/521B/522B**):
  Select AUTO for TRIGGER.

- When measuring force/external (external sensor measurement) according to the current measurement start:
  Select AUTO for TRIGGER.

* Set the trigger level of force/external to the maximum value.

- When measuring an external (external sensor measurement):
  Select EXTERNAL (EXT) or EXTERNAL for TRIGGER.

* The same setting is applied when measuring current/displacement.

* When the trigger level setting is difficult because difference between the times when measurement is performed and when not performed is small, it is recommended to use the external input trigger.

(4) TIME

To measure a current accurately, be sure to select “-DC” for DC measurement and “-AC” for AC measurement.

When the TIME setting is changed, upper and lower limits for measurement items WELD TIME and FLOW TIME and TIME, START TIME, END TIME, COOL TIME, and MEASUREMENT MIN TIME on the BASIC SETUP screens may be initialized. Set upper and lower limits and TIME, START TIME, END TIME, COOL TIME, and MEASUREMENT MIN TIME on the BASIC SETUP screens again. (Refer to "e. COMPARATOR Screen" and "l-2. BASIC SETUP (2) Screen.")

When the TRIGGER setting is changed, TIME may be initialized. Set TIME again.

- CYC-AC
  Select this option to measure single-phase AC welding current.
  Frequency: Automatically detected from the **MM-400A**’s power supply
  Measurable time: 5,000 ms max. (50 Hz: 250 CYC, 60 Hz: 300 CYC)
- ms-DC
  Select this option to measure DC output inverter welding current in units of ms.
  Measurable time: 2,000 ms max.
- CYC***Hz-AC
  Select this option to measure AC output inverter welding current in units of cycle. Set the frequency of the current you wish to pass in FREQUENCY in the BASIC SETUP (1) screen.
  Measurable time: 4,000 ms max. (M050 (50 Hz): 200 CYC, M063 (63 Hz): 50 CYC, ... M500 (500 Hz): 2000 CYC)
- CYC-DC
  Select this option to measure DC output inverter welding current in units of cycle.
  Frequency: Automatically detected from the **MM-400A**’s power supply
  Measurable time: 2,000 ms max. (50 Hz: 100 CYC, 60 Hz: 120 CYC)
- ms-AC
  Select this option to measure AC output inverter welding current in units of ms.
  Measurable time is 5,000 ms max.
- SHORT ms-DC
  Select this option to measure transistor welding current. The current flow time is 1 ms when ms-DC is selected. In contrast, the current flow time is every 0.05 ms when SHORT ms-DC is selected, thus allowing measurement at more frequent intervals.
  When you have selected SHORT ms-DC, you cannot measure force and external input (±10 V voltage or 4 to 20 mA current).
  To measure the current flow time every 0.05 ms, you need to set CURRENT SAMPLING INTERVAL to 50us. For the CURRENT SAMPLING INTERVAL

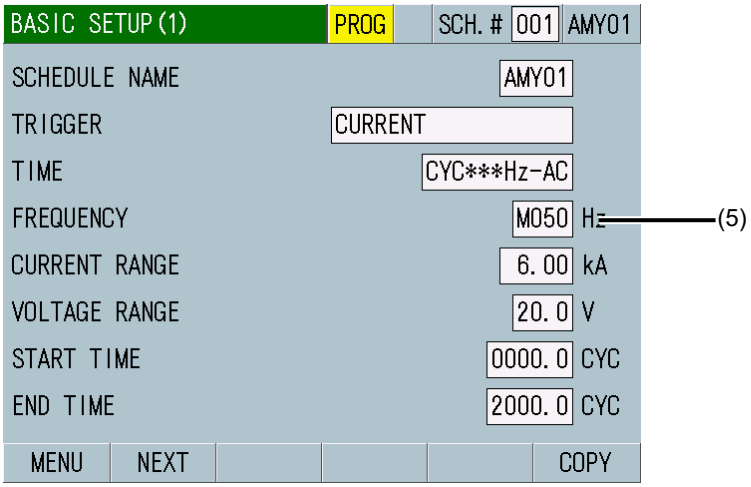
setting, refer to Chapter 8, “n-2. SYSTEM SETUP (2) Screen.”
Measurable time: 300 ms max.

- LONG CYC-AC
  Select this option to measure single-phase AC welding current for a long period. When you have selected LONG CYC-AC, you cannot measure force, external input (±10 V voltage or 4 to 20 mA current) and displacement.
  Frequency: Automatically detected from the **MM-400A**’s power supply
  Measurable time: 10 s max. (50 Hz: 500 CYC, 60 Hz: 600 CYC)

(5) FREQUENCY

When you have selected CYC***Hz-AC for TIME, set the frequency of the current to be measured as follows: M050, M053, M056, M059, M063, M067, M071, M077, M083, M091, M100, M111, M125, M143, M167, M200, M250, M294, M417, M500, 050 to 250 Hz (in unit of 1 Hz).

Set the M*** frequency when using our AC inverter welding power supply.



(6) CURRENT RANGE

Select from the following five ranges. Select one which is larger than the maximum current of welding current actually measured and close to the measured current.

Set upper and lower limits in the following ranges depending on the type of toroidal coil connected and according to the TOROIDAL COIL setting in the BASIC SETUP (3) screen:

- When 1x sensitivity coil is used: 2.000 kA range, 6.00 kA range, 20.00 kA range, 60.0 kA range, 200.0 kA range
- When 10x sensitivity coil is used: 0.200 kA range, 0.600 kA range, 2.000 kA range, 6.00 kA range, 20.00 kA range

(7) VOLTAGE RANGE

Select from the following two ranges. Select one which is larger than the maximum voltage of welding current actually measured and close to the measured voltage.

6.00 V: 6.00 V range
20.0 V: 20.0 V range

(8) START TIME / END TIME

You can measure RMS current/voltage and mean power/resistance by specifying an arbitrary range. Set the interval from the start to end of the measurement as follows according to the TIME. However, this is not the measurable time. For the measurable time, refer to TIME.

When the TRIGGER and TIME settings are changed, START TIME and END TIME may be initialized. Set START TIME and END TIME again.

- When TIME is CYC-AC: 000.0 to 300.0 CYC (in units of 0.5 CYC)
- When TIME is ms-DC: 0000 to 2000 ms (in unit of 1 ms)
- When TIME is CYC***Hz-AC: 0000.0 to 2,000.0 CYC (in units of 0.5 CYC)
- When TIME is CYC-DC: 000.0 to 120.0 CYC (in units of 0.5 CYC)
- When TIME is SHORT ms-DC: 000.00 to 300.00 ms (in units of 0.01 ms)
- When TIME is ms-AC: 0000 to 5000 ms (in unit of 1 ms)
- When TIME is LONG CYC-AC: 0.0 to 600.0 CYC (in units of 0.5 CYC)

(9) Function keys

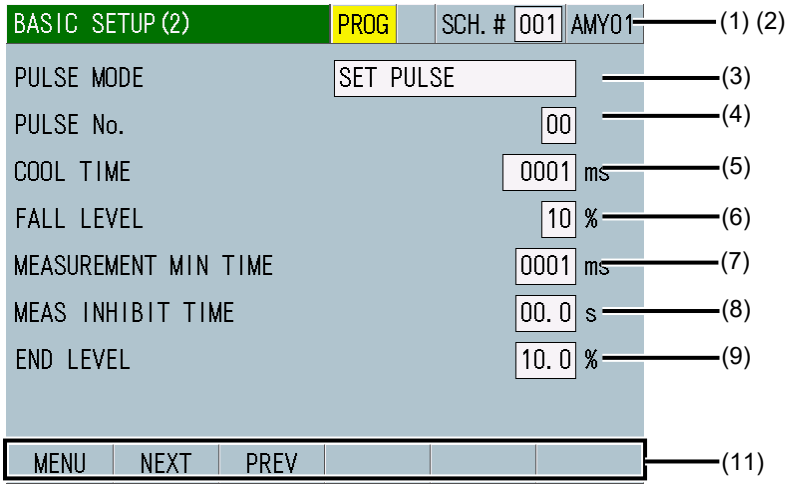
MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the BASIC SETUP (2) screen.

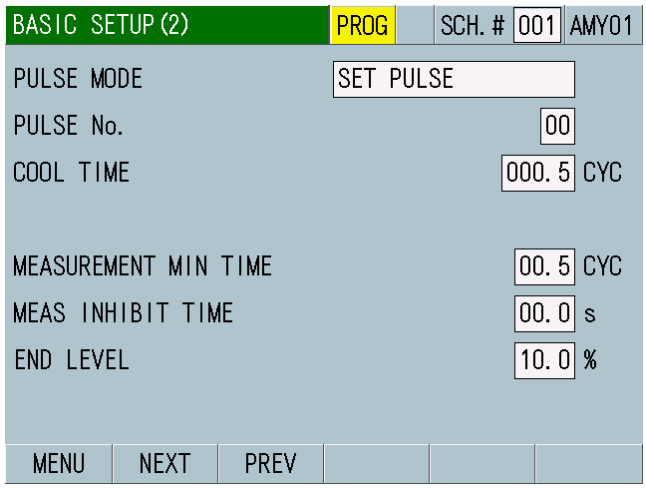
COPY: Touching this copies the settings made under the schedule number 001 (all the settings made in the COMPARATOR, ENVELOPE, BASIC SETUP, and EXTEND SETUP screens) to all the schedule numbers 002 to 127.

I-2. BASIC SETUP (2) Screen

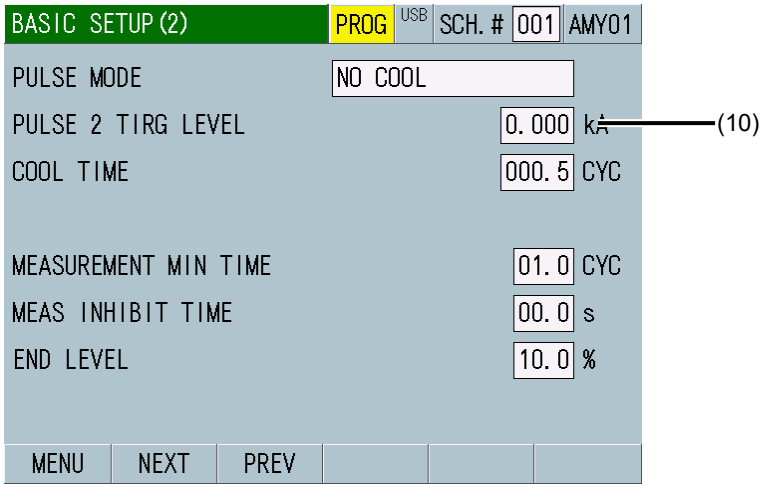
When TIME is DC



When TIME is AC



When PULSE MODE is NO COOL



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

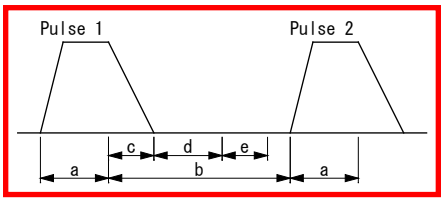
(3) PULSE MODE

For a standard single pulse spot welding, select SET PULSE for PULSE MODE, and “00” for PULSE No.

Current may be passed several times in a single welding sequence. Use the impulse settings to measure an arbitrary step, all steps, and the second step in the 2-step welding with no cooling time. Waveforms of all numbers of measured times are displayed.

(Note) Current flow interval

The cooling time of the welding power supply should be longer than the following current flow interval (time that current does not flow). If the time is shorter, the impulse measurement cannot be performed. The current flow interval should be longer than c + d + e shown below.
For COOL TIME of **MM-400A**, set the time shorter than that of the welding power supply. (Use the initial setting of 0.5 CYC or 1 ms.)
Also, when COOL TIME of **MM-400A** is longer than that of the welding power supply, the measurement is performed as the same pulse.



a: WELD (weld time of the welding power supply)
b: COOL (downtime of the welding power supply)
c: Time until current falls below the END LEVEL setting
d: Time set in COOL TIME
e: 1 CYC when TIME is CYC, 2 ms when TIME is ms

For TIME, refer to Chapter 8, “I-1. BASIC SETUP (1) Screen.”

Even if the impulse settings are used, a welding longer than the following measurable time cannot be measured. The cooling time is included.

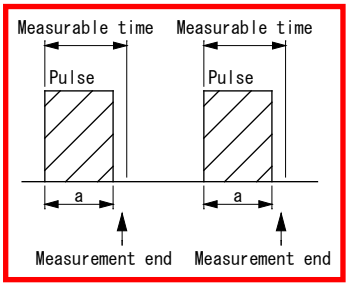
Measurable time of all-pulse measurement for each mode:

CYC-AC	5,000 ms max. (50 Hz: 250 CYC, 60 Hz: 300 CYC)
ms-DC	2,000 ms max.
CYC***Hz-AC	4,000 ms max. (M050 (50 Hz): 200 CYC, M063 (63 Hz), 250 CYC, ... M500 (500 Hz): 2,000 CYC)
CYC-DC	2,000 ms max. (50 Hz: 100 CYC, 60 Hz: 120 CYC)
ms-AC	5,000 ms max.
SHORT ms-DC	300 ms max.
LONG CYC-AC	10 s max. (50 Hz: 500 CYC, 60 Hz: 600 CYC) No impulse measurement is performed. Select SET PULSE for PULSE MODE, and “00” for PULSE No.

- SET PULSE
  Used when performing the 1-step welding (current is not passed several times) in a single welding sequence or when performing the multi-step welding in a single welding sequence and measuring the specified step

1) 1-step welding (current is not passed several times) in a single welding sequence

Set PULSE No. to “00” (no impulse measurement is performed).



a: WELD

The next measurement is made after a measurement ends.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

2) When performing the multi-step welding in a single welding sequence and measuring the specified step

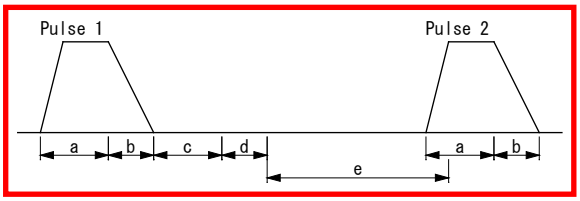
Set an arbitrary step number to measure to PULSE No.

01: Measures the first step, 02: Measures the second step,… 20: Measures the twentieth step

When the interval of the several current flows is less than 500 ms, a measurement is made as a single sequence. When 500 ms elapses, a measurement is made as another sequence.

(Note) Current flow waiting time of 500 ms

The current flow waiting time of 500 ms used for impulse measurement is the time after b + c + d.
When the current flow interval is longer than the time of b + c + d + e, a measurement is made as another sequence.

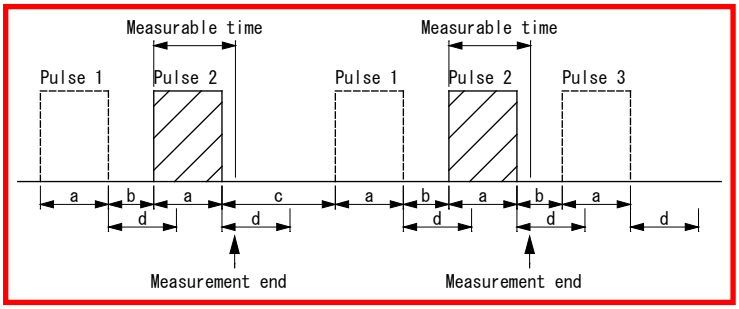


a: WELD (weld time of the welding power supply)
b: Time until the current falls below the END LEVEL setting
c: Time set in COOL TIME
d: 0.5 CYC when TIME is CYC, 1 ms when TIME is ms
e: Current flow waiting time of 500 ms

2-1) When current is first measured, and displacement, force or external input is NOT measured

The step set in PULSE No. is measured.

When the interval of the several current flows is less than 500 ms, a measurement is made as a single sequence. When 500 ms elapses, a measurement is made as another sequence.



a: WELD b: COOL, less than 500 ms
c: Interval between welding sequences, more than 500 ms
d: Current flow waiting time of 500 ms

When PULSE No. is set to 2, the second step is measured. When 500 ms elapses, a measurement of a single sequence ends.

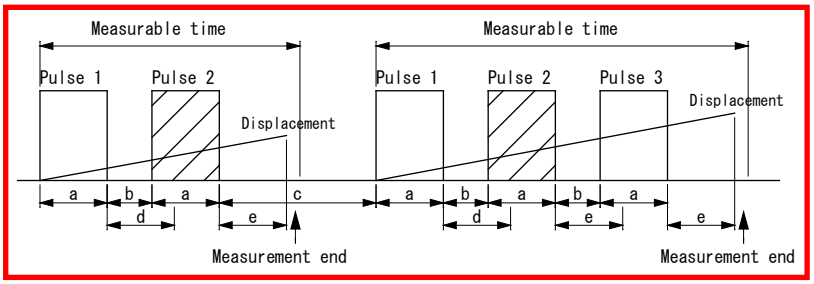
(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

2-2) When current is first measured, and displacement, force or external input is measured

The step set in PULSE No. is measured.

Before the specified step is measured, when the interval of the several current flows is less than 500 ms, a measurement is made as a single sequence. When 500 ms elapses, the impulse error occurs. After the specified step is measured, when the interval of the several current flows is shorter than the setting of FINAL DELAY TIME of DISPLACEMENT, DELAY TIME of FORCE, or DELAY TIME of EXTERNAL, a measurement is made as a single sequence. When the delay time elapses, a measurement is made as another sequence. A single welding sequence is measured as a single sequence. When the delay time elapses, a measurement is made as another sequence.

(Note) Set FINAL DELAY TIME of DISPLACEMENT, DELAY TIME of FORCE, and DELAY TIME of EXTERNAL longer than the cooling time setting of the welding power supply. Set the delay time of the item to measure.



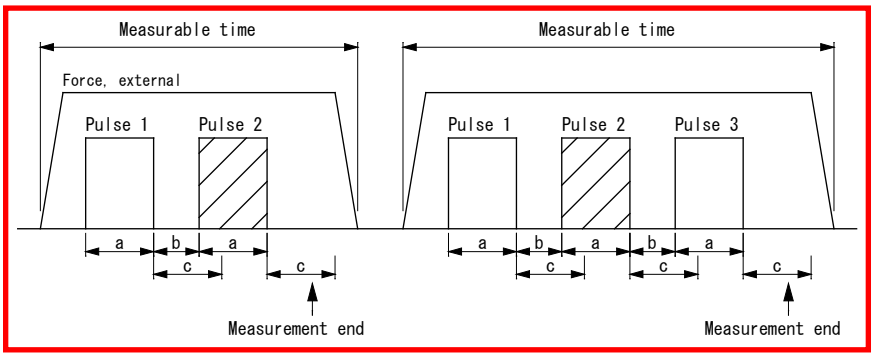
a: WELD b: COOL, less than 500 ms or delay time
c: Interval between welding sequences, more than 500 ms or delay time
d: Current flow waiting time of 500 ms e: Delay time

When PULSE No. is set to 2, the second step and DIST FINAL, FORCE FINAL or EXT FINAL after the delay time are measured and then ended. When 500 ms elapses before the specified step is measured or when the delay time elapses after the specified step is measured, a measurement of a single sequence ends.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

2-3) When force or external is first measured

When the interval of the several current flows is less than 500 ms in the measurement interval of force or external, a measurement is made as a single sequence. When 500 ms elapses, the impulse error occurs.



a: WELD b: COOL c: Current flow waiting time of 500 ms

When PULSE No. is set to 2, the second step is measured. When 500 ms elapses, a measurement of a single sequence ends.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

For FINAL DELAY TIME of DISPLACEMENT, refer to Chapter 8, “m-1. EXTEND SETUP (1) Screen.”

For DELAY TIME of FORCE, refer to Chapter 8, “m-4. EXTEND SETUP (4) Screen.”

For DELAY TIME of EXTERNAL, refer to Chapter 8, “m-6. EXTEND SETUP (6) Screen.”

- ALL PULSE (SET)
  Used when current is passed several times in a single welding sequence and the number is decided.

The instrument makes measurement of a number of times specified in PULSE No. in a single welding sequence as a single sequence.

When the number of current flow times of PULSE No. has been measured, a current measurement ends regardless of the delay time setting of displacement, force and external.

If the number of current flow times is less than the times specified by PULSE No., the impulse error occurs in the time that current is not passed after the maximum current measurement time elapses.

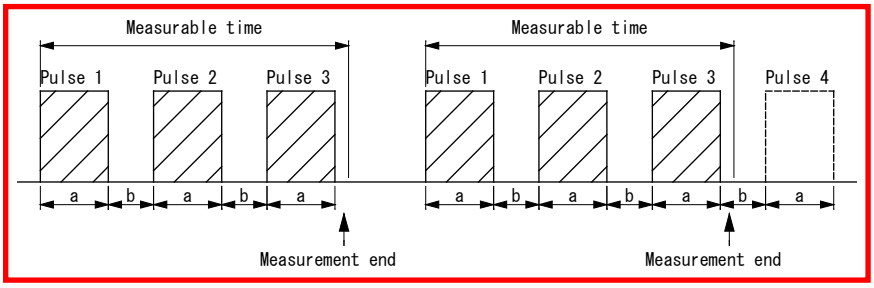
(Note) In ALL PULSE (SET), set PULSE No. to the same value as the number of current flow times in a single welding sequence.

Measurement schedule and judgment schedule
You need to set measurement schedule and judgment schedule from SCH.# of the measurement start to SCH.# of the number of current flow times. As for measurement schedule, make all SCH.# to use the same. As for judgment schedule, the schedule numbers following the schedule number of measurement start are assigned for measurement schedule, for example, first step to the schedule number of measurement start, second step to the start schedule number +1...

Ex.: When making measurement schedules for SCH.#003 to 007 contents in the BASIC SETUP (1) and (2) screens and the EXTEND SETUP (1), (4) and (6) screens the same and measuring the 3-step welding with SCH.#003

Input the judgment schedule of the first step to SCH.#003
Input the judgment schedule of the second step to SCH.#004
Input the judgment schedule of the third step to SCH.#005

1) When current is first measured, and displacement, force or external input is NOT measured

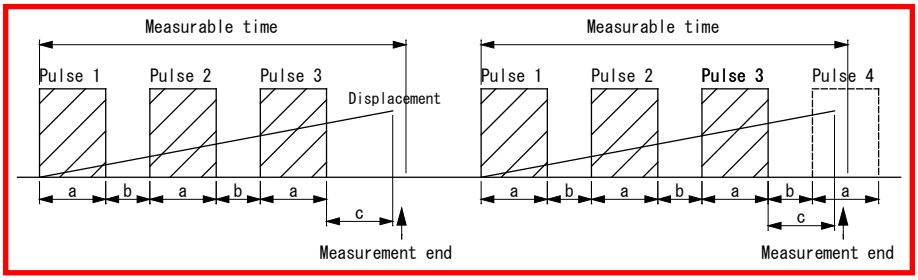


a: WELD b: COOL

When PULSE No. is set to 3, the first to third steps are measured and then ended. The fourth step is not measured.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

2) When current is first measured, and displacement, force or external input is measured

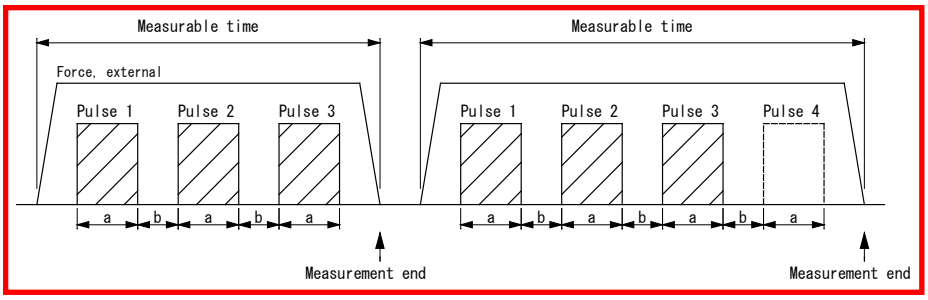


a: WELD b: COOL d: Delay time

When PULSE No. is set to 3, the first to third steps and DIST FINAL, FORCE FINAL or EXT FINAL after the delay time are measured and then ended. The fourth step is not measured.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

3) When force or external is first measured



a: WELD b: COOL

When PULSE No. is set to 3, the first to third steps are measured and then ended. The fourth step is not measured.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

For FINAL DELAY TIME of DISPLACEMENT, refer to Chapter 8, “m-1. EXTEND SETUP (1) Screen.”

For DELAY TIME of FORCE, refer to Chapter 8, “m-4. EXTEND SETUP (4) Screen.”

For DELAY TIME of EXTERNAL, refer to Chapter 8, “m-6. EXTEND SETUP (6) Screen.”

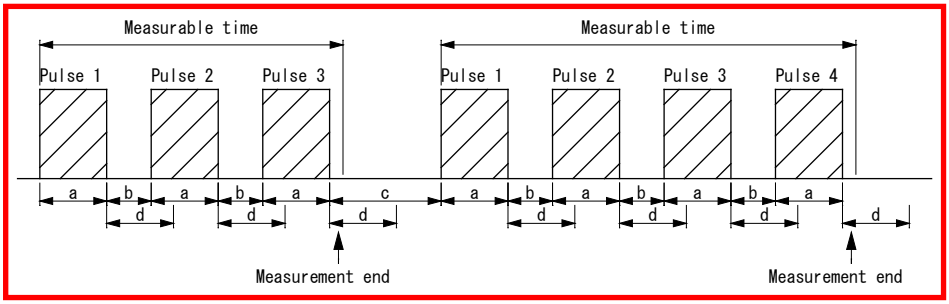
- ALL PULSE (NO SET)
  Used when current is passed several times in a single welding sequence, but the number is not decided.

PULSE No. is not used. When the interval of the several current flows is less than 500 ms, a measurement is made as a single sequence. When 500 ms elapses, a measurement is made as another sequence

The measurement schedule and judgment schedule are the same as those of ALL PULSE (SET). Set the maximum number of current flow times.

(Note) For the current flow waiting time of 500 ms, refer to "・SET PULSE, (Note) Current flow waiting time of 500 ms".

1) When current is first measured, and displacement, force or external input is NOT measured

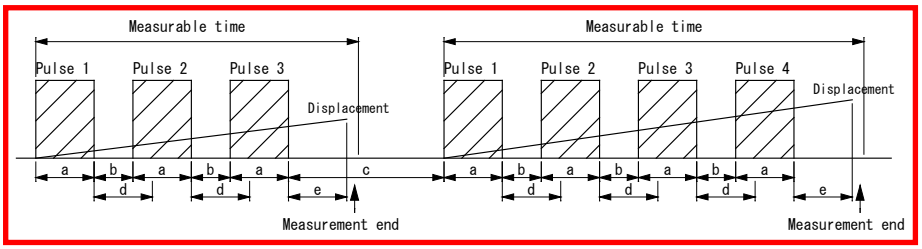


a: WELD b: COOL, less than 500 ms
c: Interval between welding sequences, 500 ms or more
d: Current flow waiting time of 500 ms

In the 3-step welding, the first to third steps are measured and then ended. In the 4-step welding, the first to fourth steps are measured and then ended. When 500 ms elapses, a measurement of a single sequence ends.

(Note) For measurable time, refer to "Measurable time of all-pulse measurement for each mode."

2) When current is first measured, and displacement, force or external input is measured

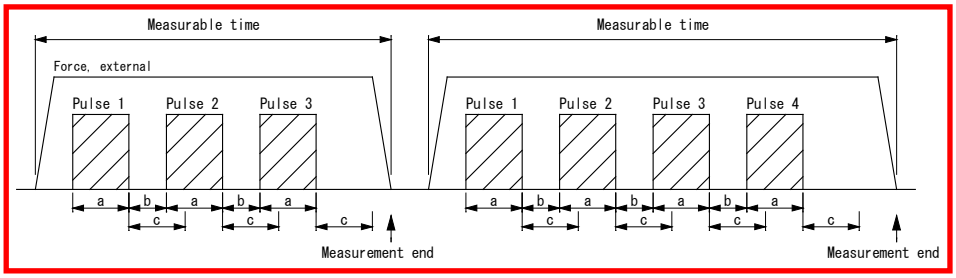


a: WELD b: COOL, less than 500 ms
c: Interval between welding sequences, 500 ms or more
d: Current flow waiting time of 500 ms e: Delay time

In the 3-step welding, the first to third steps and DIST FINAL, FORCE FINAL or EXT FINAL after the delay time are measured and then ended. In the 4-step welding, the first to fourth steps and DIST FINAL, FORCE FINAL or EXT FINAL after the delay time are measured and then ended. When 500 ms elapses, a measurement of a single sequence ends.

(Note) For measurable time, refer to "Measurable time of all-pulse measurement for each mode."

3) When force or external is first measured



a: WELD b: COOL c: Current flow waiting time of 500 ms

In the 3-step welding, the first to third steps are measured and then ended. In the 4-step welding, the first to fourth steps are measured and then ended. When 500 ms elapses, a measurement of a single sequence ends.

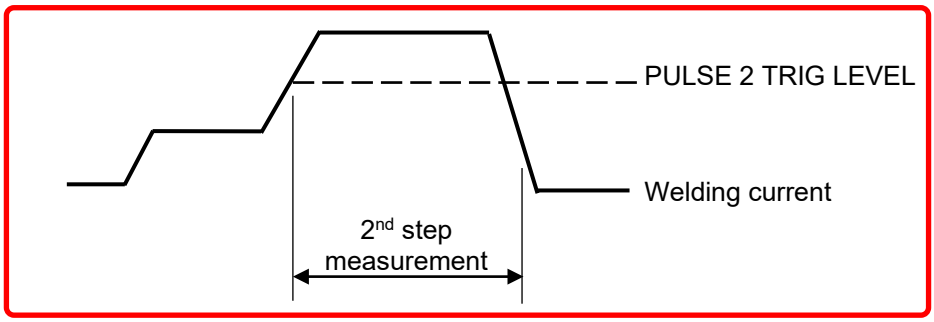
(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

For FINAL DELAY TIME of DISPLACEMENT, refer to Chapter 8, “m-1. EXTEND SETUP (1) Screen.”

For DELAY TIME of FORCE, refer to Chapter 8, “m-4. EXTEND SETUP (4) Screen.”

For DELAY TIME of EXTERNAL, refer to Chapter 8, “m-6. EXTEND SETUP (6) Screen.”

- NO COOL (2nd step measurement)
  Set a measurement start current in PULSE 2 TRIG LEVEL. The instrument starts measurement determining the point in time where the start current is exceeded as the measurement start point. Measurement is possible only if the current at the second step is larger than that at the first step.



- ALL PULSE (SET2)
  Used when current is passed several times in a single welding sequence and but the number is decided. This setting is ALL PULSE (SET) with the delay time setting, and measurement is continued when the next current flows within the delay time.

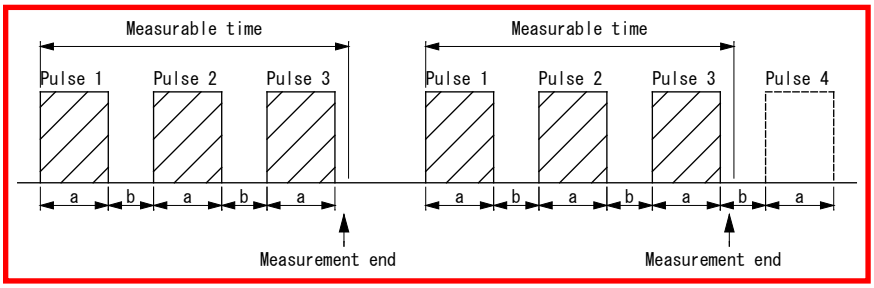
The instrument makes measurement of a number of times specified in PULSE No. in a single welding sequence and then continues measurement when the next current flows within the delay time.

If the number of current flow times is less than the times specified by PULSE No., the impulse error occurs in the time that current is not passed after the maximum current measurement time elapses.

In ALL PULSE (SET2), set PULSE No. to a value less than or equal to the minimum number of current flow times in a single welding sequence.

The measurement schedule and judgment schedule are the same as those of ALL PULSE (SET). Set the number of measurements.

1) When current is first measured, and displacement, force or external input is NOT measured (Same operation as that of ALL PULSE SET)

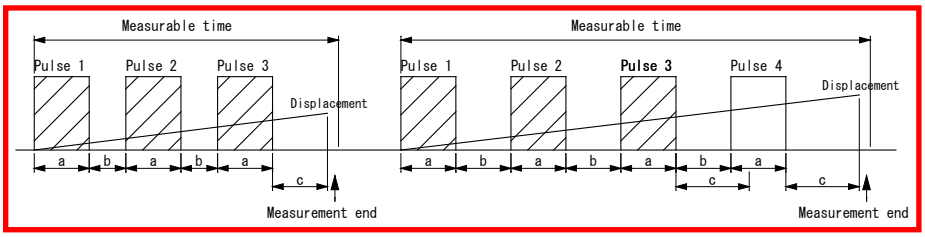


a: WELD b: COOL

When PULSE No. is set to 3, the first to third steps are measured and then ended. The fourth step is not measured.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

2) When current is first measured, and displacement, force or external input is measured

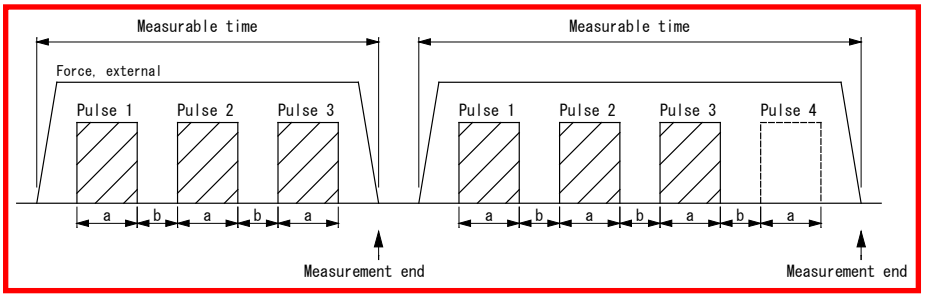


a: WELD b: COOL d: Delay time

When PULSE No. is set to 3, the first to third steps and DIST FINAL, FORCE FINAL or EXT FINAL after the delay time are measured and then ended. The fourth step is not measured.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

3) When force or external is first measured (Same operation as that of ALL PULSE SET)



a: WELD b: COOL

When PULSE No. is set to 3, the first to third steps are measured and then ended. The fourth step is not measured.

(Note) For measurable time, refer to “Measurable time of all-pulse measurement for each mode.”

For FINAL DELAY TIME of DISPLACEMENT, refer to Chapter 8, “m-1. EXTEND SETUP (1) Screen.”

For DELAY TIME of FORCE, refer to Chapter 8, “m-4. EXTEND SETUP (4) Screen.”

For DELAY TIME of EXTERNAL, refer to Chapter 8, “m-6. EXTEND SETUP (6) Screen.”

(4) PULSE No.

For a standard single pulse, set “00” for PULSE No.

When SET PULSE is selected for PULSE MODE, set the number of current flow times to measure. When ALL PULSE (SET) is selected, set the number of current flow times in a single welding sequence. When ALL PULSE (NO SET) is selected, any setting is good since PULSE No. is not used.

When NO COOL is selected for PULSE MODE, set a measurement start timing current for PULSE 2 TRIG LEVEL. For PULSE 2 TRIG LEVEL, set a value within the specified measurement range.

When LONG CYC-AC is selected for TIME, no impulse measurement is performed. To operate, select SET PULSE for PULSE MODE, and “00” for PULSE No.

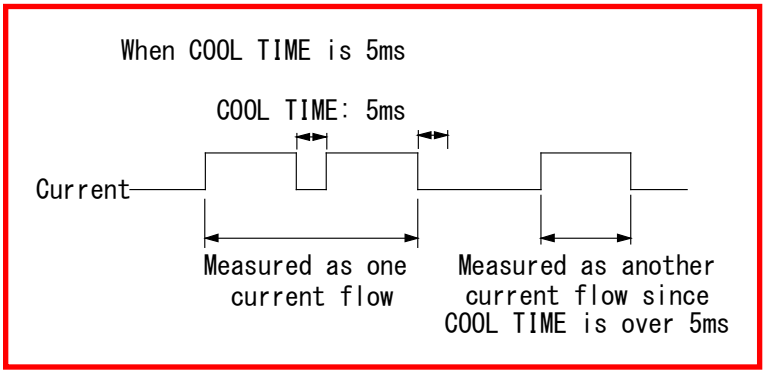
For TIME, refer to Chapter 8, “l-1. BASIC SETUP (1) Screen.”

(5) COOL TIME

If, during current measurement, the COOL TIME (time that current does not flow) is shorter than the value specified here, the instrument makes measurement determining the current to be a single current flow. Set the COOL TIME in the following ranges.

When the TRIGGER and TIME settings are changed, COOL TIME may be initialized. Set COOL TIME again. (Refer to "l-1. BASIC SETUP (1) Screen.")

- When CYC-AC, CYC-DC, LONG CYC-AC, or CYC***Hz-AC is selected for TIME: 000.5 to 100.0 CYC
- When ms-DC or ms-AC is selected for TIME: 1 to 2,000 ms
- When SHORT ms-DC is selected for TIME: 000.1 to 200.0 ms



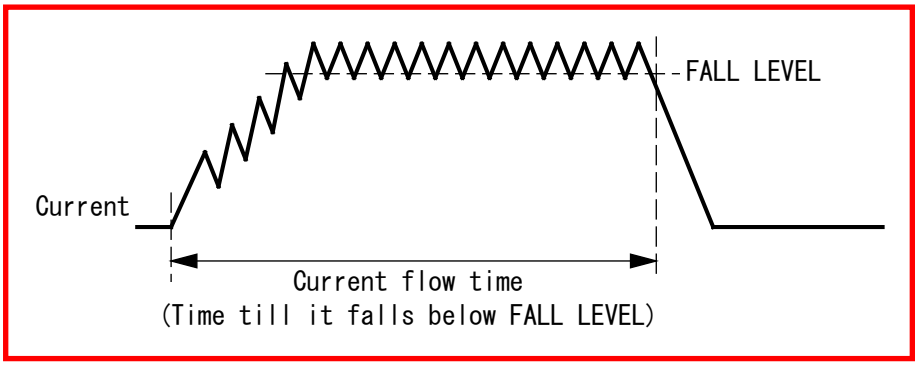
When measuring as a single current flow, set COOL TIME of **MM-400A** longer than the cooling time of the welding power supply.

When measuring as another current flow, set COOL TIME of **MM-400A** shorter than the cooling time of the welding power supply. (Use the initial setting of 0.5 CYC or 1 ms).

(6) FALL LEVEL

When ms-DC, CYC-DC or SHORT ms-DC is selected for TIME, you can measure the current flow time till the FALL LEVEL setting is reached. Set the FALL LEVEL as the ratio to the peak (10 to 90%).

Refer to (Note 1) Difference between the original measurement mode and the ISO17657-compliant measurement mode for RMS calculation in “c. VIEW Screen.”



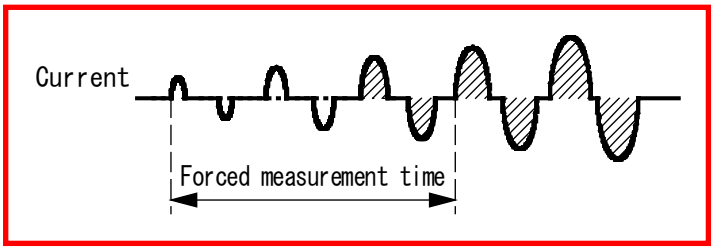
(7) MEASUREMENT MIN TIME

In the early steps of current flow, the instrument may fail to measure the current if the current is excessively low. (This likely occurs if the upslope is used.) In such a case, set a forced measurement time. Set a forced measurement time in the following ranges.

When the TRIGGER and TIME settings are changed, MEASUREMENT MIN TIME may be initialized. Set MEASUREMENT MIN TIME again. (Refer to "I-1. BASIC SETUP (1) Screen.")

- When CYC-AC, CYC-DC, LONG CYC-AC or CYC***Hz-AC is selected for TIME: 00.5 to 50.0 CYC
- When ms-DC or ms-AC is selected for TIME: 0001 to 1,000 ms
- When SHORT ms-DC is selected for TIME: 000.1 to 100.0 ms

Set a time so that currents of measurable magnitude (shaded areas in the figure) are included.



(8) MEAS INHIBIT TIME

Set a measurement prohibition time (0.0 to 10.0 sec). Select SET PULSE for PULSE MODE, and “00” for PULSE No.

By setting a measurement prohibition time, a non-measurement time following a measurement is provided not to measure a reset current following a welding current flow peculiar to a capacitor-type welding machine.

(9) END LEVEL

You can measure the current flow time till the Current End Level setting is reached. Set the Current End Level as the ratio to the used current range (1.5 to 15.0%).

Refer to (Note 1) Difference between the original measurement mode and the ISO17657-compliant measurement mode for RMS calculation in “c. VIEW Screen.”

(10) PULSE 2 TRIG LEVEL

When you have selected NO COOL for PULSE MODE, this can be set. The instrument starts measurement determining the point in time where the start current is exceeded as the measurement start point. Measurement is possible only if the current at the second step is larger than that at the first step.

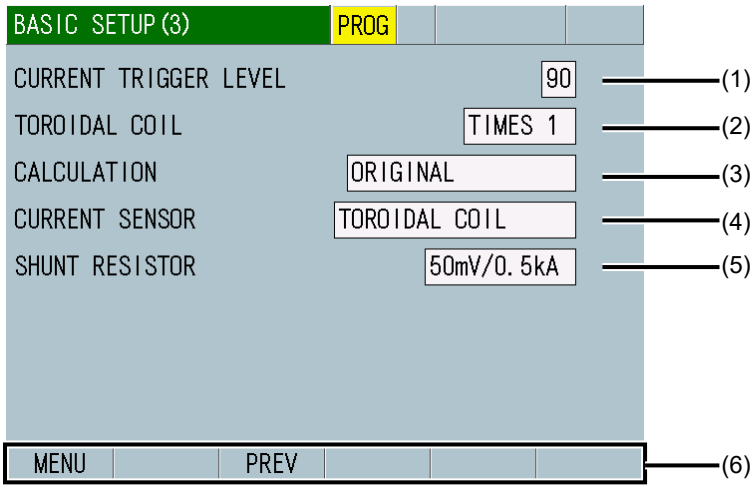
(11) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the BASIC SETUP (3) screen.

PREV: Touching this displays the BASIC SETUP (1) screen.

I-3. BASIC SETUP (3) Screen



(1) CURRENT TRIGGER LEVEL

The sensitivity increases as you increase the value. Excessively increasing the sensitivity may cause malfunction. If set to around 99, the current trigger may not be complete. At the time, decrease the value.

(2) TOROIDAL COIL

Set as follows depending on the type of toroidal coil connected:

When 1x sensitivity coil is used: 1
When 10x sensitivity coil is used: 10

(3) CALCULATION

Select original or ISO17657-compliant to set the calculation system of RMS.

Refer to (Note 1) Difference between the original measurement mode and the ISO17657-compliant measurement mode for RMS calculation in “c. VIEW Screen.”

(4) CURRENT SENSOR

Select a toroidal coil or a shunt resistor.

(Note) Even when SHUNT RESISTOR is selected, a toroidal coil is required to be connected for a current trigger.

(5) SHUNT RESISTOR

Select a conversion coefficient of shunt resistor according to the measurement current. Available only for the force/displacement-equipped specification.

- 25 to 500A: 50 mV / 0.500 kA or 100 mV / 0.500 kA
- 50 to 1000A: 50 mV / 1.000 kA or 100 mV / 1.000 kA

(Note) The position where a shunt resistor is mounted should be 50 V or less.

(6) Function keys

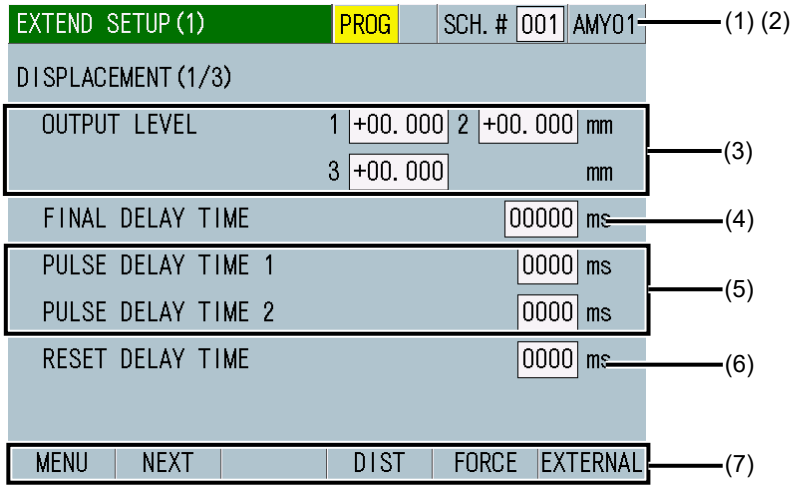
MENU: Touching this displays the MENU screen.

PREV: Touching this displays the BASIC SETUP (2) screen.

m. EXTEND SETUP Screen

This screen is displayed only in the force/displacement-equipped specification.

m-1. EXTEND SETUP (1) Screen: DISPLACEMENT (1/3)



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) OUTPUT LEVEL

If the measured value reaches the set displacement levels, you can output signals from external outputs DIST LEV1, DIST LEV2, and DIST LEV3. There are three input fields because you can specify three levels for a single measurement and measure the displacement level at three locations. The setting range varies depending on the SENSOR STEP setting in the EXTEND SETUP (3) screen: DISPLACEMENT (3/3).

- When a sensor with 1 μm resolution or less is used: -30.000 mm to +30.000 mm
- When a sensor with 1.1 μm resolution or more is used: -300.00 mm to +300.00 mm

(4) FINAL DELAY TIME

Set a delay time (welding/displacement stabilization time) from the end of current flow or from when the external displacement trigger turns OFF to when the displacement measurement position is reached in the range from 00000 to 10,000 ms. Be sure that the total of the current flow time, the displacement delay time (including the cooling time between current flows), cooling time, and time to judge the current flow end does not exceed the maximum current measurement range. Make a measurement in a marginal range since the time to judge the current flow end changed depending on the magnitude of the current.

When displacement trigger is not used:

If, following the end of the first step current flow, the second step current flow occurs before the displacement delay time elapses, the instrument measures the displacement delay time again after the end of the second step current flow.

The instrument measures the displacement after the displacement delay time elapses following the end of current flow.

When displacement trigger is used:

If the external displacement trigger turns OFF after the current flow, the instrument measures the displacement after the elapse of the displacement delay time following the turning OFF of the external displacement trigger.

If the current flow ends after the external displacement trigger turns OFF, the instrument measures the displacement after the elapse of the displacement delay time following the end of the current flow. On the other hand, if the third step current flow occurs after the second step current flow, the instrument operates in the same manner as when external displacement trigger is not used.

(5) PULSE DELAY TIME 1 / PULSE DELAY TIME 2

When you have selected DELAY TIME for MEAS AFTER PULSE, set the time from the end of WELD1 and WELD2 to the displacement measurement in the range from 0000 to 1,000 ms.

(6) RESET DELAY TIME

When you have selected REFERENCE for MEASUREMENT MODE and ON for PULSE 2 RESET, a zero rest of displacement is performed after the elapse of the time set in RESET DELAY TIME following the end of WELD1. The setting range is 0000 to 1,000 ms.

(7) Function keys

MENU: Touching this displays the MENU screen.

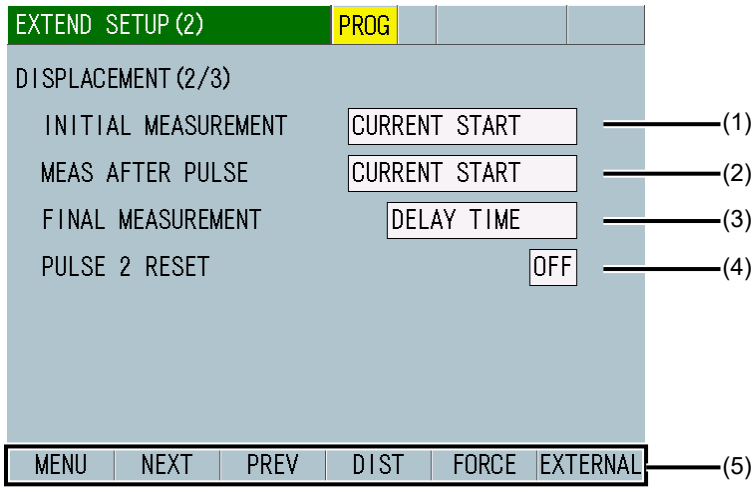
NEXT: Touching this displays the EXTEND SETUP (2): DISPLACEMENT (2/3) screen.

DIST: Touching this displays the EXTEND SETUP (2): DISPLACEMENT (2/3) screen.

FORCE: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

EXTERNAL: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

m-2. EXTEND SETUP (2) Screen: DISPLACEMENT (2/3)

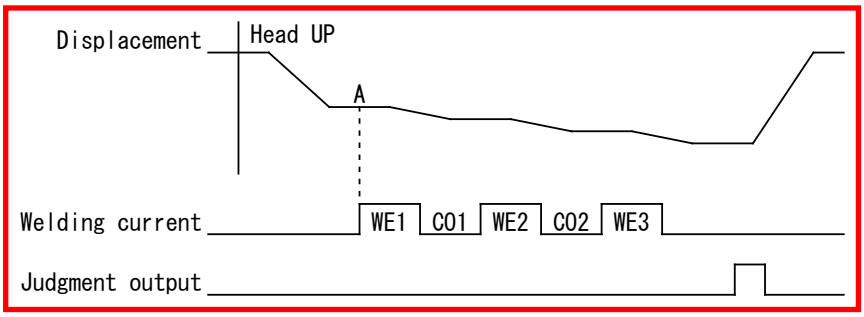


(1) INITIAL MEASUREMENT

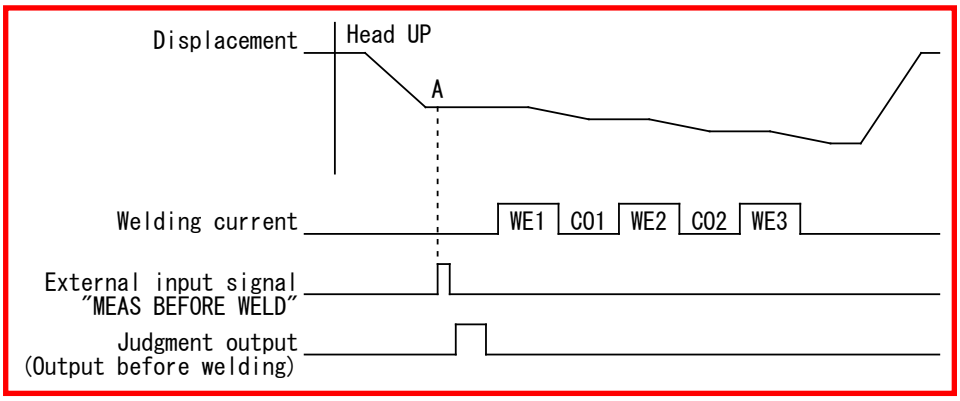
Select CURRENT START or EXTERNAL INPUT.

Available only when any of ABSOLUTE1 to ABSOLUTE4 is set for MEASUREMENT MODE.

- When CURRENT START is selected for INITIAL MEASUREMENT



- When EXTERNAL START is selected for INITIAL MEASUREMENT

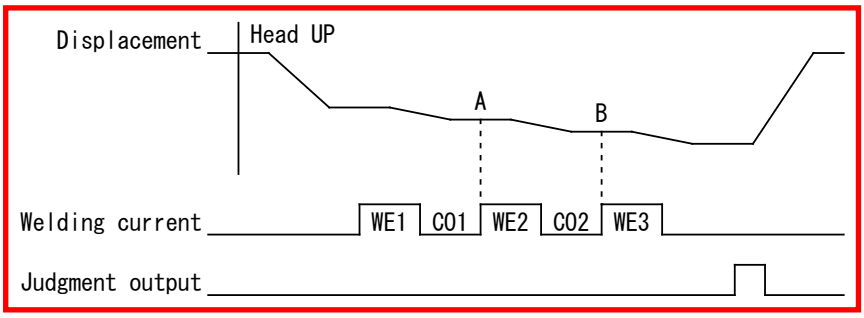


A: Measurement of “DIST INITIAL”

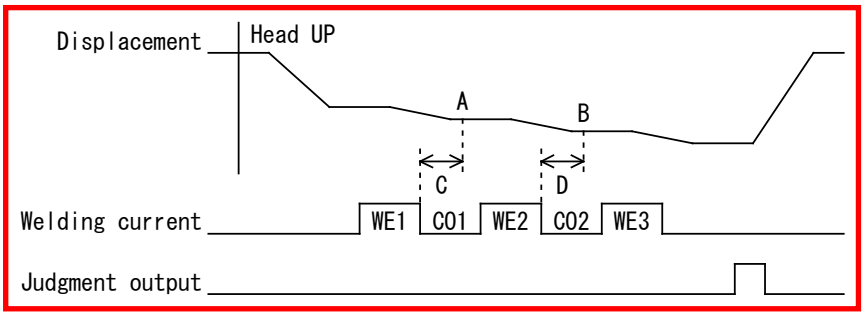
(2) MEAS AFTER PULSE

Select CURRENT START or DELAY TIME.

- When CURRENT START is selected for MEAS AFTER PULSE



- When DELAY TIME is selected for MEAS AFTER PULSE

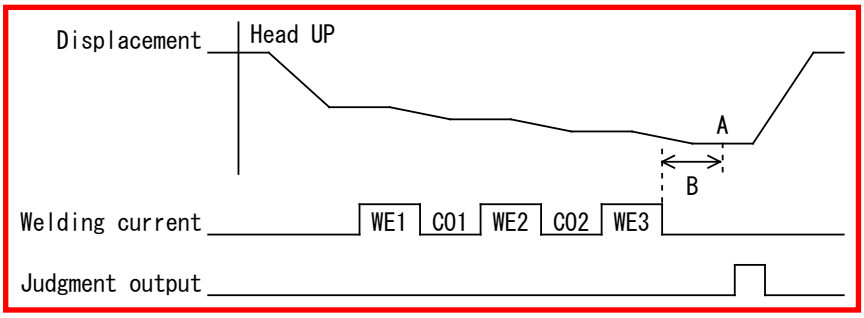


A: Measurement of “DIST PULSE1” B: Measurement of “DIST PULSE2”
C: Pulse delay time 1 D: Pulse delay time 2

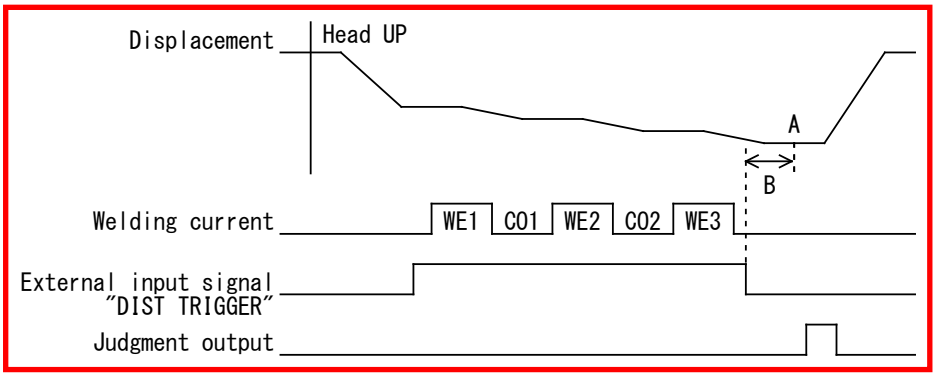
(3) FINAL MEASUREMENT

Select DELAY TIME or EXTERNAL INPUT.

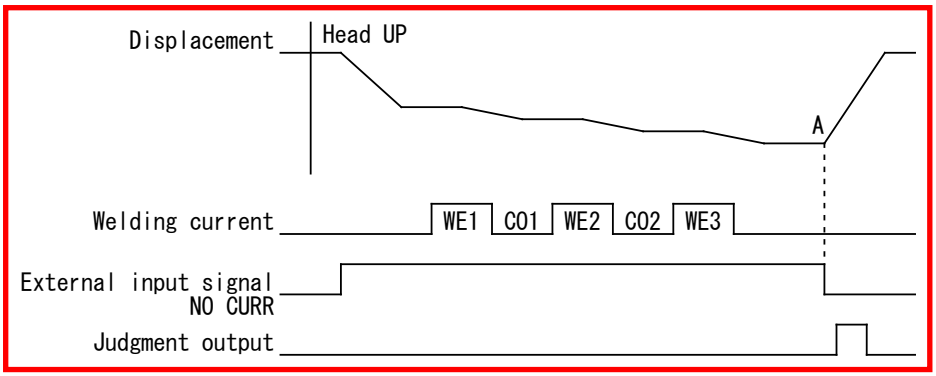
- When DELAY TIME is selected for FINAL MEASUREMENT, and an option other than REAL TIME and DISPLACEMENT (EXT) is selected for TRIGGER



- When DELAY TIME is selected for FINAL MEASUREMENT, and DISPLACEMENT (EXT) is selected for TRIGGER



- When EXTERNAL INPUT is selected for FINAL MEASUREMENT



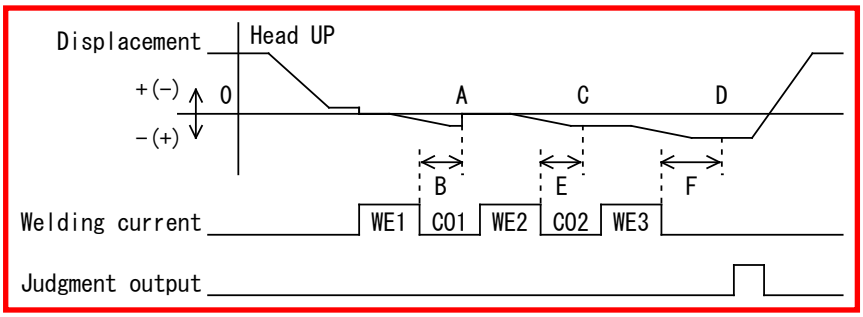
A: Measurement of “DIST FINAL” B: Final delay time

For the trigger, refer to Chapter 8, “I-1. BASIC SETUP (1) Screen.”

(4) PULSE 2 RESET

Select OFF or ON.

Available only when REFERENCE is set for MEASUREMENT MODE. For the measurement mode, refer to Chapter 8, “m-3. EXTEND SETUP (3) Screen.”



A: A zero rest of displacement is performed after the elapse of RESET DELAY TIME following the end of WE1.
B: Reset delay time
C: Measurement of “DIST PULSE2”
D: Measurement of “DIST FINAL”
E: Pulse delay time 2
F: Final delay time

(5) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the EXTEND SETUP (3): DISPLACEMENT (3/3) screen.

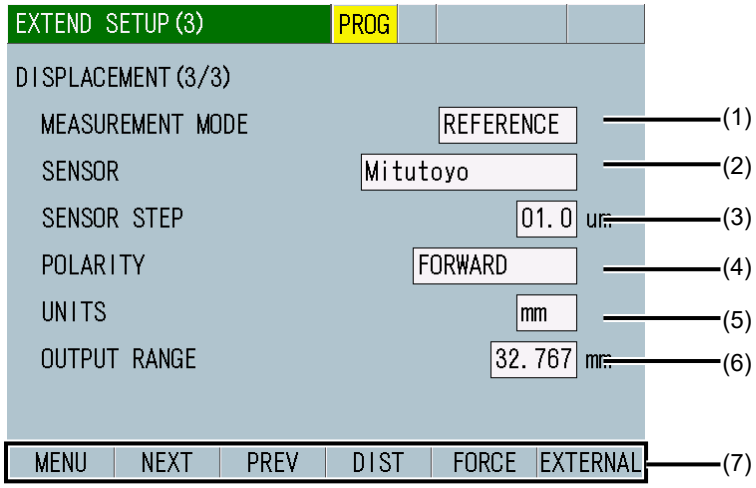
PREV: Touching this displays the EXTEND SETUP (1): DISPLACEMENT (1/3) screen.

DIST: Touching this displays the EXTEND SETUP (3): DISPLACEMENT (3/3) screen.

FORCE: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

EXTERNAL: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

m-3. EXTEND SETUP (3) Screen: DISPLACEMENT (3/3)



(1) MEASUREMENT MODE

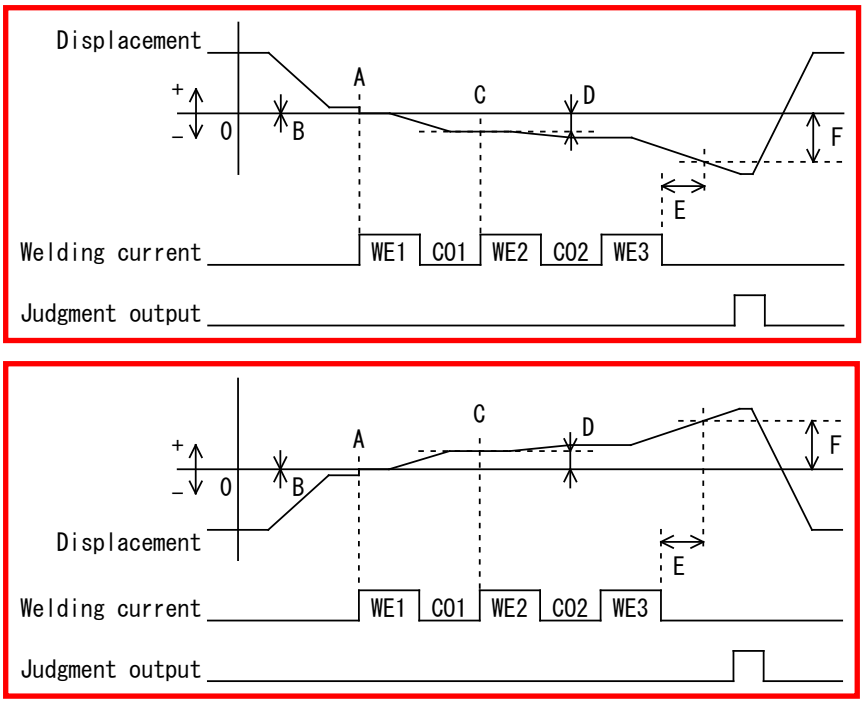
Select the displacement measurement system from the following:

REFERENCE: The displacement is reset (0 mm) at the start of current or the external input signal “DIST TRIGGER” and the measurement is started.

In “DIST INITIAL”, “DIST PULSE1”, “DIST PULSE2”, and “DIST FINAL”, the moving amount from the position set to 0 mm at the start of current or the external input signal “DIST TRIGGER” is measured.

The displacement level 1 to 3 outputs “DIST LEV1 to 3” are output when moving from the position set to 0 mm at the start of current or the external input signal “DIST TRIGGER” is output.
In the level output, signals are output when “measured value ≥ level output value” is satisfied in plus (+) setting and “measured value ≤ level output value” is satisfied in minus (-) setting.

When setting TRIGGER to “CURRENT”, INITIAL MEASUREMENT to “CURRENT START”, MEAS AFTER PULSE to “CURRENT START”, and FINAL MEASUREMENT to “DELAY TIME” to measure “DIST INITIAL”, “DIST PULSE1” and “DIST FINAL.”



- Performs a reset (0 mm) of displacement at the timing of WE1 current start (A).
- Measures the position of 0 mm as “DIST INITIAL” (B) at the timing of WE1 current start (A). (To measure “DIST INITIAL”, use any of ABSOLUTE1 to ABSOLUTE4.)
- Measures the moving amount from the position set to 0 mm at the start of current as “DIST PULSE1” (D) at the timing of WE2 current start (C).
- Measures the moving amount from the position set to 0 mm at the start of current as “DIST FINAL” (F) at the timing of the elapse of the delay time (E).

ABSOLUTE1: The position of 0 mm is set in advance and the displacement is measured.

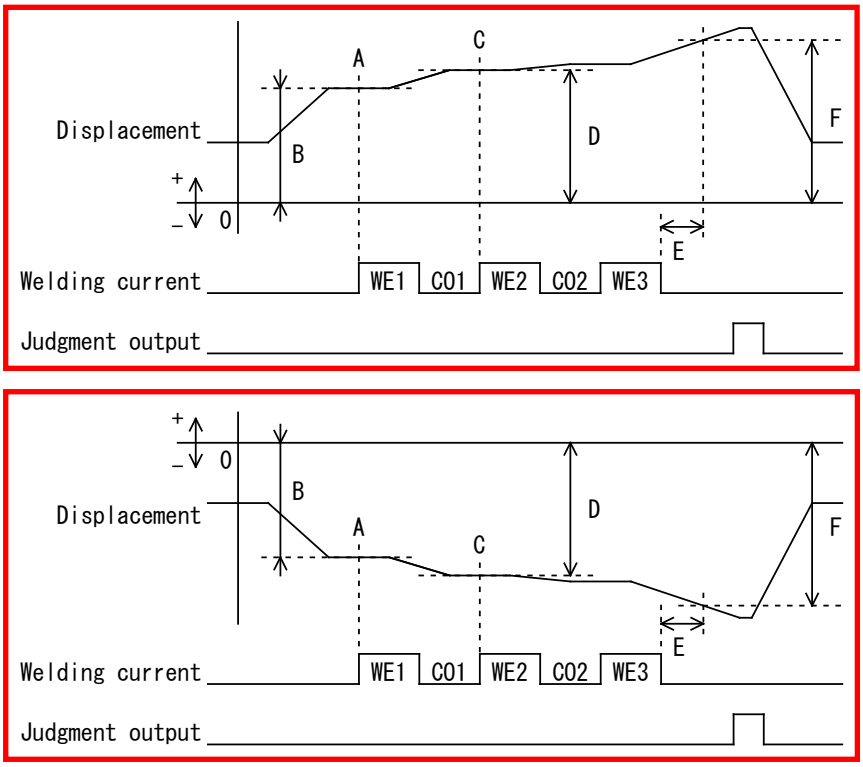
In “DIST INITIAL”, “DIST PULSE1”, “DIST PULSE2”, and “DIST FINAL”, the moving amount from the position set to 0 mm set in advance is measured.

The displacement level 1 to 3 outputs “DIST LEV1 to 3” are output when moving away from the position set to 0 mm set in advance is output.
In the level output, signals are output when “measured value ≥ level output value” is satisfied in plus (+) setting and “measured value ≤ level output value” is satisfied in minus (-) setting.

By applying force without setting workpieces, perform a reset with a reference position (0 mm).

When using a Mitutoyo’s, HEIDENHAIN’s, or Ono Sokki’s displacement sensor, the displacement position cannot be held with the power supply of the **MM-400A** turned off. Reset displacement after turning on the power supply of the **MM-400A**.

When setting TRIGGER to “CURRENT”, INITIAL MEASUREMENT to “CURRENT START”, MEAS AFTER PULSE to “CURRENT START”, and FINAL MEASUREMENT to “DELAY TIME” to measure “DIST INITIAL”, “DIST PULSE1” and “DIST FINAL.”



- Measures the moving amount from the position set to 0 mm in advance as “DIST INITIAL” (B) at the timing of WE1 current start (A).
- Measures the moving amount from the position set to 0 mm in advance as “DIST PULSE1” (D) at the timing of WE2 current start (C).
- Measures the moving amount from the position set to 0 mm in advance as “DIST FINAL” (F) at the timing of the elapse of the delay time (E).

For the trigger, refer to Chapter 8, “I-1. BASIC SETUP (1) Screen.”

(Caution) When measuring displacement (at the start of current, at the start of the external input signal “DIST TRIGGER”, and constantly) by changing MEASUREMENT MODE to REFERENCE, displacement is reset (0 mm).

ABSOLUTE2: The position of 0 mm is set in advance and the displacement is measured.

In “DIST PULSE1”, “DIST PULSE2”, and “DIST FINAL”, the moving amount from the position set to 0 mm at the start of current or the external input signal “DIST TRIGGER” is measured.

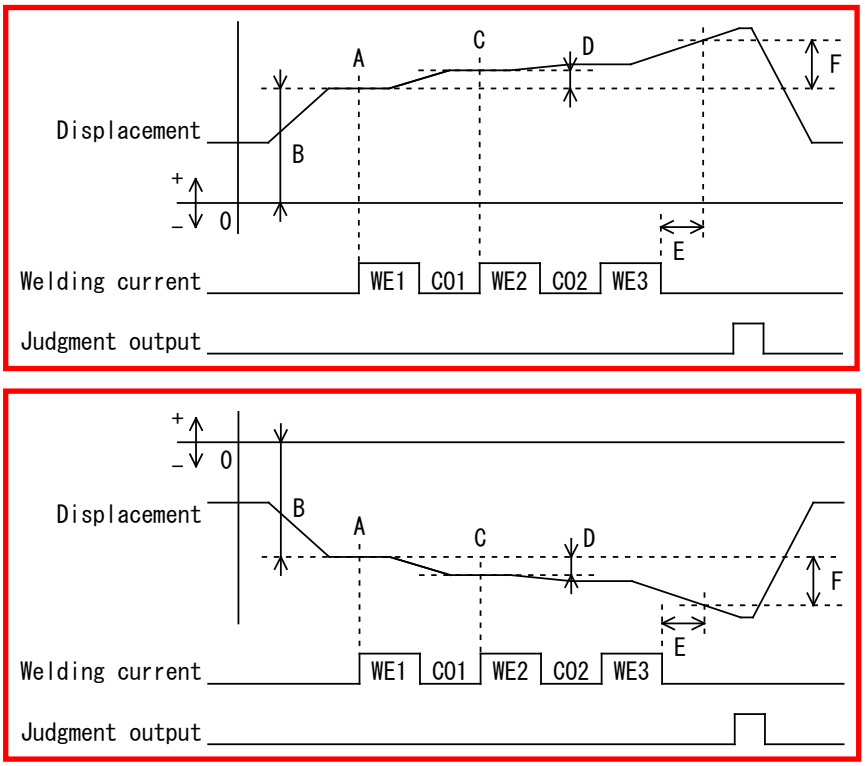
In “DIST INITIAL”, the moving amount from the position set to 0 mm set in advance is measured.

The displacement level 1 to 3 outputs “DIST LEV1 to 3” are output when moving away from the position set to 0 mm set in advance is output.
In the level output, signals are output when “measured value ≥ level output value” is satisfied in plus (+) setting and “measured value ≤ level output value” is satisfied in minus (-) setting.

By applying force without setting workpieces, perform a reset with a reference position (0 mm).

When using a Mitutoyo’s, HEIDENHAIN’s, or Ono Sokki’s displacement sensor, the displacement position cannot be held with the power supply of the **MM-400A** turned off. Reset displacement after turning on the power supply of the **MM-400A**.

When setting TRIGGER to “CURRENT”, INITIAL MEASUREMENT to “CURRENT START”, MEAS AFTER PULSE to “CURRENT START”, and FINAL MEASUREMENT to “DELAY TIME” to measure “DIST INITIAL”, “DIST PULSE1” and “DIST FINAL.”



- Measures the moving amount from the position set to 0 mm in advance as “DIST INITIAL” (B) at the timing of WE1 current start (A).
- Measures the moving amount from the position of the current start (A) as “DIST PULSE1” (D) at the timing of WE2 current start (C).
- Measures the moving amount from the position of the current start (A) as “DIST FINAL” (F) at the timing of the elapse of the delay time (E).

For the trigger, refer to Chapter 8, “I-1. BASIC SETUP (1) Screen.”

(Caution) When measuring displacement (at the start of current, at the start of the external input signal “DIST TRIGGER”, and constantly) by changing MEASUREMENT MODE to REFERENCE, displacement is reset (0 mm).

ABSOLUTE3: The position of 0 mm is set in advance and the displacement is measured.

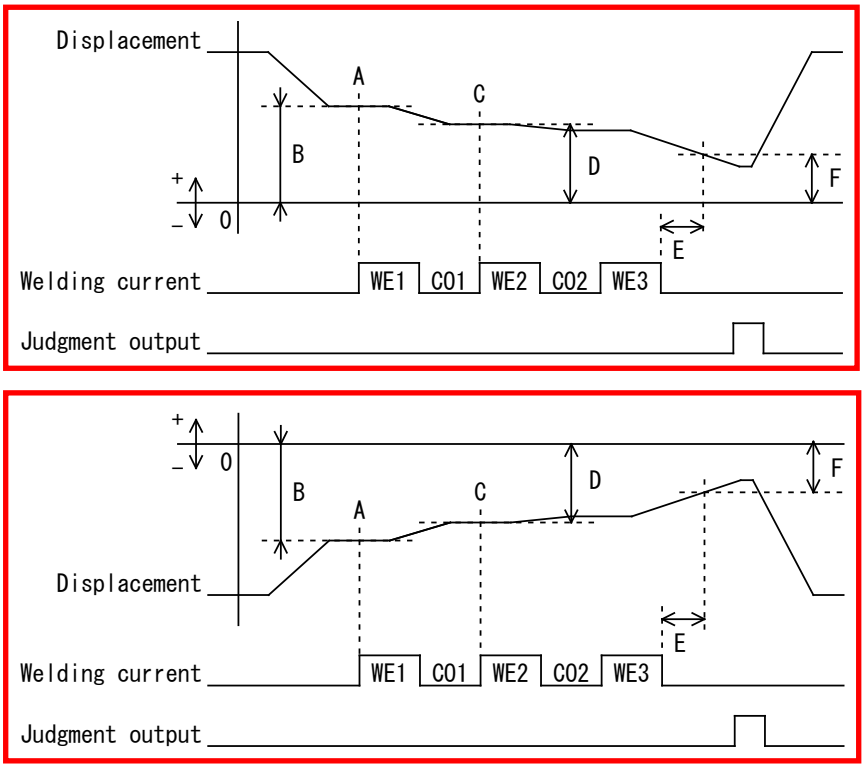
In “DIST INITIAL”, “DIST PULSE1”, “DIST PULSE2”, and “DIST FINAL”, the moving amount from the position set to 0 mm set in advance is measured.

The displacement level 1 to 3 outputs “DIST LEV1 to 3” are output when moving close to the position set to 0 mm set in advance is output.
In the level output, signals are output when “measured value ≤ level output value” is satisfied in plus (+) setting and “measured value ≥ level output value” is satisfied in minus (-) setting.

By applying force without setting workpieces, perform a reset with a reference position (0 mm).

When using a Mitutoyo’s, HEIDENHAIN’s, or Ono Sokki’s displacement sensor, the displacement position cannot be held with the power supply of the **MM-400A** turned off. Reset displacement after turning on the power supply of the **MM-400A**.

When setting TRIGGER to “CURRENT”, INITIAL MEASUREMENT to “CURRENT START”, MEAS AFTER PULSE to “CURRENT START”, and FINAL MEASUREMENT to “DELAY TIME” to measure “DIST INITIAL”, “DIST PULSE1” and “DIST FINAL.”



- Measures the moving amount from the position set to 0 mm in advance as “DIST INITIAL” (B) at the timing of WE1 current start (A).
- Measures the moving amount from the position set to 0 mm in advance as “DIST PULSE1” (D) at the timing of WE2 current start (C).
- Measures the moving amount from the position set to 0 mm in advance as “DIST FINAL” (F) at the timing of the elapse of the delay time (E).

For the trigger, refer to Chapter 8, “I-1. BASIC SETUP (1) Screen.”

(Caution) When measuring displacement (at the start of current, at the start of the external input signal “DIST TRIGGER”, and constantly) by changing MEASUREMENT MODE to REFERENCE, displacement is reset (0 mm).

ABSOLUTE4: The position of 0 mm is set in advance and the displacement is measured.

In “DIST PULSE1”, “DIST PULSE2”, and “DIST FINAL”, the moving amount from the position set to 0 mm at the start of current or the external input signal “DIST TRIGGER” is measured.

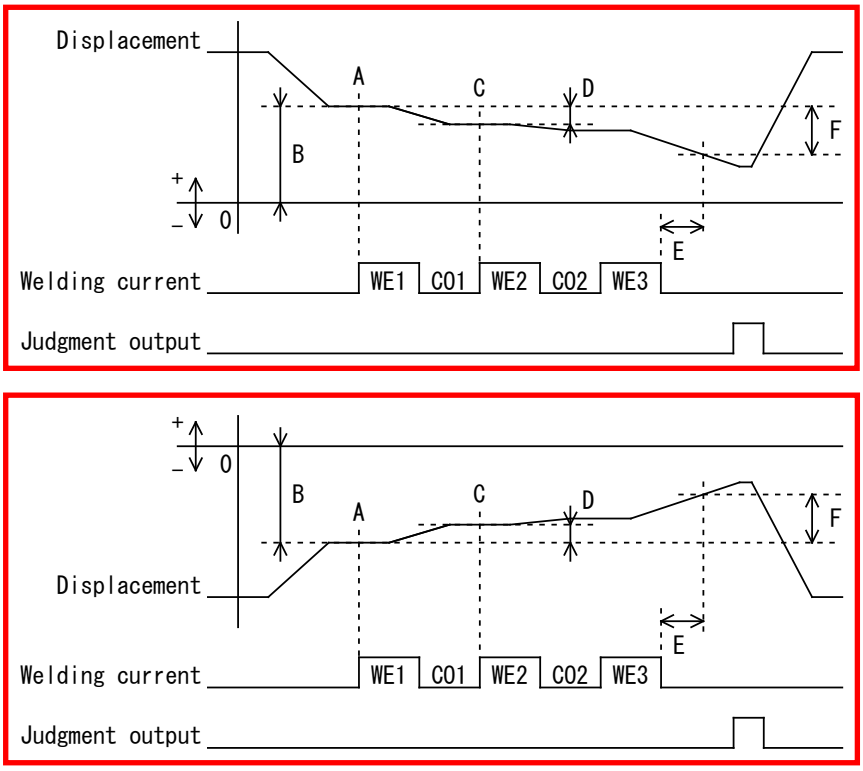
In “DIST INITIAL”, the moving amount from the position set to 0 mm set in advance is measured.

The displacement level 1 to 3 outputs “DIST LEV1 to 3” are output when moving close to the position set to 0 mm set in advance is output.
In the level output, signals are output when “measured value ≤ level output value” is satisfied in plus (+) setting and “measured value ≥ level output value” is satisfied in minus (-) setting.

By applying force without setting workpieces, perform a reset with a reference position (0 mm).

When using a Mitutoyo’s, HEIDENHAIN’s, or Ono Sokki’s displacement sensor, the displacement position cannot be held with the power supply of the **MM-400A** turned off. Reset displacement after turning on the power supply of the **MM-400A**.

When setting TRIGGER to “CURRENT”, INITIAL MEASUREMENT to “CURRENT START”, MEAS AFTER PULSE to “CURRENT START”, and FINAL MEASUREMENT to “DELAY TIME” to measure “DIST INITIAL”, “DIST PULSE1” and “DIST FINAL.”



- Measures the moving amount from the position set to 0 mm in advance as “DIST INITIAL” (B) at the timing of WE1 current start (A).
- Measures the moving amount from the position of the current start (A) as “DIST PULSE1” (D) at the timing of WE2 current start (C).
- Measures the moving amount from the position of the current start (A) as “DIST FINAL” (F) at the timing of the elapse of the delay time (E).

For the trigger, refer to Chapter 8, “I-1. BASIC SETUP (1) Screen.”

(Caution) When measuring displacement (at the start of current, at the start of the external input signal “DIST TRIGGER”, and constantly) by changing MEASUREMENT MODE to REFERENCE, displacement is reset (0 mm).

(2) SENSOR

Select the manufacturer's name of the sensor to be connected from the following:

Ono Sokki, Mitutoyo, KEYENCE, HEIDENHAIN

(3) SENSOR STEP

Enter the displacement sensor resolution. Set the value between 0.1 to 10.0 μm.

(Ex.) **GS-1830A**, **GS-1813A**, **LGK-110**, **LG200-110**: 1.0 μm
ST1278: 0.5 μm

The measurement range changes depending on the SENSOR STEP setting. The measurement range of displacement is ± (SENSOR STEP setting x 30000) μm.

(Ex.) When the SENSOR STEP setting is 1 μm:
± (1 x 30000) μm = ±30000 μm = ±30 mm

(4) POLARITY

Set the displacement polarity.

FORWARD: Plus (+) in the direction of displacement sensor retraction)
REVERSE: Minus (-) in the direction of displacement sensor retraction)

(5) UNITS

Select mm or inch as the unit to measure and display the displacement.

(6) OUTPUT RANGE

Select an analog output range for displacement.

Setting	Output voltage and displacement	Multiplying factor
2 mm	±2.047 mm (±5 V)	16x
10 mm	±8.191 mm (±5 V)	4x
30 mm	±32.767 mm (±5 V)	1x

(7) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

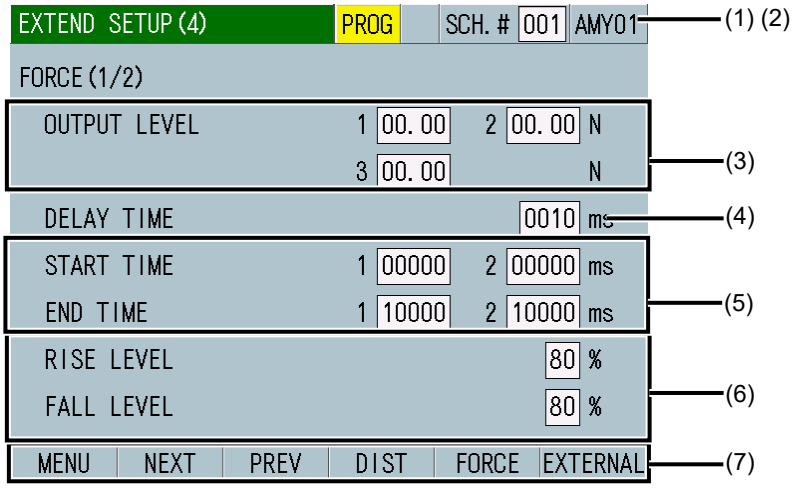
PREV: Touching this displays the EXTEND SETUP (2): DISPLACEMENT (2/3) screen.

DIST: Touching this displays the EXTEND SETUP (1): DISPLACEMENT (1/3) screen.

FORCE: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

EXTERNAL: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

m-4. EXTEND SETUP (4) Screen: FORCE (1/2)



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) OUTPUT LEVEL

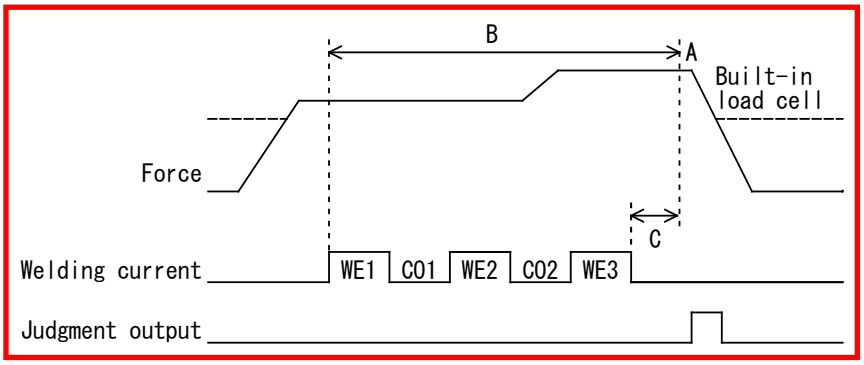
You can output signals from external outputs FORCE LEV1, FORCE LEV2 and FORCE LEV3 if the measured value exceeds the set force level. There are three input fields because you can specify three levels for a single measurement and measure the force level at three locations. Set a force level within the set measurement range.

(4) DELAY TIME

Set a delay time from the end of current flow to when the force measurement interval or position is reached in the range from 0 to 1,000 ms.

Be sure that the total of the current flow time, the delay time (including the cooling time between current flows), cooling time, and time to judge the current flow end does not exceed the maximum current measurement range.

Make a measurement in a marginal range since the time to judge the current flow end changed depending on the magnitude of the current.



A: Measurement of “FORCE FINAL”
B: Measurement range of “FORCE PEAK”, “FORCE AVG1” and “FORCE AVG2”
C: Delay time

(5) START TIME / END TIME

By specifying an arbitrary range, you can measure mean force. Set START TIME and END TIME in the range from 0 to 10,000 ms. As for force, there are three input fields for each item because you can specify three ranges for a single measurement and measure the force at three locations.

(6) RISE LEVEL / FALL LEVEL

Set RISE LEVEL and FALL LEVEL as the ratio to the peak (10 to 90%). This setting applies to the time measurements in the FORCE TIMING screen.

(7) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the EXTEND SETUP (5): FORCE (2/2) screen.

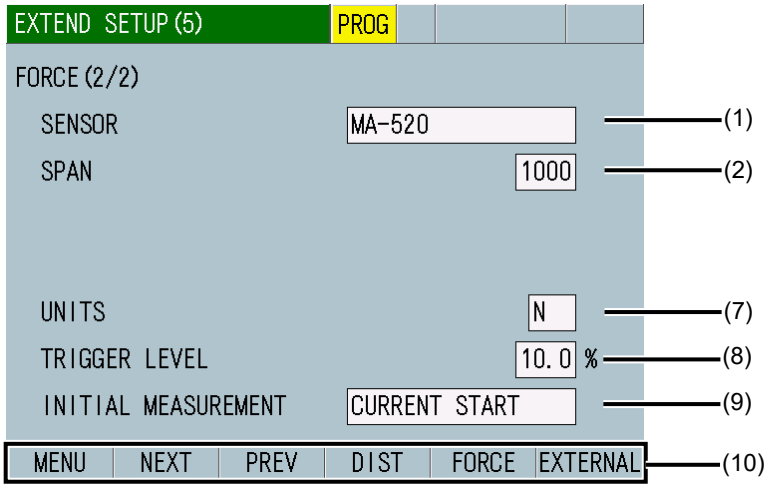
PREV: Touching this displays the EXTEND SETUP (3): DISPLACEMENT (3/3) screen.

DIST: Touching this displays the EXTEND SETUP (1): DISPLACEMENT (1/3) screen.

FORCE: Touching this displays the EXTEND SETUP (5): FORCE (2/2) screen.

EXTERNAL: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

m-5. EXTEND SETUP (5) Screen: FORCE (2/2)



(1) SENSOR

Select the connected force sensor from the following.

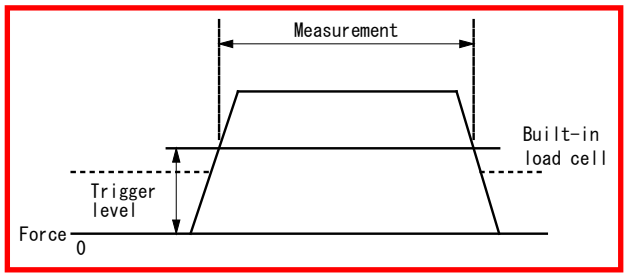
Force sensor	SENSOR setting	TRIGGER LEVEL setting
MA-520-01, MA-520B-00	MA-520	Absolute value
MA-521-01, MA-521B-00	MA-521	
MA-522-01, MA-522B-00	MA-522	
MA-770A-00	MA-770	
MA-771A-00	MA-771	
Sensors other than above	RATED SETTING1	
	RATED SETTING2	Relative value

When the SENSOR setting is changed, RATE may be initialized. Set RATE again.

- When setting TRIGGER LEVEL by an absolute value

When selecting MA-520, MA-521, MA-522, MA-770, MA-771, or RATED SETTING1, the measurement starts when the force set in TRIGGER LEVEL is exceeded.

Set the force of TRIGGER LEVEL set when changing into the measurement mode (MEAS).

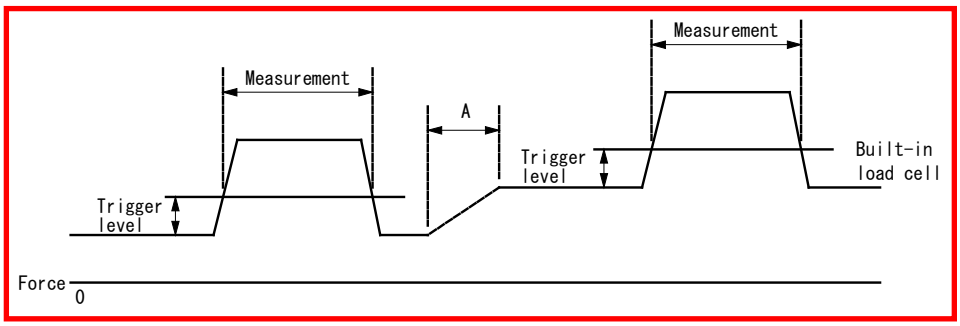


- When setting TRIGGER LEVEL by a relative value

When selecting RATED SETTING2, the measurement starts when the force set in TRIGGER LEVEL changes.

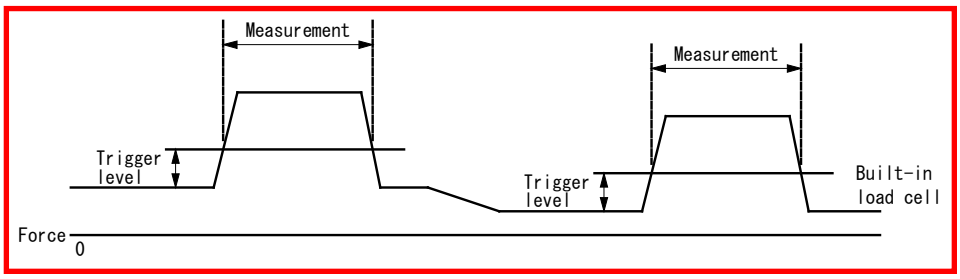
Based on the force when the mode is changed into the measurement mode (MEAS), set the force of TRIGGER LEVEL.

TRIGGER LEVEL is not set at the program mode (PROG) or power-off and it is reset when the mode is changed into the measurement mode (MEAS). Before changing the force of the welding head, change the mode into the program mode (PROG).



A: At the program mode (PROG) or power-off

When the force is reduced in the measurement mode (MEAS), change the force of TRIGGER LEVEL with the reduced force.



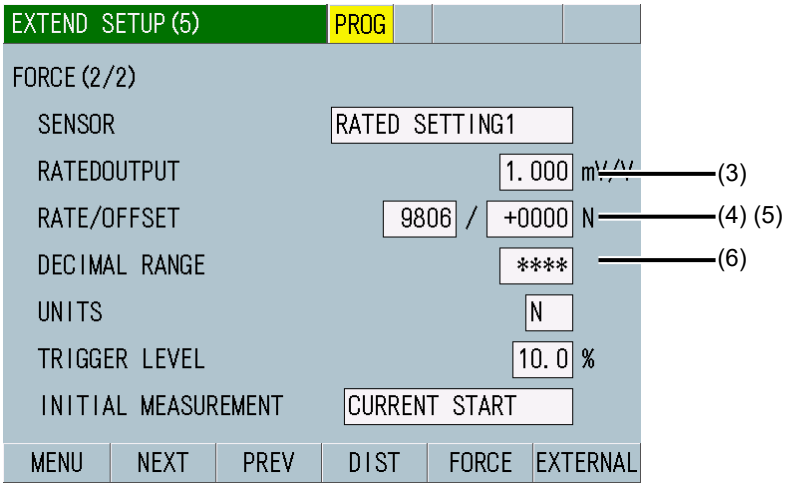
(2) SPAN

When you have not selected RATED SETTING1 or RATED SETTING2 for SENSOR, select a force span (500 to 1,500). Corrects the sensor output. Since the sensor have some variation in accuracy, value and force span to

correct it are listed on the label of our force sensor and current/force sensor. Set the value of force span on the label to the SPAN.

(3) RATED OUTPUT

When you have selected RATED SETTING1 or RATED SETTING2 for SENSOR, set the rated output of force (0.750 to 2.000). The rated output value is shown in the test report of the purchased load cell. (The set value is not changed even if initialized.)



(4) RATE

When you have selected RATED SETTING1 or RATED SETTING2 for SENSOR, set a force rating as follows:

DECIMAL RANGE	RATE		
	UNITS “N”	UNITS “kgf”	UNITS “lbf”
.	4.90 to 98.06	0.50 to 10.00	1.10 to 22.04
***.*	49.0 to 980.6	5.0 to 100.0	11.0 to 220.4
****	490 to 9806	50 to 1000	110 to 2204

(Caution) When the UNITS setting is changed, the RATE setting should be also changed. (It is not calculated automatically.) Conversion example) “1 N = 0.10197 kgf = 0.2248 lbf”

When the SENSOR and UNITS settings are changed, RATE may be initialized. Set RATE again.

(5) OFFSET

Performs correction for the measured value of force. Usually, do not change the setting.

The measured values of measurement items “FORCE PEAK”, “FORCE AVG1”, “FORCE AVG2”, “FORCE” INITIAL, “FORCE FINAL”, and “FORCE REAL TIME” are corrected.

Difference between the force sensor built in the pressure follow-up mechanism element and the force sensor sandwiched by electrodes for measurement can be corrected.

DECIMAL RANGE	OFFSET
.	-99.99 to +99.99
***.*	-999.9 to +999.9
****	-9999 to +9999

This correction also affects the measurement of TRIGGER LEVEL to start measurement of force. When setting OFFSET, also review the TRIGGER LEVEL setting.

(6) DECIMAL RANGE

When you have selected RATED SETTING1 or RATED SETTING2 for SENSOR, set a decimal point as follows: **.**, ***.*, ****

(7) UNITS

Select the force unit used for settings and display related to force from N, kgf, and lbf.

When the UNITS setting is changed, RATE may be initialized. Set RATE again.

(8) TRIGGER LEVEL

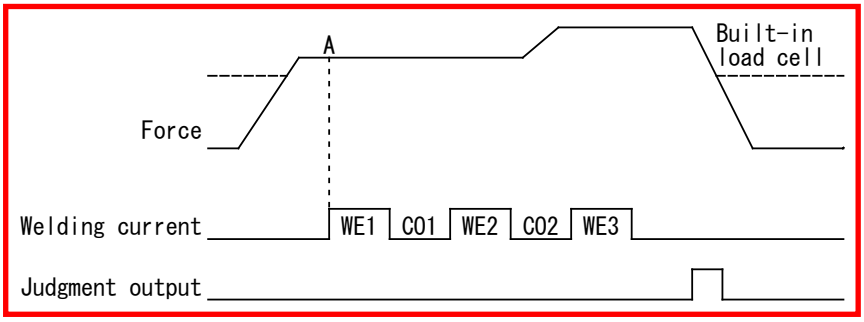
Set a trigger level (1.0 to 99.9%) as the percentage of full scale. A force is measured while it exceeds the trigger level.

Set it to 99.9% when performing measurement according to the current measurement start.

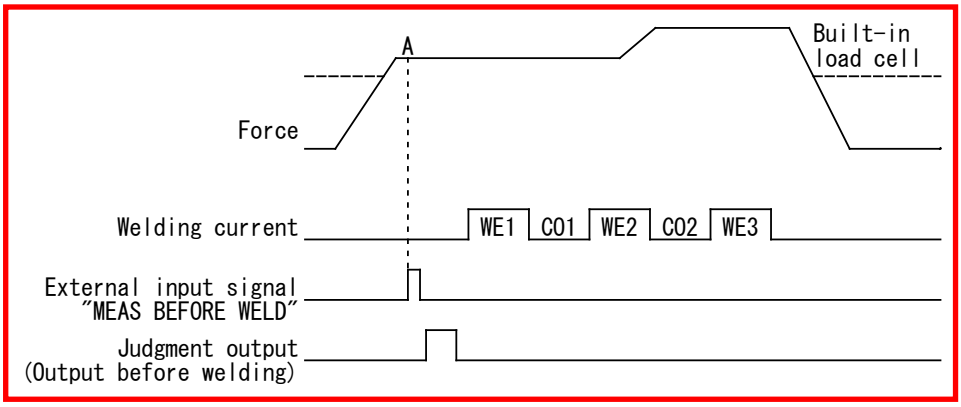
(9) INITIAL MEASUREMENT

Select CURRENT START or EXTERNAL INPUT.

CURRENT START: The force before welding is measured when the WE1 starts.



EXTERNAL INPUT: When the MEAS BEFORE WELD input signal (refer to (1) in “o-1. EXT INPUT/OUTPUT (1) Screen”) is received, the force before welding is measured. After measurement, judgment of the output before welding can be set.



A: Measurement of “FORCE INITIAL”

(10) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

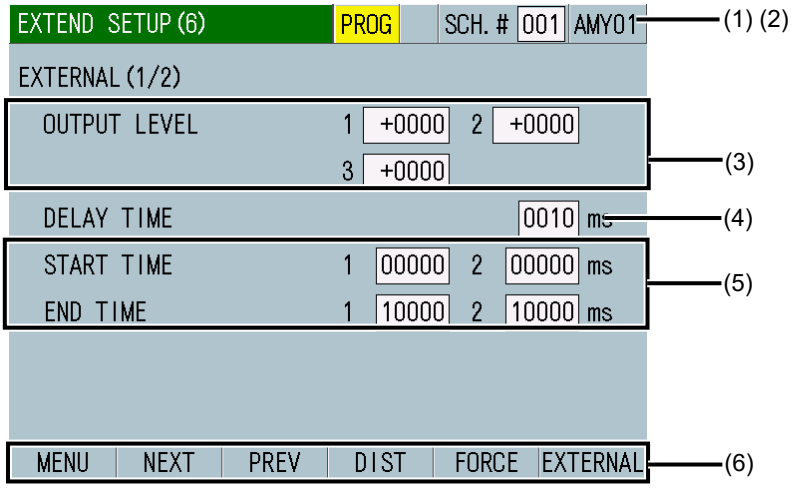
PREV: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

DIST: Touching this displays the EXTEND SETUP (1): DISPLACEMENT (1/3) screen.

FORCE: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

EXTERNAL: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

m-6. EXTEND SETUP (6) Screen: EXTERNAL (1/2)



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) OUTPUT LEVEL

You can output signals from external outputs EXT LEV1, EXT LEV2 and EXT LEV3 if the measured value exceeds the set external input level. There are three input fields because you can specify three levels for a single measurement and measure the external input level at three locations. Set an external input level within the set measurement range.

(4) DELAY TIME

Set a delay time (welding/external input signal stabilization time) from the end of current flow to when the external input measurement position is reached in the range from 0 to 1,000 ms. Be sure that the total of the current flow time, the delay time (including the cooling time between current flows), cooling time, and time to judge the current flow end does not exceed the maximum current measurement range. Make a measurement in a marginal range since the time to judge the current flow end changed depending on the magnitude of the current.

(5) START TIME / END TIME

By specifying an arbitrary range, you can measure mean external input (±10 V voltage or 4 to 20 mA current input). Set START TIME and END TIME in the range from 0 to 10,000 ms. There are three input fields for each item because you can specify three ranges for a single measurement and measure the external input at three locations.

(6) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the EXTEND SETUP (7): EXTERNAL (2/2) screen.

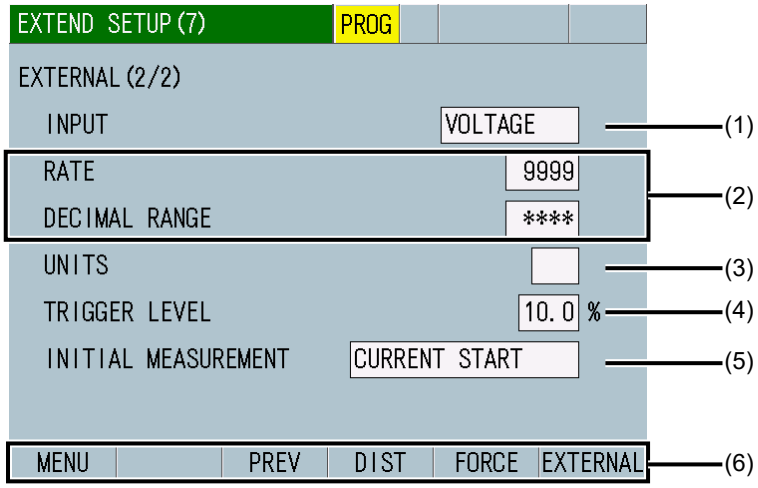
PREV: Touching this displays the EXTEND SETUP (5): FORCE (2/2) screen.

DIST: Touching this displays the EXTEND SETUP (1): DISPLACEMENT (1/3) screen.

FORCE: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

EXTERNAL: Touching this displays the EXTEND SETUP (7): EXTERNAL (2/2) screen.

m-7. EXTEND SETUP (7) Screen: EXTERNAL (2/2)



(1) INPUT

Select voltage input (±10 V) or current input (4 to 20 mA).

(2) RATE / DECIMAL RANGE

You can change the setting range of RATE arbitrarily according to the DECIMAL RANGE setting.

DECIMAL RANGE	RATE
*.***	0.500 to 9.999
.	05.00 to 99.99
***.*	050.0 to 999.9
****	0500 to 9999

(3) UNITS

Select the unit used for settings and display of external input from the followings:

No unit / voltage V / force N, kgf, lbf / temperature °C, °F / air pressure Mpa, bar, psi

(4) TRIGGER LEVEL

Set a trigger level (2.0 to 99.9%) as the percentage of full scale. An external input is measured while it exceeds the trigger level.

Set it to 99.9% when performing measurement according to the current measurement start.

(5) INITIAL MEASUREMENT

Select CURRENT START or EXTERNAL INPUT.

(6) Function keys

MENU: Touching this displays the MENU screen.

PREV: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

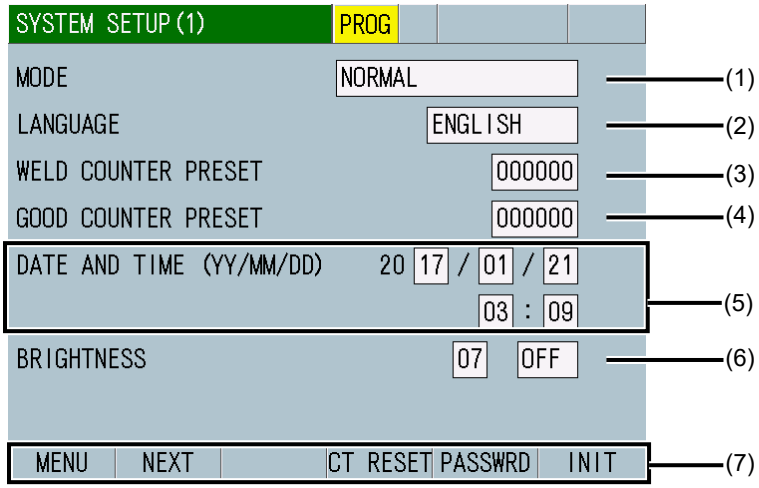
DIST: Touching this displays the EXTEND SETUP (1): DISPLACEMENT (1/3) screen.

FORCE: Touching this displays the EXTEND SETUP (4): FORCE (1/2) screen.

EXTERNAL: Touching this displays the EXTEND SETUP (6): EXTERNAL (1/2) screen.

n. SYSTEM SETUP Screen

n-1. SYSTEM SETUP (1) Screen



(1) MODE

Select NORMAL, SEAM, NORMAL TRACE, or SINGLE TRACE.

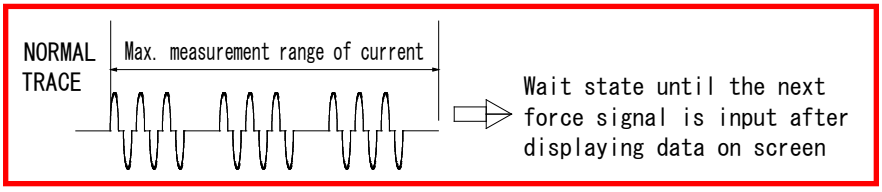
- NORMAL
  The instrument performs measurement each time a current signal is input, showing the measured values and waveforms.
- SEAM
  The instrument measures the seam current and voltage for five minutes maximum.
- NORMAL TRACE
  The instrument measures the maximum measurement range of current upon input of a current signal. After displaying the data on screen, the instrument goes into wait state until the next current signal is input. The instrument shows “-” in the measured value field without showing the measured value and making any OK/NG judgment on the value.

1) Current normal trace mode

The instrument measures the maximum measurement range of current upon input of a current signal. After displaying the data on screen, the instrument goes into wait state until the next current signal is input. The instrument shows “-” in the measured value field without showing the measured value and making any OK/NG judgment on the value. Only waveforms and all cycles are measured.

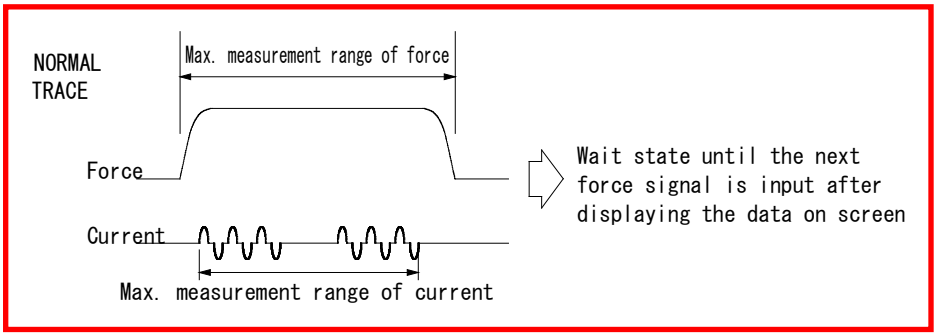
The maximum current measurement range varies as follows depending on the TIME setting in the BASIC SETUP (1) screen:

CYC-AC: 5,000 ms
CYC***Hz-AC: 4000 ms
ms-AC: 2000 ms
CYC-LONG: 1,000 ms (current only)
CYC-DC: 2,000 ms
ms-DC: 2,000 ms
SHORT ms-DC: 100 ms (current only)



2) Force normal trace mode

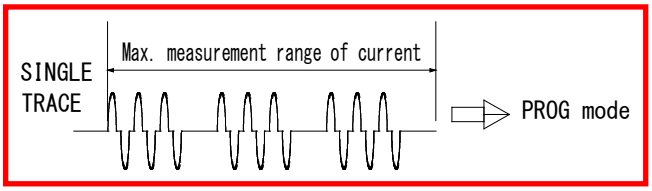
The instrument measures the maximum force measurement time upon input of a force signal. After displaying the data on screen, the instrument goes into wait state until the next force signal is input. The instrument shows "-" in the measured value field without showing the measured value and making any OK/NG judgment on the value. Only waveforms and all cycles are measured. The maximum force measurement range is 10000 ms.



- SINGLE TRACE
  The instrument measures the maximum measurement range of current upon input of a current signal, after which it enters the program mode (PROG). The instrument shows "-" in the measured value field without showing the measured value and making any OK/NG judgment on the value.

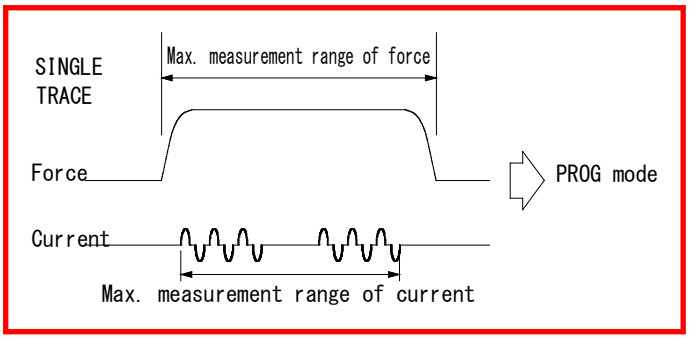
1) Current single-trace mode

The instrument measures the maximum measurement range of current upon input of a current signal, after which it enters program mode (PROG). The instrument shows "-" in the measured value field without showing the measured value and making any OK/NG judgment on the value. Only waveforms and all cycles are measured. The maximum force measurement range is the same as that of normal trace mode.



2) Force single-trace mode

The instrument measures the maximum measurement range of current upon input of a current signal, after which it enters program mode (PROG). The maximum force measurement range is 10000 ms.



(2) LANGUAGE

Select a language for on-screen display from among Japanese, English, Chinese, Korean, French, German and Spanish.

(3) WELD COUNTER PRESET

Set a preset count value (0 to 999,999) of the weld counter. The weld counter counts up by 1 for each measurement whether the value is within upper and lower limits or not. When the counter reaches the preset count value, the COUNT UP signal is output. When “0” is set for the preset count value, the COUNT UP signal is not output.

(4) GOOD COUNTER PRESET

Set a preset count value (0 to 999,999) of the good counter. The good counter counts up by 1 for each measurement only when the value is within upper and lower limits. When the counter reaches the preset count value, the COUNT UP signal is output. When “0” is set for the preset count value, the COUNT UP signal is not output.

(5) DATE AND TIME

Set the date in the format: year (2016 to 2077), month (1 to 12) and day (1 to 31). Set the time in the format: hour (0 to 23) and minutes (0 to 59).

(6) BRIGHTNESS

Set the brightness of a screen in the range of 01 to 10 (01: dark ... 10: bright).

When AUTO is set, the energy saving mode is started if no operation is performed within continuing three minutes, and the screen display disappears automatically. Touching the screen again redisplays the screen.

(7) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the SYSTEM SETUP (2) screen.

CT RESET: Touching this resets the counter value.

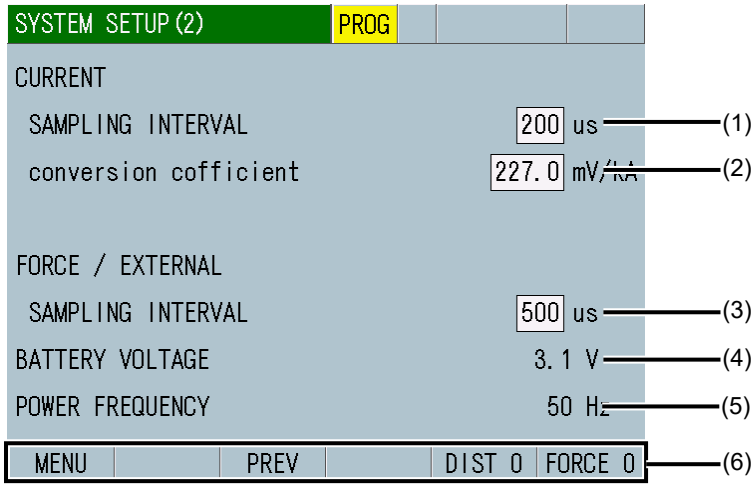
PASSWRD: Touching this displays the PASSWORD screen.

INIT: Touching this initializes all setting conditions and envelope conditions. It takes about 60 seconds for initialization.

IMPORTANT

Do not turn off the power supply during initialization. If not, it results in malfunction.

n-2. SYSTEM SETUP (2) Screen



(1) CURRENT SAMPLING INTERVAL

Set the sampling interval of current, voltage, displacement, power, and resistance.

20us: Performs measurement (sampling) every 20 us, calculates and displays waveforms every 20 us, and outputs data*1 every 20 us. (Notes 1 and 2)

50us: Performs measurement (sampling) every 50 us, calculates and displays waveforms every 50 us, and outputs data*1 every 50 us. (Note 1)

100us: Performs measurement (sampling) every 100 us, calculates and displays waveforms every 100 us, and outputs data*1 every 100 us.

200us: Performs measurement (sampling) every 100 us, calculates every 100 us, displays waveforms every 200 us, and outputs data*1 every 100 us*2.

*1: Waveform output by communication and USB

*2: In a combination of force and external, data is output every 100 us. In a combination of current, voltage, displacement, power, and resistance, data is output every 200 us. When data is output every 100 us, measured values change every 0.2 ms.

100 us interval (calculation)		**200 us interval (data output)**		**Remarks**
Time [ms]	**Current [kA]**	**Time [ms]**	**Current [kA]**	
0.0	0.00	0.0	0.00	
0.1	0.50	0.1	0.00	Same as 0.0 ms
0.2	0.60	0.2	0.60	
0.3	0.70	0.3	0.60	Same as 0.2 ms

(Note 1) When 20 µs is selected for SAMPLING INTERVAL and the TIME setting in the BASIC SETUP (1) screen is a setting other than SHORT ms-DC, the sampling interval becomes 50 µs automatically. Also, when displacement is measured, the sampling interval becomes 50 µs automatically.

(Note 2) When 20 µs or 50 µs is selected for SAMPLING INTERVAL and force or external input is measured, the sampling interval becomes 100 µs automatically.

(2) CURRENT CONVERSION COEFFICIENT

Set a conversion coefficient of toroidal coil. The setting is valid only when TIMES 1 is selected for TOROIDAL COIL. (Refer to (2) in "I-3. BASIC SETUP (3) Screen.") For our ISO toroidal coil (**MB-400M/800M**), the rated conversion coefficient is 227.0 mV/kA.

When using our toroidal coil, do not change the conversion coefficient.

(3) FORCE / EXTERNAL SAMPLING INTERVAL

Set the sampling interval of force and external input (voltage or current) measurement.

100us: Performs measurement (sampling) every 100 us, calculates and displays waveforms every 100 us, and outputs data*1 every 100 us. (Note 1)

200us: Performs measurement (sampling) every 200 us, calculates and displays waveforms every 200 us, and outputs data*1 every 200 us.

500us: Performs measurement (sampling) every 500 us, calculates and displays waveforms every 500 us, and outputs data*1 every 500 us.

Available only for the force/displacement-equipped specification.

*1: Waveform output by communication and USB

(Note 1) When 200 µs is selected for CURRENT SAMPLING INTERVAL, the sampling interval becomes 200 µs automatically.

(4) BATTERY VOLTAGE

Shows the voltage of the backup battery of the **MM-400A**. When the residual capacity of a battery is small, an error occurs.

(5) POWER FREQUENCY

Automatically measures commercial frequency of the power supply connected to the **MM-400A** and displays it. Displays 50Hz or 60Hz for commercial power supply and "- Hz" for 24 V DC power supply.

(6) Function keys

MENU: Touching this displays the MENU screen.

PREV: Touching this displays the SYSTEM SETUP (1) screen.

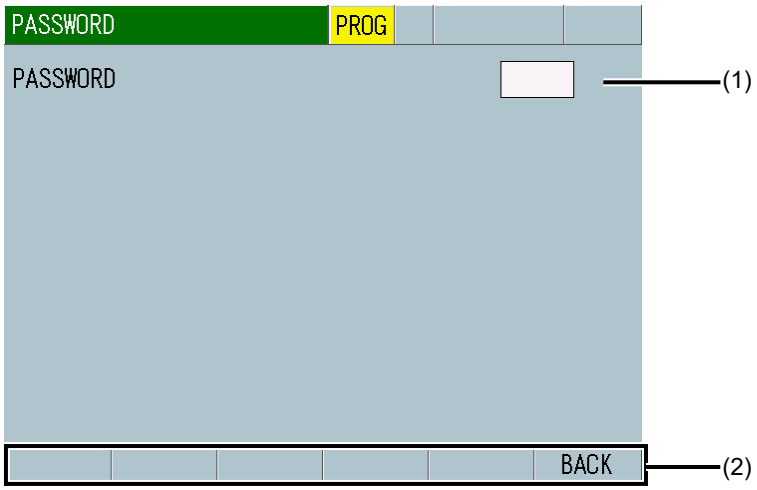
DIST 0: Touching this resets the measured value of displacement at that time to 0. Available only for the force/displacement-equipped specification.

FORCE 0: Touching this resets the measured value of force at that time to 0. Available only for the force/displacement-equipped specification. Perform a reset without applying loads to the force sensor.

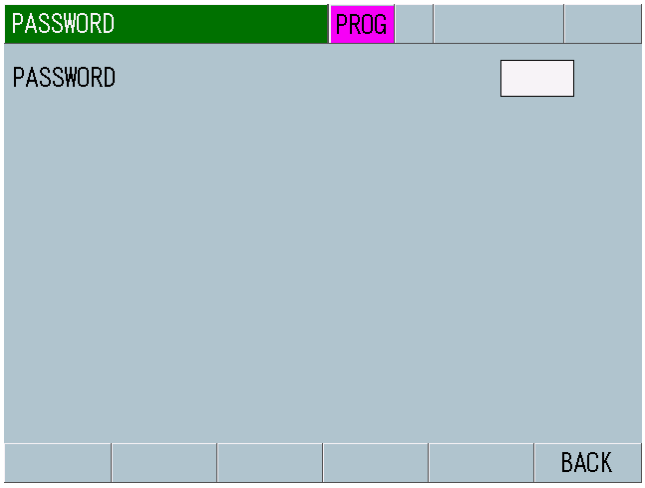
n-3. PASSWORD Screen

You can protect set values by setting the password. When the password is set and validated, schedule settings cannot be input from the panel.

Status in the supervisor mode



Status in the operator mode



(1) PASSWORD

Input a password (0000 to 9999). (Initial password: 0000)

The password is displayed as "*." When the input password coincides with the set password, the mode changes from the operator mode to the supervisor mode.

The supervisor mode is maintained while the power supply in turned on. To enter the operator mode, set the password the number other than 0000 and restart the power supply. For details, refer to **[How to change the password]**. If you forget the password, contact us.

Operation contents	Supervisor mode	Operator mode
Schedule setting in each screen	Can change	Cannot change
COPY in the BASIC SETUP (1) screen	Can operate	Cannot operate
CT RESET and INIT in the SYSTEM SETUP (1) screen DIST 0 and FORCE 0 in the SYSTEM SETUP (2) screen	Can operate	Cannot operate
COUNT RESET, DIST 0 RESET and FORCE 0 RESET in the external inputs	Can input	Can input
ALL DEL in the HISTORY screen READ and ALL DEL in the READ FLASH MEMORY screen	Can operate	Cannot operate
Schedule number in the PROG mode *1	Can change	Can change
Schedule number in the MEAS mode *1	Can change	Cannot change
SCH1 to 64 in the external inputs	Can input	Can input

*1: When you change the schedule number from 3 to 5 in the supervisor mode and switch the mode to MEAS, the schedule number changes to 5. When you change the schedule number from 3 to 5 in the operator mode and switch the mode to MEAS, the schedule number returns to 3. (You cannot change the schedule number for measurement in the operator mode.)

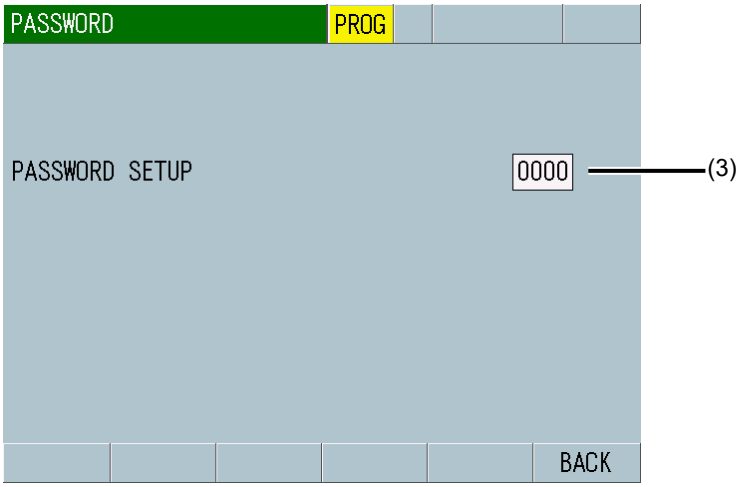
(2) Function keys

BACK: Touching this displays the SYSTEM SETUP (1) screen.

(3) PASSWORD SETUP

Changes a password (0000 to 9999) in the supervisor mode. Input a four-digit number.

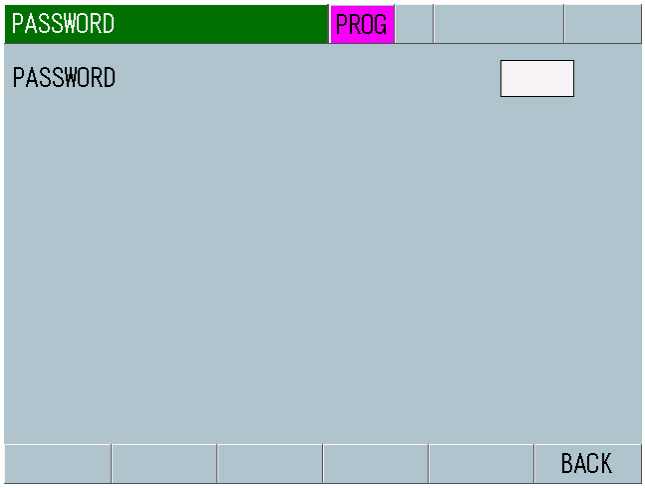
For details, refer to **[How to change the mode]**.



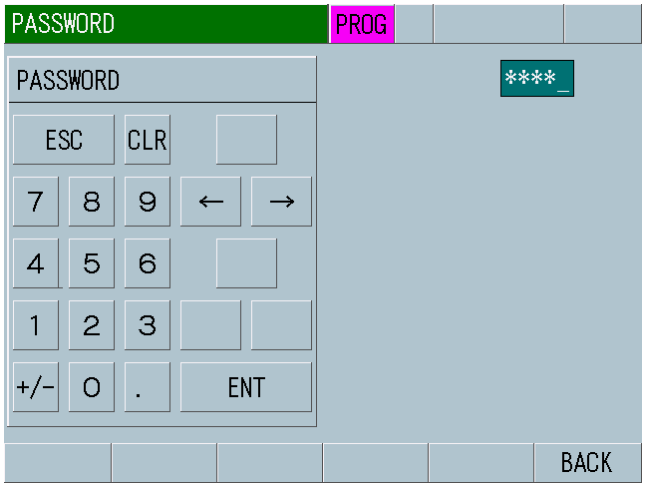
[How to change the mode]

As an example, how to change the mode from the operator mode to the supervisor mode with the password 1111 is explained below.

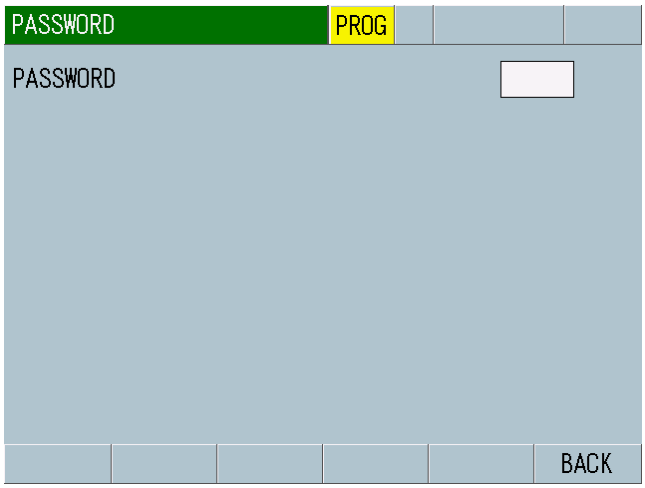
1) Move to the PASSWORD screen.



2) Touch the white frame and input a password 1111.



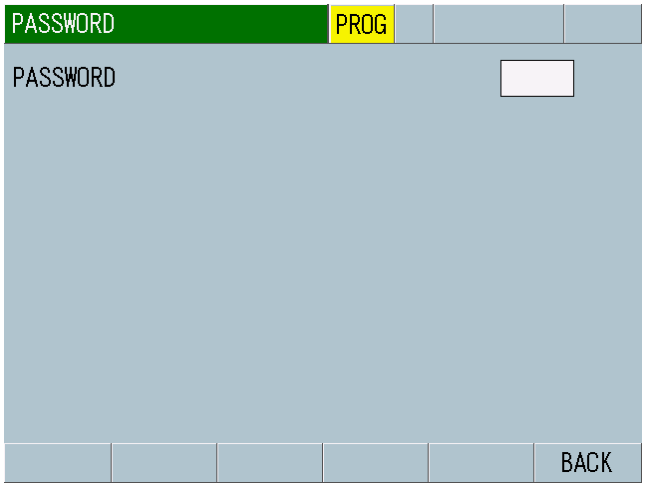
3) Touching ENT switches the mode to the supervisor mode. However, the password is wrong, the screen display does not change.



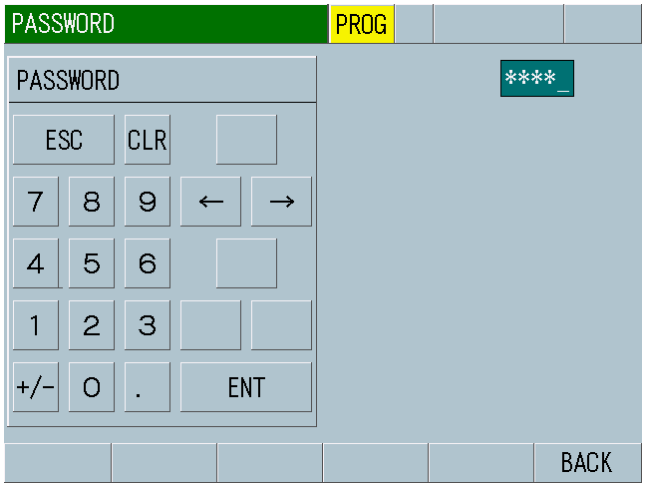
[How to change the password]

As an example, how to change the password from 0000 to 1111 is explained below. Before changing the password, change the mode from the operator mode to the supervisor mode.

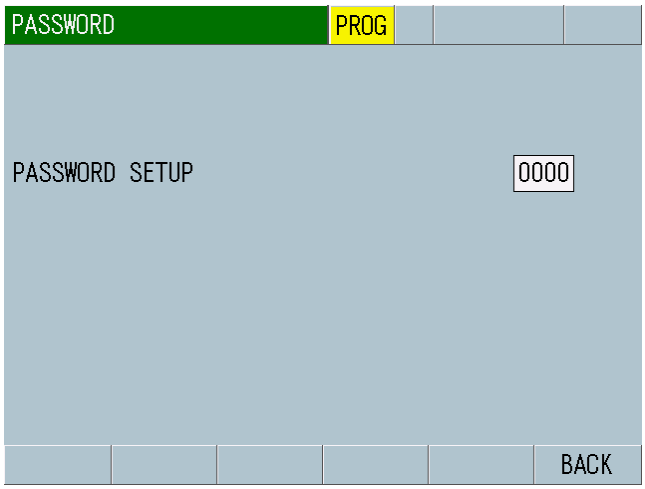
1) Move to the PASSWORD screen.



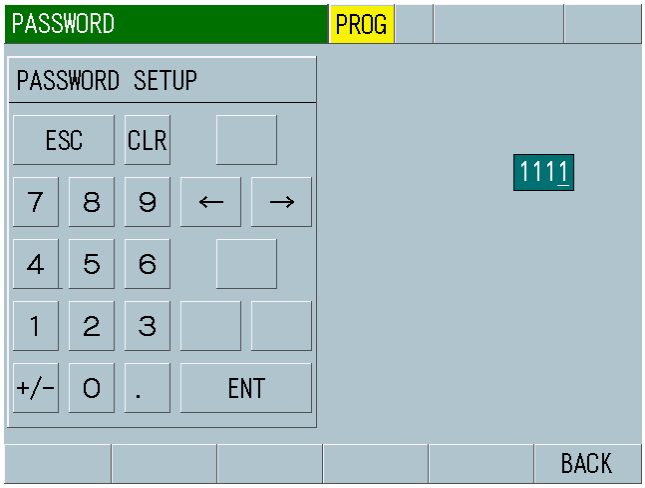
2) Touch the white frame and input a password 0000.



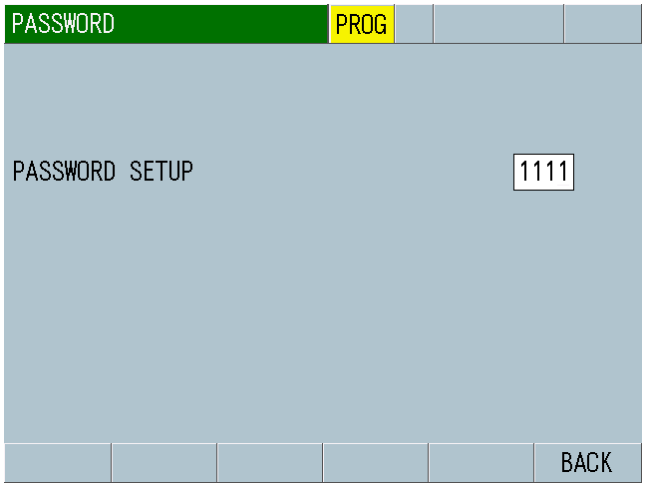
3) Touching ENT displays PASSWORD SETUP.



4) Touch the white frame and input a desired password 1111.

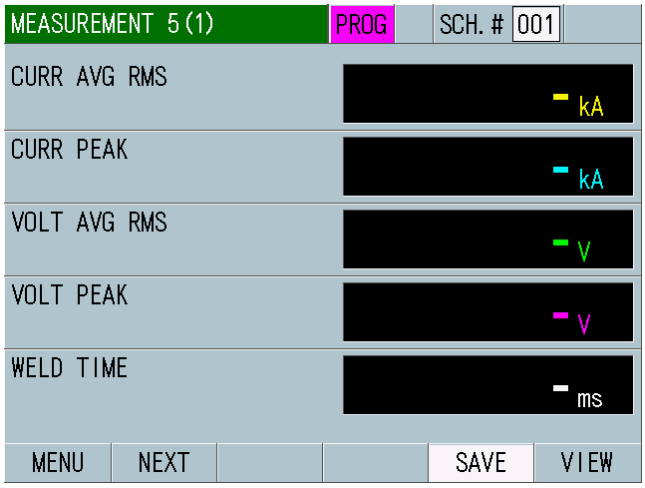


5) Touching ENT changes the number of PASSWORD SETUP.



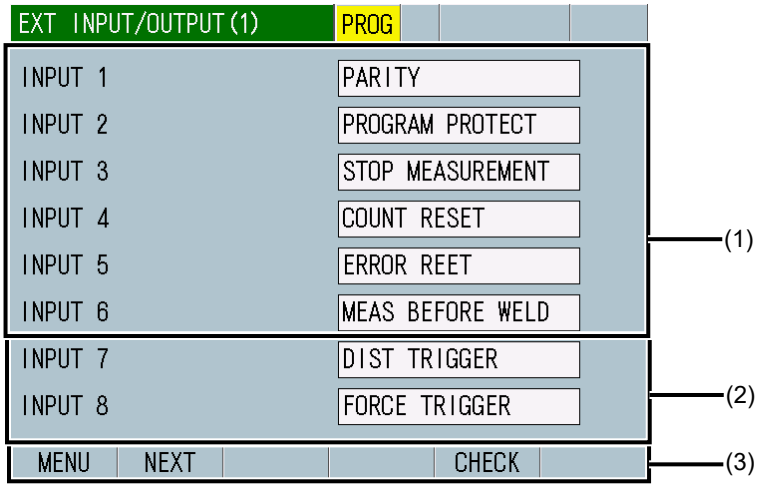
Password change is now complete. When you go to the other screen, perform the same procedures from 1).

6) When you touch MEAS in the MEASUREMENT screen after restarting the power supply, PROG is displayed in purple color indicating the operator mode.



o. EXT INPUT/OUTPUT Screen

o-1. EXT INPUT/OUTPUT (1) Screen



(1) INPUT 1 to 6

Select from the following nine items:

- PARITY: Be sure that the number of signal lines to turn ON is always odd when selecting the schedule by SCH1 to 64.
- PROGRAM PROTECT: When this terminal closed, schedule setting input from the panel is rejected.

Operation contents	PROGRAM PROTECT	
	Open	Closed
Schedule setting in each screen	Can change	Cannot change
COPY in the BASIC SETUP (1) screen	Can operate	Cannot operate
CT RESET and INIT in the SYSTEM SETUP (1) screen DIST 0 and FORCE 0 in the SETUP (2) screen	Can operate	Cannot operate
COUNT RESET, DIST 0 RESET and FORCE 0 RESET in the external inputs	Can input	Can input
ALL DEL in the HISTORY screen READ and ALL DEL in the READ FLASH MEMORY Screen	Can operate	Cannot operate
Schedule number in the PROG mode *1	Can change	Can change
Schedule number in the MEAS mode *1	Can change	Cannot change
SCH1 to 64 in the external inputs	Can input	Can input

*1: When you change the schedule number from 3 to 5 with PROGRAM PROTECT open and switch the mode to MEAS, the schedule number changes to 5. When you change the schedule number from 3 to 5 with PROGRAM PROTECT closed and switch the mode to MEAS, the schedule number returns to 3. (You cannot change the schedule number for measurement with PROGRAM PROTECT closed.)

- STOP MEASUREMENT: The instrument does not perform any measurement while this terminal is closed. If the terminal closes during current flow, the data during that period is ignored.
- COUNT RESET: Closing this terminal resets the counter to 0.

- ERROR RESET: Closing this terminal cancels error display and error output.
- MEAS BEFORE WELD: At the point when this terminal is closed, the measured value of displacement, force or external input before welding start is established
- DIST 0 RESET: At the point when this terminal is closed, a zero reset of displacement measurement is performed.
- FORCE 0 RESET: At the point when this terminal is closed, a zero reset of force measurement is performed.
- No setting

(2) INPUT 7 to 8

Select from the followings. Available only for the force/displacement-equipped specification.

- DIST TRIGGER: Used to start displacement measurement from external device.
- FORCE TRIGGER: Used to start force measurement from external device.
- EXTERNAL TRIGGER: Used to start external voltage/current input measurement from external device.
- No setting

(Caution) Do not make INPUT 1 to INPUT 8 the same setting. If INPUT 7 and INPUT 8 are the same, INPUT 7 works.

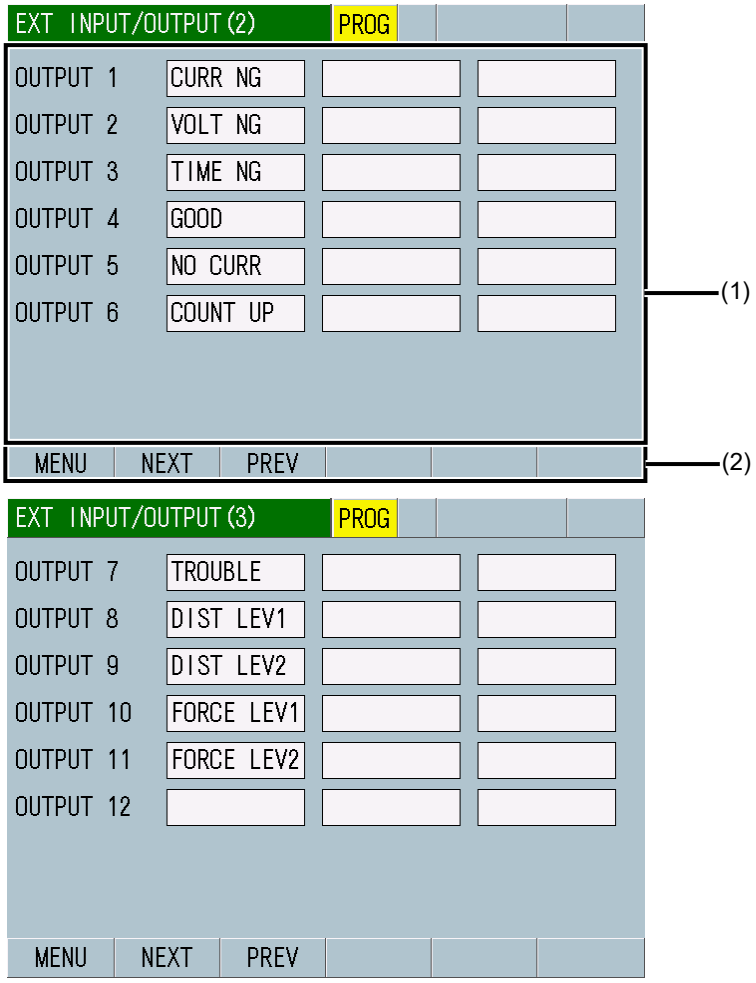
(3) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the EXT INPUT/OUTPUT (1) screen.

CHECK: Touching this displays the INPUT/OUTPUT CHECK screen.

o-2. EXT INPUT/OUTPUT (2) (3) Screen



(1) OUTPUT 1 to 12

Set up to three items for each of outputs 1 to 12 from the following:

(Ex.) To make current OK/NG judgment against upper and lower limits, set the outputs as follows:

Output 1: CURR-L and CURR-U
Output 2: TIME-L and TIME-U
Output 3: GOOD
Output 4: NG
Output 5: TROUBLE
This provides you with an output from Output 3 when current flows properly, an output from Output 1 if the measured current falls outside the upper and lower limits, an output from Output 2 if the measured current flow time falls outside the upper and lower limits, an output from Output 4 in the event of an error such as overrange error, and an output from Output 5 in the event of an error in the **MM-400A**.

- When NORMAL, NORMAL TRACE or SINGLE TRACE is set for MODE in the SYSTEM SETUP (1) screen (Refer to Chapter 8, “n-1. SYSTEM SETUP (1) Screen.”)

1) CURR NG: Current error
Output if the currents (peak and RMS) exceed the upper limits or fall below the lower limits.

2) VOLT NG: Voltage error
Output if the voltages (peak and RMS) exceed the upper limits or fall below the lower limits.

3) TIME NG: Current flow time error
Output if the current flow time exceeds the upper limit or fall below the lower limit.

4) TIME TP NG: Current flow time TP error
Output if the current flow time TP falls below the lower limit or fall below the lower limit.

5) TIME TH NG: Current flow time TH error
Output if the current flow time TH falls below the lower limit or fall below the lower limit.

6) FL TIME NG: Current flow time (including fall time) error
Output if the current flow time (including fall time) exceeds the upper limit or falls below the lower limit.

7) POWER NG: Power error
Output if the power exceeds the upper limit or falls below the lower limit.

8) RESIS NG: Resistance error
Output if the resistance exceeds the upper limit or falls below the lower limit.

9) DIST NG: Displacement error[*1]
Output if the displacement exceeds the upper limit or falls below the lower limit.

10) FORCE NG: Force error[*1]
Output if the force exceeds the upper limit or falls below the lower limit.

11) EXT NG: External voltage or current input error[*1]
Output if the external ±10 V voltage inputs or the external 4 to 20 mA current input exceeds the upper limit or falls below the lower limit.

12) NO CURR: Lack-of-current error
Output if lack of current occurs. (The NO CURR signal input terminal on the external input connector must be used.)

13) NG: Error
Output if an upper/lower limit, overrange, impulse, lack-of-current, or parity error occurs.

14) GOOD: Normal
Output when the measured value falls within the upper and lower limits, with current flowing properly.

15) PREDIST NG: Displacement before welding error[*1]
Output when the displacement before a welding start exceeds the upper limit or falls below the lower limit.

16) PREFORCE NG: Force before welding error[*1]
Output when the force before a welding start exceeds the upper limit or falls below the lower limit.

17) PRE EXT NG: External voltage or current input error[*1]
Output when the external input (±10 V voltage input or 4 to 20 mA current input) before a welding start exceeds the upper limit or falls below the lower limit.

18) PRE GOOD: Normal before welding
Output when the measured value before a welding start is within the upper and lower limits.

19) TROUBLE: Trouble
Output if an instrument error (E**) occurs.

20) SCH NG: Lack-of-schedule-input error
Output if measurement is made with no external schedule input. (The schedule signal input terminal on the external input connector must be used.)

21) COUNT UP: Count up
Output if the counter exceeds the preset count.

22) POWER ON: Power ON
Output when the power is ON.

23) READY: Ready
Output when the **MM-400A** is ready for measurement. However, not output during measurement (including calculation time) or the program mode (PROG).

(Note) There are two types for general ready output, when the power is on and when the instrument is ready for measurement (not in the abnormality, during measurement, or during setting). Set POWER ON for the former and READY for the latter.

24) DIST LEV1: Displacement level 1 output[*1]
Closed when the displacement reaches the set value.

25) DIST LEV2: Displacement level 2 output[*1]
Closed when the displacement reaches the set value.

26) DIST LEV3: Displacement level 3 output[*1]
Closed when the displacement reaches the set value.

27) FORCE LEV1: Force level 1 output[*1]
Closed when the force reaches the set value.

28) FORCE LEV2: Force level 2 output[*1]
Closed when the force reaches the set value.

29) FORCE LEV3: Force level 3 output[*1]
Closed when the force reaches the set value.

30) EXT LEV1: External level 1 output[*1]
Closed when the external voltage or current input reaches the set value.

31) EXT LEV2: External level 2 output[*1]
Closed when the external voltage or current input reaches the set value.

32) EXT LEV3: External level 3 output[*1]
Closed when the external voltage or current input reaches the set value.

33) CURR-U: Current upper limit error
Output if the currents (peak and RMS) exceed the upper limits.

34) CURR-L: Current lower limit error
Output if the currents (peak and RMS) fall below the lower limits.

35) VOLT-U: Voltage upper limit error
Output if the voltages (peak and RMS) exceed the upper limits.

36) VOLT-L: Voltage lower limit error
Output if the voltages (peak and RMS) fall below the lower limits.

37) TIME-U: Current flow time upper limit error
Output if the current flow time exceeds the upper limits.

38) TIME-L: Current flow time lower limit error
Output if the current flow time falls below the lower limits.

39) TIME TP-U: Current flow time TP upper limit error
Output if the current flow time TP falls below the lower limits.

40) TIME TP-L: Current flow time TP lower limit error
Output if the current flow time TP falls below the lower limits.

41) TIME TH-U: Current flow time TH upper limit error
Output if the current flow time TH falls below the lower limits.

42) TIME TH-L: Current flow time TH lower limit error
Output if the current flow time TH falls below the lower limits.

43) FL TIME-U: Current flow time (including fall time) upper limit error
Output when the current flow time (including fall time) exceeds the upper limit.

44) FL TIME-L: Current flow time (including fall time) lower limit error
Output when the current flow time (including fall time) falls below the lower limits.

45) POWER-U: Power upper limit error
Output if the power exceeds the upper limit.

46) POWER-L: Voltage lower limit error
Output if the power falls below the lower limit.

47) RESIS-U: Resistance upper limit error
Output if the resistance exceeds the upper limit.

48) RESIS-L: Resistance lower limit error
Output if the resistance falls below the lower limit.

49) DIST-U: Displacement upper limit error[*1]
Output if the displacement exceeds the upper limit.

50) DIST-L: Displacement lower limit error[*1]
Output if the displacement falls below the lower limit.

51) FORCE-U: Force upper limit error[*1]
Output if the forces (peak and RMS) exceed the upper limits.

52) FORCE-L: Force lower limit error[*1]
Output if the forces (peak and RMS) fall below the lower limits.

53) EXT-U: External voltage or current input upper limit error[*1]
Output if the external ±10 V voltage inputs or the external 4 to 20 mA current input exceed the upper limits.

54) EXT-L: External voltage or current input lower limit error[*1]
Output if the external ±10 V voltage inputs or the external 4 to 20 mA current input fall below the lower limits.

55) NG-U: Upper limit error
Output if an upper limit error occurs.

56) NG-L: Lower limit error
Output if a lower limit error occurs.

57) PREDIST U: Displacement before welding upper limit error[*1]
Output if the displacement before a welding start exceed the upper limits.

58) PREDIST L: Displacement before welding lower limit error*1
Output if the displacement before a welding start fall below the lower limits.

59) PREFORCE U: Force before welding upper limit error*1
Output if the force before a welding start exceed the upper limits.

60) PREFORCE L: Force before welding lower limit error*1
Output if the force before a welding start fall below the lower limits.

61) PRE EXT U: External input before welding upper limit error*1
Output if the external input before a welding start exceed the upper limits.

62) PRE EXT L: External input before welding lower limit error*1
Output if the external input before a welding start fall below the lower limits.

63) No setting

*1: Force/displacement-equipped specification function

- When SEAM is set for MODE in the SYSTEM SETUP (1) screen (Refer to Chapter 8, “n-1. SYSTEM SETUP (1) Screen.”)

1) CURR NG: Current error
Output if the currents (peak and RMS) exceed the upper limits or fall below the lower limits. (Judgment output is made after the current flow end.)

2) VOLT NG: Voltage error
Output if the voltages (peak and RMS) exceed the upper limits or fall below the lower limits. (Judgment output is made after the current flow end.)

4) BK CURR NG: Current error
Output if the currents (peak and RMS) exceed the upper limits or fall below the lower limits. (Judgment output is made during the current flow. The instrument continues the output during the current flow, and then operates with the OUTPUT TIME setting in the EXT INPUT/OUTPUT (4) screen.)

5) BK VOLT NG: Voltage error
Output if the voltages (peak and RMS) exceed the upper limits or fall below the lower limits. (Judgment output is made during the current flow. The instrument continues the output during the current flow, and then operates with the OUTPUT TIME setting in the EXT INPUT/OUTPUT (4) screen.)

33) CURR-U: Current upper limit error
Output if the currents (peak and RMS) exceed the upper limits. (Judgment output is made after the current flow end.)

34) CURR-L: Current lower limit error
Output if the currents (peak and RMS) fall below the lower limits. (Judgment output is made after the current flow end.)

35) VOLT-U: Voltage upper limit error
Output if the voltages (peak and RMS) exceed the upper limits. (Judgment output is made after the current flow end.)

36) VOLT-L: Voltage lower limit error
Output if the voltages (peak and RMS) fall below the lower limits. (Judgment output is made after the current flow end.)

39) BK CURR-U: Current upper limit error
Output if the currents (peak and RMS) exceed the upper limits. (Judgment output is made during the current flow. The instrument continues the output during the current flow, and then operates with the OUTPUT TIME setting in the EXT INPUT/OUTPUT (4) screen.)

40) BK CURR-L: Current lower limit error
Output if the currents (peak and RMS) fall below the lower limits. (Judgment output is made during the current flow. The instrument continues the output during the current flow, and then operates with the OUTPUT TIME setting in the EXT INPUT/OUTPUT (4) screen.)

41) BK VOLT-U: Voltage upper limit error
Output if the voltages (peak and RMS) exceed the upper limits. (Judgment output is made during the current flow. The instrument continues the output during the current flow, and then operates with the OUTPUT TIME setting in the EXT INPUT/OUTPUT (4) screen.)

42) BK VOLT-L: Voltage lower limit error
Output if the voltages (peak and RMS) fall below the lower limits. (Judgment output is made during the current flow. The instrument continues the output during the current flow, and then operates with the OUTPUT TIME setting in the EXT INPUT/OUTPUT (4) screen.)

(Note) For item names of 3), 6) to 32), 37) to 38), and 43) to 63), refer to "When NORMAL, NORMAL TRACE or SINGLE TRACE is set for MODE in the SYSTEM SETUP (1) screen."

(2) Function keys

MENU: Touching this displays the MENU screen.

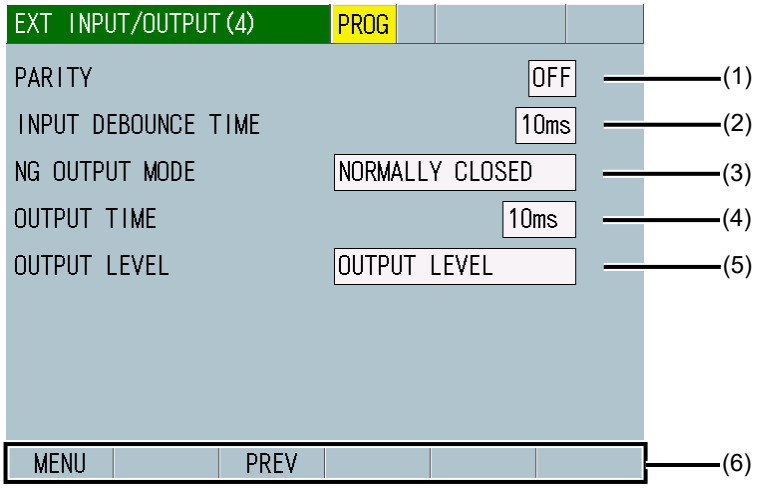
NEXT: Touching this displays the EXT INPUT/OUTPUT (3) or (4) screen.

PREV: Touching this displays the EXT INPUT/OUTPUT (1) or (2) screen.

(Caution) In the judgment operation of displayed items DIST INITIAL, FORCE INITIAL and EXT INITIAL in the VIEW screen, the output signals are different between the measurement start by current, force or external trigger and measurement by external input (MEAS BEFORE WELD).

	DIST INITIAL	FORCE INITIAL	EXT INITIAL
Measurement start by current, force or external trigger	DIST NG DIST U DIST L GOOD	FORCE NG FORCE U FORCE L GOOD	EXT NG EXT U EXT L GOOD
Measurement by external input (MEAS BEFORE WELD)	PREDIST NG PREDIST U PREDIST L PRE GOOD	PREFORCE NG PREFORCE U PREFORCE L PRE GOOD	PRE EXT NG PRE EXT U PRE EXT L PRE GOOD

o-3. EXT INPUT/OUTPUT (4) Screen



(1) PARITY

Select whether to use parity terminals. When you select ON, be sure that the total number of schedule selection and parity terminals that are closed is odd.

(2) INPUT DEBOUNCE TIME

Set a delay time from the signal input to when the signal settles down. This setting makes it possible to eliminate input signal chatter.

(3) NG OUTPUT MODE

Set a mode for the output terminals. Among OUTPUT 1 to 12 selected items, 1) to 13), 15) to 17), 19) to 20) and 33) to 62) are applied. GOOD, PREGOOD, COUNT, POWER ON, READY, and force/displacement/external level signal work as NORMALLY OPEN irrespective of the NG OUTPUT MODE setting.

NORMALLY CLOSED: Open at output
NORMALLY OPEN: Closed at output

(4) OUTPUT TIME

Select an output time. Among OUTPUT 1 to 12 selected items, 1) to 20) and 31) to 59) are applied.

10ms: Output time of 10 ms
100ms: Output time of 100 ms
HOLD: Holds output and cancels output at the start of next measurement, the start of no-current check, or in the event of an error reset.

(5) OUTPUT LEVEL

Select the output method of force/displacement/external level signal. The pulse output time is in conformity with OUTPUT TIME, but it becomes 100 ms when HOLD is selected.

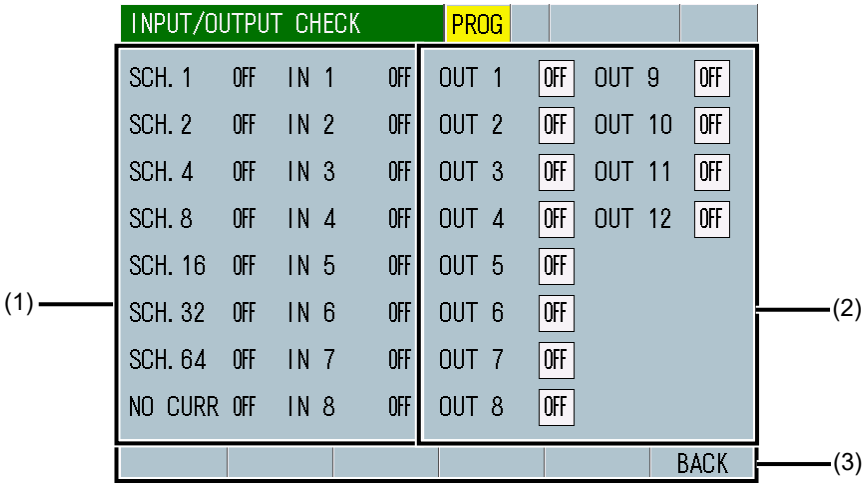
OUTPUT PULSE: Pulse output
OUTPUT LEVEL: Level output

(6) Function keys

MENU: Touching this displays the MENU screen.

PREV: Touching this displays the EXT INPUT/OUTPUT (3) screen.

o-4. INPUT/OUTPUT CHECK Screen



(1) Input signal status

Shows ON/OFF of the corresponding input signal.

(Note) NO CURR and IN 8 can be switched by either ON/OFF by input signals or ON/OFF by voltage input. (Refer to “10. Interface.”)

(2) Output signal status

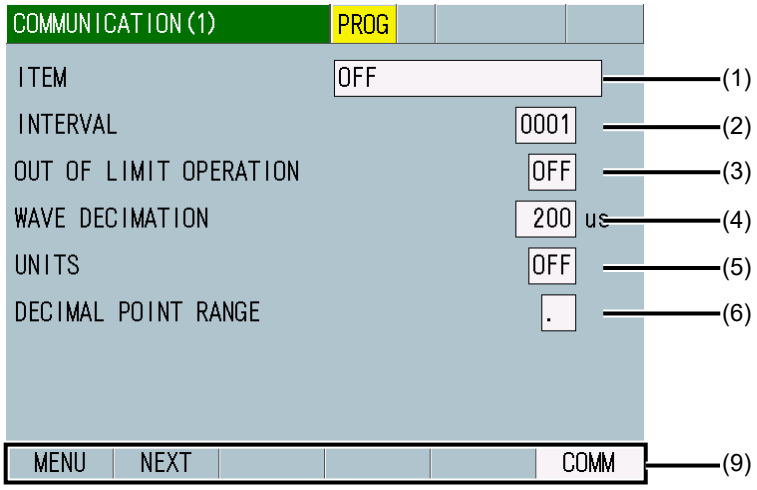
Closes or opens a circuit of corresponding output signal by switching ON and OFF.

(3) Function keys

BACK: Touching this displays the EXT INPUT/OUTPUT (1) screen.

p. COMMUNICATION Screen

p-1. COMMUNICATION (1) Screen



(1) ITEM

Select an item to output from the following:

- OFF
  No communication
- MEASUREMENT
  Outputs the measured values of ten items selected in the VIEW screen. Outputs after the end of measurement or when COMM is touched.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no communication is made.
- WAVEFORM
  Outputs the waveforms of four items selected in the VIEW screen. You can set waveform decimation for output interval of the waveform sample value. Note that if you set an interval smaller than the data sampling interval stored in the instrument, the data will be output at the internally stored interval. You can select the waveforms to output with waveform ON/OFF in the VIEW screen. Outputs after the end of measurement or when COMM is touched.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no communication is made.
- CURR ALL CYCLE
  Outputs current all cycles. Outputs after the end of measurement or when COMM is touched.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen or ISO17657 is selected for CALCULATION in the BASIC SETUP (3) screen, no communication is made.
- FORCE ALL CYCLE
  Outputs force all cycles. Outputs after the end of measurement or when COMM is touched. Available only for the force/displacement-equipped specification.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no communication is made.
- HISTORY
  Outputs history selected in HISTORY AREA (20**/**/** to 20**/**/**) among measured values saved in the HISTORY screen. To output, first select this item, and then touch COMM.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no communication is made.

- HISTORY OUT OF LIM
  Outputs history selected in HISTORY AREA (20**/**/** to 20**/**/**) among measured values with Upper limit error, Lower limit error, Overrange error, Impulse error, or Parity error saved in the HISTORY screen. To output, first select this item and touch COMM.
  When SEAM is selected for MODE in the SYSTEM SETUP (1) screen, no communication is made.
- SCHEDULE
  Outputs schedule data. To output, first select the schedule number, and then touch COMM.

(2) INTERVAL (*)

When you have selected ONE WAY with a setting other than OFF for MODE in the COMMUNICATION (2) screen, you can set a communication interval (1 to 1,000). Communicates irrespective of a communication interval in the event of Upper limit error, Lower limit error, Overrange error, Impulse error, or Parity error. The setting of communication interval is valid only when MEASUREMENT, WAVEFORM, CURR ALL CYCLE, or FORCE ALL CYCLE is selected for ITEM. When OUT OF LIMIT OPERATION is set to ON, a communication interval does not work.

(Note) During data communication, “SCI” is shown in orange at the upper part of a screen, and no measurement can be performed during that time.

(*) About interval

The interval corresponds to the number of weldings. Since it depends on the number from the last communication, the number of prints changes depending on the OUT OF LIMIT OPERATION setting.

INTERVAL setting		1	1	3	3
OUT OF LIMIT OPERATION setting		ON	OFF	ON	OFF
1st welding	OK	-	Commu-nicate	-	-
2nd welding	OK	-	Commu-nicate	-	-
3rd welding	OK	-	Commu-nicate	Commu-nicate	Commu-nicate
4th welding	OK	-	Commu-nicate	-	-
5th welding	NG	Commu-nicate	Commu-nicate	Commu-nicate	-
6th welding	OK	-	Commu-nicate	-	Commu-nicate
7th welding	OK	-	Commu-nicate	-	-
8th welding	OK	-	Commu-nicate	Commu-nicate	-

(3) OUT OF LIMIT OPERATION

Select ON/OFF to specify whether to communicate only in the event of Upper limit error, Lower limit error (excluding Upper/lower limit error at envelope), Overrange error, Impulse error, or Parity error.

ON: Communicates in the event of an error.
OFF: Communicates irrespective of errors.

Communicates at intervals set for INTERVAL when normal. Communicates at the time of an error occurrence when abnormal. The setting of error communication is valid only when MEASUREMENT, WAVEFORM, CURR ALL CYCLE, or FORCE ALL CYCLE is selected for ITEM.

(4) WAVE DECIMATION

Set a waveform decimation. You can select from among 20 us, 50 us, 100 us, 200 us, 500 us, and 1000 us. If you set a decimation smaller than the data sampling interval stored in the instrument, the data will be output at the internally stored interval. The setting of waveform decimation is valid only when WAVEFORM is selected for ITEM.

WAVE DECIMATION is reflected when the followings are satisfied.

<table>
<tr><th>CURRENT SAMPLING INTERVAL</th><th>FORCE SAMPLING INTERVAL</th><th>Current measure-ment</th><th>Displace-ment measure-ment</th><th>Force/ external measure-ment</th><th>TIME</th><th>WAVE DECIMATION</th></tr>
<tr><td>20us</td><td>100us
200us
500us</td><td rowspan="11">Yes</td><td>No</td><td rowspan="5">No</td><td>SHORT
ms-DC</td><td>20us, 100us, 200us, 500us, and 1000us are the same as setting. 50us becomes 20us.</td></tr>
<tr><td>20us*1</td><td rowspan="3">100us
200us
500us</td><td rowspan="6">Yes/No</td><td rowspan="6">All settings</td><td>50us, 100us, 200us, 500us, and 1000us are the same as setting. 20us becomes 50us.</td></tr>
<tr><td>50us</td></tr>
<tr><td>100us</td><td>100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.</td></tr>
<tr><td>200us*1</td><td>200us, 500us and 1000us are the same as setting. 20us, 50us and 100us become 200us.</td></tr>
<tr><td rowspan="3">20us*1
50us*1
100us</td><td>100us</td><td rowspan="3">No</td><td>100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.</td></tr>
<tr><td>200us</td><td>100us, 200us and 1000us are the same as setting. 20us, 50us and 500us become 100us.</td></tr>
<tr><td>500us</td><td>100us, 500us and 1000us are the same as setting. 20us, 50us and 200us become 100us.</td></tr>
</table>

CURRENT SAMPLING INTERVAL	FORCE SAMPLING INTERVAL	Current measure-ment	Displace-ment measure-ment	Force/ external measure-ment	TIME	WAVE DECIMATION
200us*1	100us*1	Yes	Yes/No	No	All settings	100us, 200us and 1000us are the same as setting. 20us, 50us and 500us become 100us.
	200us					
	500us					100us, 500us and 1000us are the same as setting. 20us, 50us and 200us become 100us.
20us*1 50us*1 100us	100us	No	No		-	100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.
	200us					200us and 1000us are the same as setting. 20us, 50us, 100us, and 500us become 200us.
	500us					500us and 1000us are the same as setting. 20us, 50us, 100us, and 200us become 500us.
200us*1	100us*1					200us and 1000us are the same as setting. 20us, 50us, 100us, and 500us become 200us.
	200us					
	500us					500us and 1000us are the same as setting. 20us, 50us, 100us, and 200us become 500us.

*1: Also refer to CURRENT SAMPLING INTERVAL and FORCE/ EXTERNAL SAMPLING INTERVAL in Chapter 8, “n-2. SETUP SYSTEM (2) Screen.”

(5) UNITS

Select whether to add a unit to the communication data or not.

OFF: Not added
ON: Added

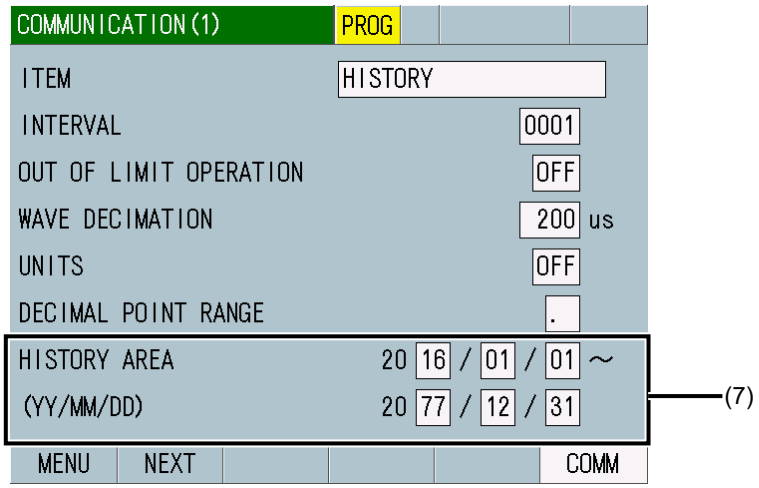
(6) DECIMAL POINT RANGE

Select “.” (period) or “,” (comma) for a symbol for decimal point. The data is written in the selected decimal point.

(7) HISTORY AREA

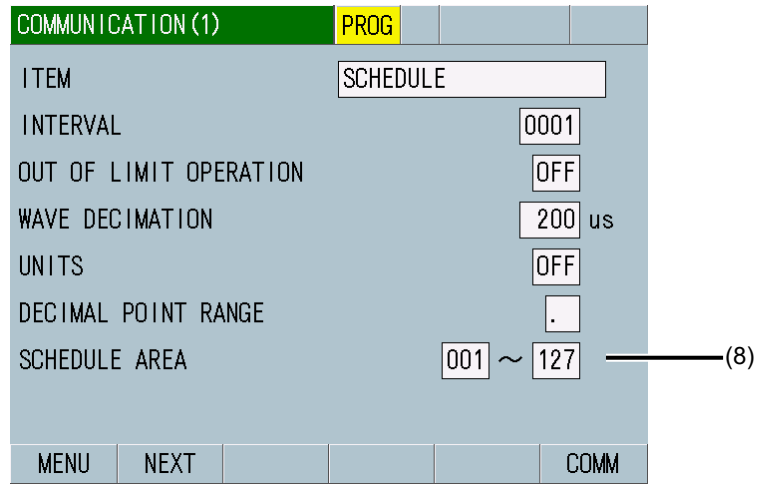
Shown when you have selected HISTORY or HISTORY OUT OF LIM for ITEM. Set a communication range with year, month and day.

(Note) The start date should be before the end date.



(8) SCHEDULE AREA

Shown when you have selected SCHEDULE for ITEM. Set the range of schedule numbers to communicate schedule data from 001 to 127. The setting of schedule data range is valid only when schedule data is communicated.



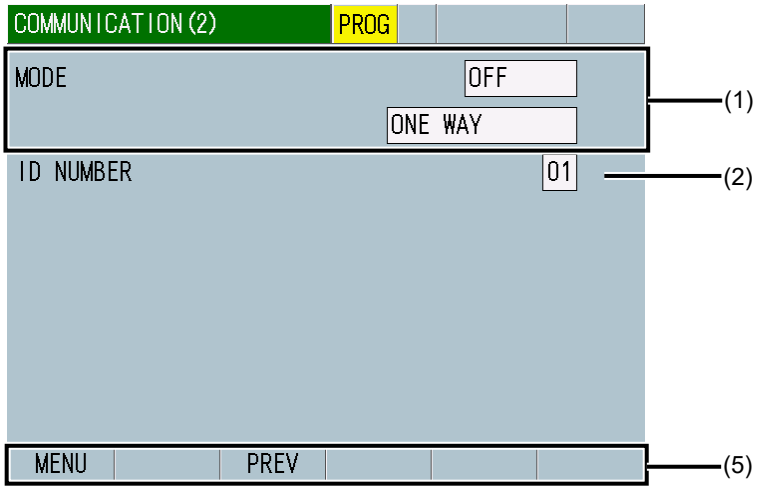
(9) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the COMMUNICATION (2) screen.

COMM: Touching this outputs items selected for ITEM.

p-2. COMMUNICATION (2) screen



(1) MODE

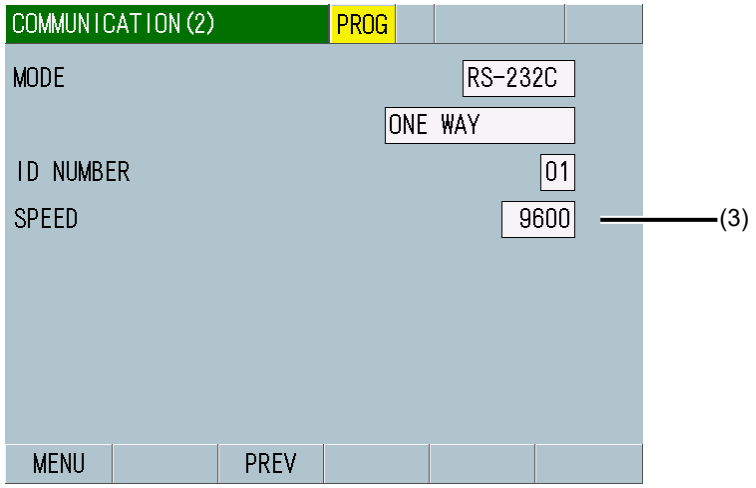
Select whether to use OFF, RS-232C, RS-485 or ETHERNET for communication. Specify unidirectional or bidirectional communication system.

(2) ID NUMBER

Set an instrument number (1 to 31).

(3) SPEED

Select from 9,600 bps, 19,200 bps and 38,400 bps. Shown only when RS-232C or RS-485 is selected for MODE.

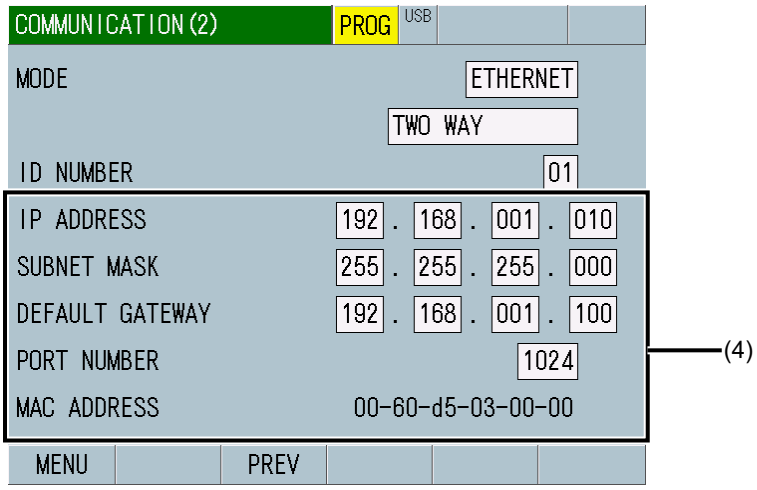


(4) TCP/IP settings

When you have selected ETHERNET for MODE, set the following: IP address, subnet mask, default gateway, and port number

Also, device MAC address is displayed.

PORT NUMBER can be set between 1024 and 5000.



(5) Function keys

MENU: Touching this displays the MENU screen.

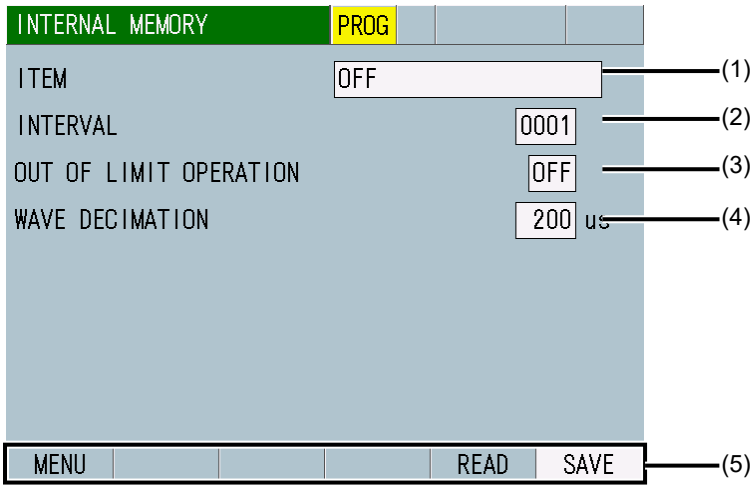
PREV: Touching this displays the COMMUNICATION (1) screen.

q. INTERNAL MEMORY Screen

q-1. INTERNAL MEMORY Screen

Waveforms and all cycle data are saved in the built-in flash memory.

Waveforms and all cycles are deleted when the power supply is turned off. Since 120 waveforms and all cycles in total (guide) can be saved in the built-in flash memory even after the power is turned off, you can load the saved data to check them.



(1) ITEM

Selects the data to save.

- OFF
  No data is saved.
- WAVEFORM
  Outputs the waveforms of four items selected in the VIEW screen. You can set waveform decimation for output interval of the waveform sample value. Note that if you set an interval smaller than the data sampling interval stored in the instrument, the data will be output at the internally stored interval. You can select the waveforms to save with waveform ON/OFF in the VIEW screen. Touching the SAVE key saves them in the internal memory.
- CURRENT ALL CYCLE
  Saves current all cycles by touching the SAVE key.
  When ISO17657 is selected for CALCULATION in the BASIC SETUP (3) screen, no data is saved.
- FORCE ALL CYCLE
  Saves force all cycles by touching the SAVE key. Available only for the force/displacement-equipped specification.

(2) INTERVAL (*)

You can set an interval automatically saved in the built-in flash memory each measurement (1 to 1,000). Saves irrespective of a save interval in the event of Upper limit error, Lower limit error (excluding Upper/lower limit error at envelope), Overrange error, Impulse error, or Parity error. When (3) OUT OF LIMIT OPERATION is set to ON, a save interval does not work in the event of above errors.

(Note) In writing, “MON” is shown in orange at the upper part of a screen, and no measurement can be performed during that time. The flash memory used in the internal memory has a write limit (100,000). An error message “E15: INTERNAL MEMORY ERROR” appears if the write limit is exceeded.

(*) About interval

The interval corresponds to the number of weldings. Since it depends on the number from the last save, the number of saves changes depending on the OUT OF LIMIT OPERATION setting.

INTERVAL setting		1	1	3	3
OUT OF LIMIT OPERATION setting		ON	OFF	ON	OFF
1st welding	OK	-	Save	-	-
2nd welding	OK	-	Save	-	-
3rd welding	OK	-	Save	Save	Save
4th welding	OK	-	Save	-	-
5th welding	NG	Save	Save	Save	-
6th welding	OK	-	Save	-	Save
7th welding	OK	-	Save	-	-
8th welding	OK	-	Save	Save	-

(3) OUT OF LIMIT OPERATION

Select ON/OFF to specify whether to save only in the event of Upper limit error, Lower limit error, Overrange error, Impulse error, or Parity error.

ON: Saves irrespective of interval in the event of an error.
OFF: Saves each interval irrespective of errors.

Saves at intervals set for INTERVAL when normal. Saves at the time of an error occurrence when abnormal.

(4) WAVE DECIMATION

Set a waveform decimation. You can select from among 20 us, 50 us, 100 us, 200 us, 500 us, and 1000 us. If you set a decimation smaller than the data sampling interval stored in the instrument, the data will be output at the internally stored interval. The setting of waveform decimation is valid only when WAVEFORM is selected for ITEM.

WAVE DECIMATION is reflected when the followings are satisfied.

<table>
<tr><th>CURRENT SAMPLING INTERVAL</th><th>FORCE SAMPLING INTERVAL</th><th>Current measure-ment</th><th>Displace-ment measure-ment</th><th>Force/ external measure-ment</th><th>TIME</th><th>WAVE DECIMATION</th></tr>
<tr><td>20us</td><td>100us
200us
500us</td><td rowspan="9">Yes</td><td>No</td><td rowspan="6">No</td><td>SHORT
ms-DC</td><td>20us, 100us, 200us, 500us, and 1000us are the same as setting. 50us becomes 20us.</td></tr>
<tr><td>20us*1</td><td rowspan="3">100us
200us
500us</td><td rowspan="8">Yes/No</td><td rowspan="7">All settings</td><td rowspan="2">50us, 100us, 200us, 500us, and 1000us are the same as setting. 20us becomes 50us.</td></tr>
<tr><td>50us</td></tr>
<tr><td>100us</td><td>100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.</td></tr>
<tr><td>200us*1</td><td>200us, 500us and 1000us are the same as setting. 20us, 50us and 100us become 200us.</td></tr>
<tr><td rowspan="3">20us*1
50us*1
100us</td><td>100us</td><td rowspan="3">No</td><td>100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.</td></tr>
<tr><td>200us</td><td>100us, 200us and 1000us are the same as setting. 20us, 50us and 500us become 100us.</td></tr>
<tr><td>500us</td><td>100us, 500us and 1000us are the same as setting. 20us, 50us and 200us become 100us.</td></tr>
</table>

CURRENT SAMPLING INTERVAL	FORCE SAMPLING INTERVAL	Current measure-ment	Displace-ment measure-ment	Force/ external measure-ment	TIME	WAVE DECIMATION
200us*1	100us*1	Yes	Yes/No	No	All settings	100us, 200us and 1000us are the same as setting. 20us, 50us and 500us become 100us.
	200us					
	500us					100us, 500us and 1000us are the same as setting. 20us, 50us and 200us become 100us.
20us*1 50us*1 100us	100us	No	No		-	100us, 200us, 500us, and 1000us are the same as setting. 20us and 50us become 100us.
	200us					200us and 1000us are the same as setting. 20us, 50us, 100us, and 500us become 200us.
	500us					500us and 1000us are the same as setting. 20us, 50us, 100us, and 200us become 500us.
200us*1	100us*1					200us and 1000us are the same as setting. 20us, 50us, 100us, and 500us become 200us.
	200us					
	500us					500us and 1000us are the same as setting. 20us, 50us, 100us, and 200us become 500us.

*1: Also refer to CURRENT SAMPLING INTERVAL and FORCE/ EXTERNAL SAMPLING INTERVAL in Chapter 8, “n-2. SETUP SYSTEM (2) Screen.”

(5) Function keys

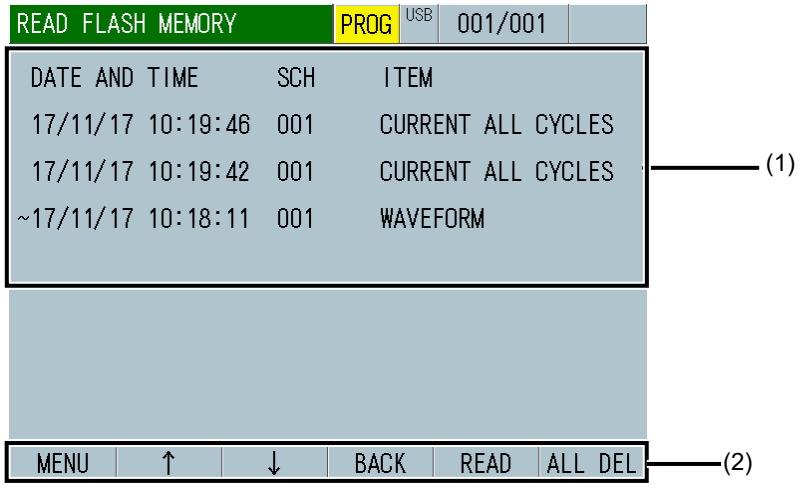
MENU: Touching this displays the MENU screen.

READ: Touching this displays the measurement data saved in the built-in flash memory. When you touch this data directly, it is selected by a line-based cursor. Touch the READ key again to read data. Note that only one selected among WAVEFORM, CURRENT ALL CYCLE and FORCE ALL CYCLE can be read.

SAVE: Touching this saves the contents selected for ITEM of the measurement data in the built-in flash memory.

q-2. READ FLASH MEMORY Screen

Histories of WAVEFORM, CURRENT ALL CYCLE and FORCE ALL CYCLE saved in the built-in flash memory are displayed.



(1) Loaded data display

Shows the measured values stored in the built-in flash memory.
When you touch this data directly, it is selected by a line-based cursor. Touch the READ key again to read data. Note that only one selected among WAVEFORM, CURRENT ALL CYCLE and FORCE ALL CYCLE can be read.

(2) Function keys

MENU: Touching this displays the MENU screen.

↑↓: Touching this moves a page of the screen.

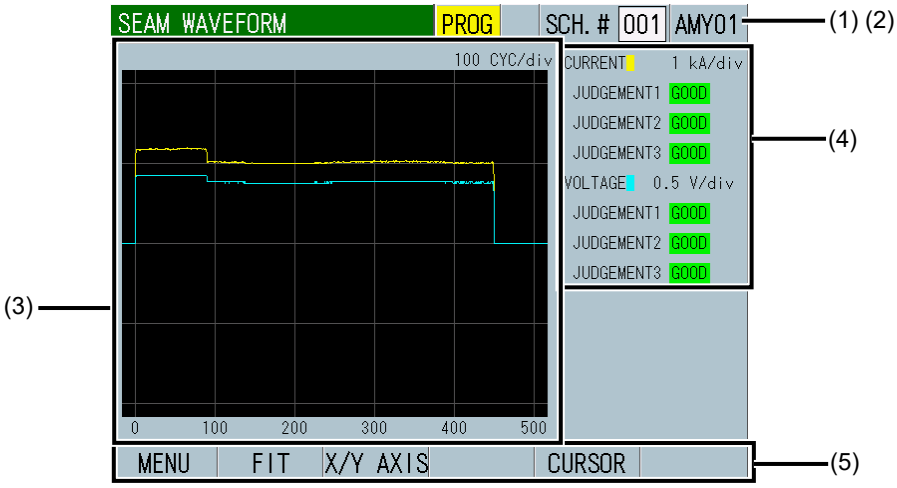
BACK: Touching this returns to the INTERNAL MEMORY screen.

READ: Touching this reads data selected with a blue cursor.

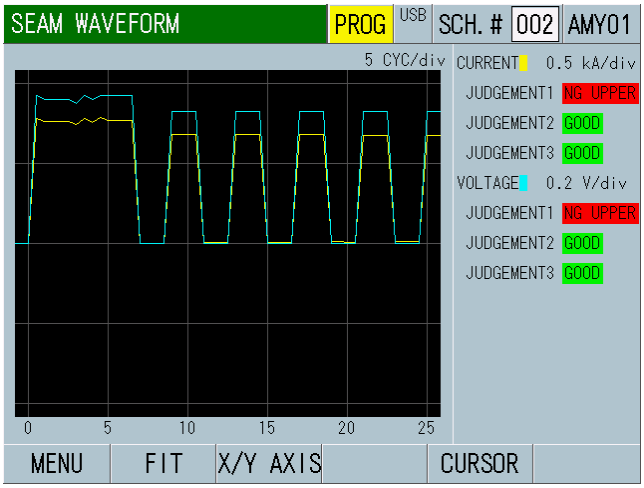
ALL DEL: Touching this clears all measured values from the built-in flash memory.

r. SEAM WAVEFORM Screen

Waveform of continuous seam current / voltage



Waveform of intermittent seam current / voltage



The **MM-400A** realizes seam welding by repeating measurement of the specified range. The measured value calculated with the measurement range and the measurement interval is displayed.

The waveform in the SEAM WAVEFORM screen displays the measured value resulting from calculation with the set contents. This method is different from the WAVEFORM screen displaying the instantaneous value in the normal measurement mode.

The judgment value can be set for three judgment periods (JUDGEMENT1 to 3), respectively.

In the AC measurement, current and voltage can be measured in a max. 5-minute current flow.

In the DC measurement, voltage can be measured in a max. 5-minute current flow.

(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) Waveform

Waveform display items can be selected in the VIEW screen.

(4) Judgment display

Shows the judgment results of CURRENT at the upper part and VOLTAGE at the lower part. Shows the judgment result of three range sections (JUDGEMENT1 to 3) for CURRENT and VOLTAGE respectively.

Shows GOOD when the waveform is within the range, NG UPPER when it exceeds the upper limit, and NG LOWER when it falls below the lower limit even if 1 section. When it is out of both upper and lower limits at the same time, NG LOWER is preferentially displayed. Also, when the measured value exceeds the measurable range, OVER is displayed.

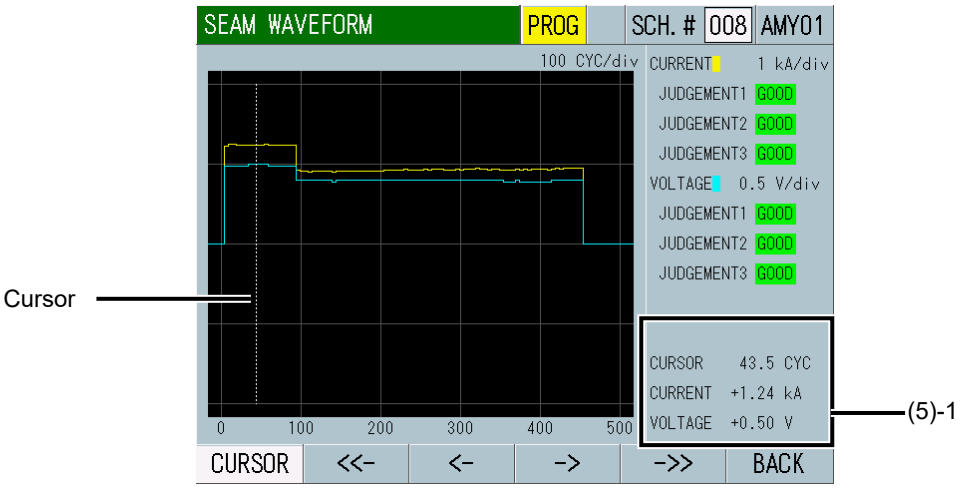
(5) Function keys

MENU: Touching this displays the MENU screen.

FIT and X/Y AXIS: Same as the function keys in the WAVEFORM screen. Refer to “d. WAVEFORM Screen.”

CURSOR: Touching this displays the cursor of the vertical axis and cursor command at the function key. (Refer to (5)-1.)

(5)-1 Cursor command



Shows the current time axis information of the cursor and the measured values of the waveforms at the point in time indicated by the cursor.

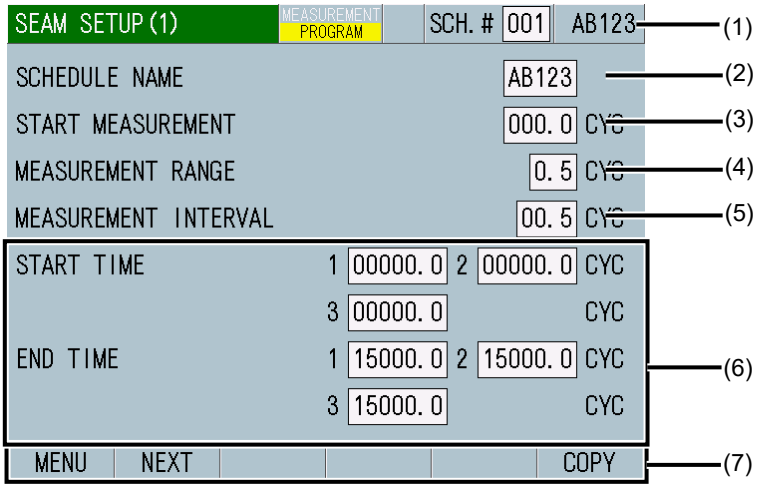
You can move the white line (cursor) on the grid right and left by touching the function keys.

<- ->: Touching this moves the cursor right and left by 1 dot. The cursor moves only while the key is touched.

<<- ->>: Touching this moves the cursor right and left by 50 dots.

s. SEAM SETUP Screen

s-1. SEAM SETUP (1) Screen



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) SCHEDULE NAME

Inputs the name for the set schedule. Up to five alphanumeric characters can be input.

(3) START MEASUREMENT

Set the time to start the seam welding in time or cycle from the welding start.

When the TRIGGER and TIME settings are changed, START MEASUREMENT may be initialized. Set START MEASUREMENT again. (Refer to "s-3. SEAM SETUP (3) Screen.")

CYC-AC, CYC-DC: 0.0 to 120.0 CYC
ms-DC, ms-AC: 10 to 2,000 ms (in units of 10 ms)
SHORT ms-DC: 1 to 200 ms

(4) MEASUREMENT RANGE

Calculates the measured value in this range to use it for judgment. When the cooling time is included, the measured value falls correspondingly.

When the TRIGGER and TIME settings are changed, MEASUREMENT RANGE may be initialized. Set MEASUREMENT RANGE again. (Refer to "s-3. SEAM SETUP (3) Screen.")

CYC-AC, CYC-DC: 0.5 to 6.0 CYC
ms-DC, ms-AC: 10 to 100 ms (in units of 10 ms)
SHORT ms-DC: 1 to 10 ms

(5) MEASUREMENT INTERVAL

Shifts the measurement range at this interval. (The cooling time is included.)

When the TRIGGER and TIME settings are changed, MEASUREMENT INTERVAL may be initialized. Set MEASUREMENT INTERVAL again. (Refer to "s-3. SEAM SETUP (3) Screen.")

CYC-AC, CYC-DC: 0.5 to 12.0 CYC
ms-DC, ms-AC: 10 to 200 ms (in units of 10 ms)
SHORT ms-DC: 1 to 20 ms

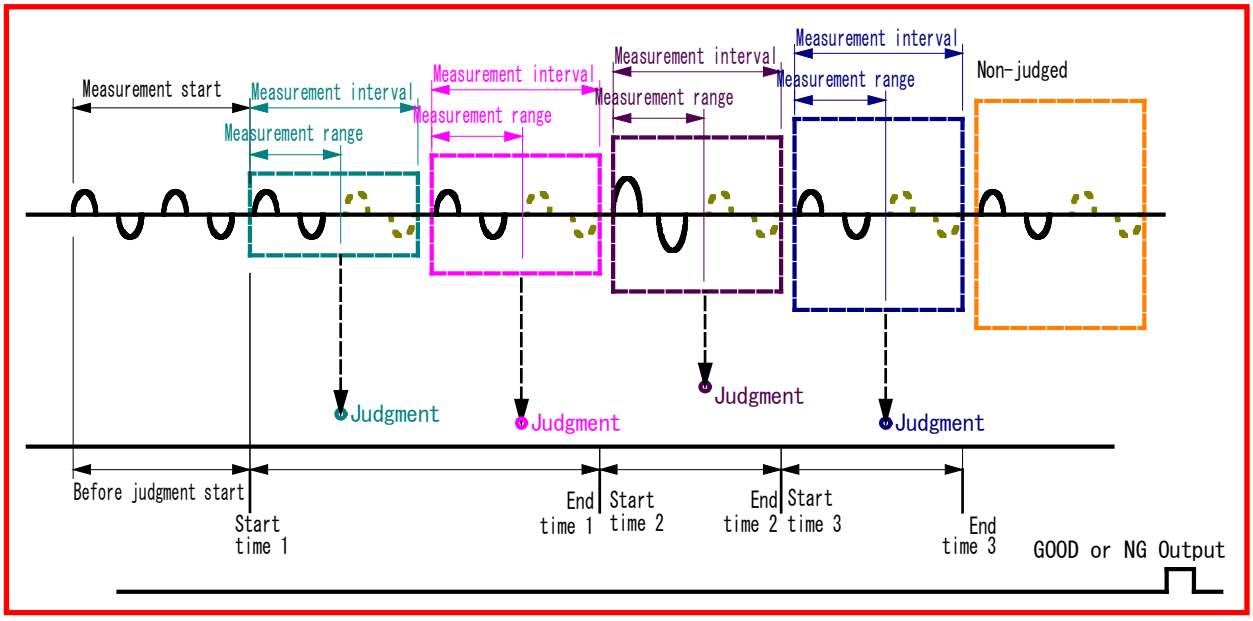
(Note) Use with measurement interval ≥ measurement range. In the intermittent current flow, set so that one cycle of WELD/COOL be the measurement interval and WELD time be the measurement range.

(6) START TIME / END TIME

Set the judgment start time and end time of the judgment periods1 to 3 in time or cycle from the welding start. In this judgment period, GOOD or NG judgment is made after each measurement range and output at the end of welding. When all judgments are within upper and lower limits, the judgment period is judged as GOOD.

When the TRIGGER and TIME settings are changed, START TIME and END TIME may be initialized. Set START TIME and END TIME again. (Refer to "s-3. SEAM SETUP (3) Screen.")

CYC-AC, CYC-DC: 0 to 18,000 CYC
ms-DC, ms-AC: 0 to 300,000 ms (in units of 10 ms)
SHORT ms-DC: 0 to 30,000 ms



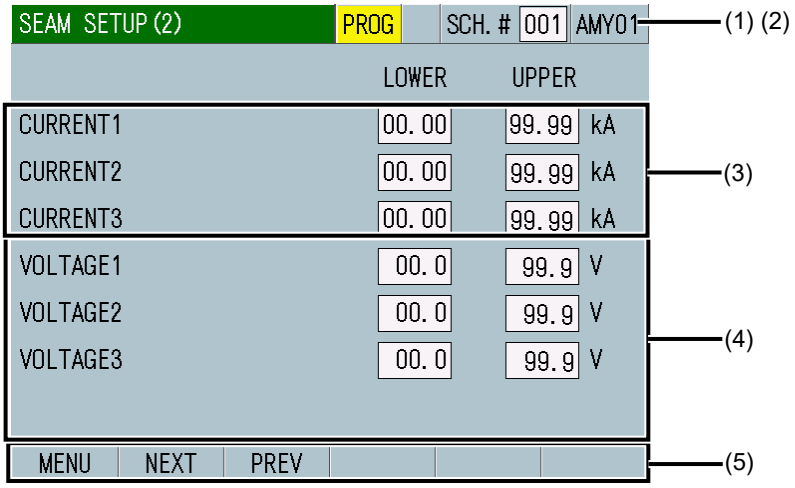
(7) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the SEAM SETUP (2) screen.

COPY: Touching this copies the settings made under the schedule number 001 (all the settings made in the COMPARATOR, ENVELOPE, BASIC SETUP, and EXTEND SETUP screens) to all the schedule numbers 002 to 127.

s-2. SEAM SETUP (2) Screen



(1) SCH.#

Shows the measurement schedule number used (1 to 127). On the other hand, you can change schedules by selecting this field and inputting a value.

(2) Schedule name

Shows the name of SCH.#. This can be set in the BASIC SETUP (1) screen.

(3) CURRENT 1 to 3

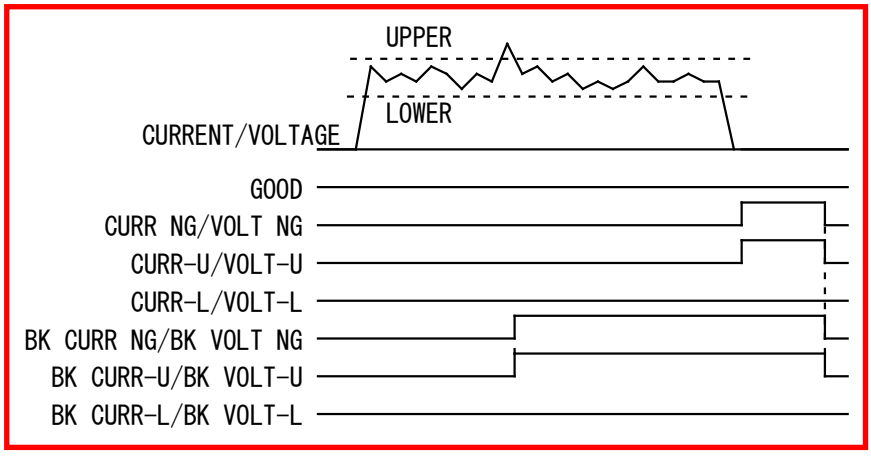
Set upper and lower limit values of the current in the judgment period 1 to 3.

(4) VOLTAGE 1 to 3

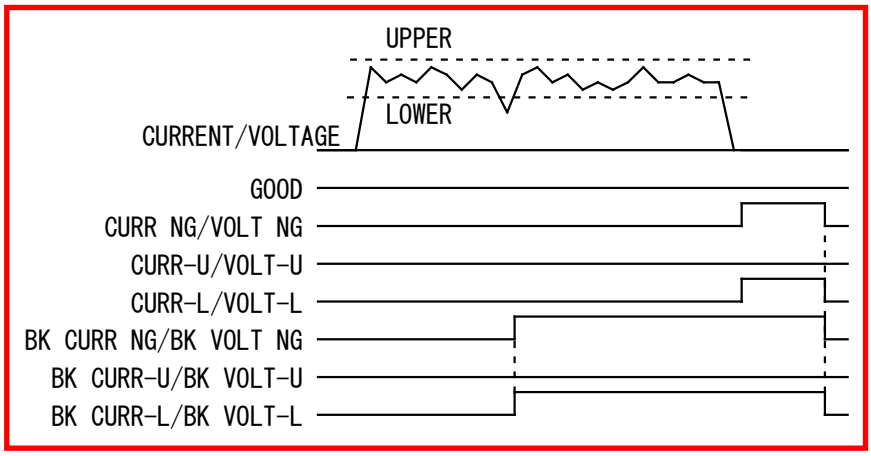
Set upper and lower limit values of the voltage in the judgment period 1 to 3

There are two settings for judgment output for CURRENT 1 to 3 and VOLTAGE 1 to 3, that after the current flow end and that during the current flow. (Refer to Chapter 8, “o-2. EXT INPUT/OUTPUT (2) (3) Screen.”)

- When exceeding the upper limit



- When falling below the lower limit



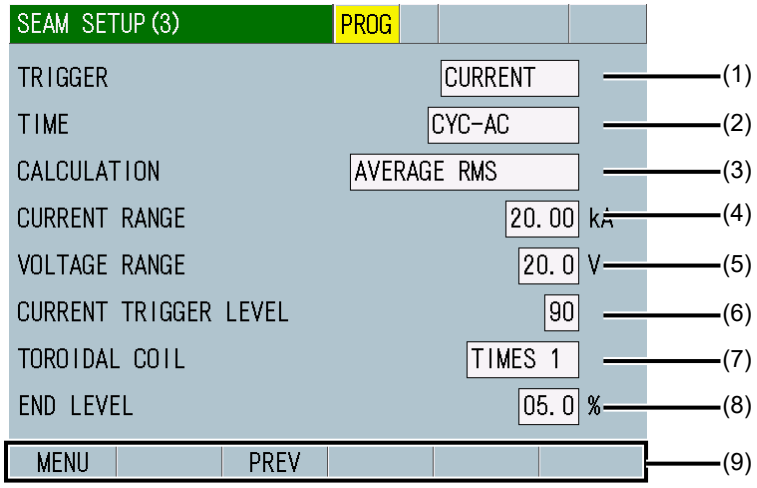
(5) Function keys

MENU: Touching this displays the MENU screen.

NEXT: Touching this displays the SEAM SETUP (3) screen.

PREV: Touching this displays the SEAM SETUP (1) screen.

s-3. SEAM SETUP (3) Screen



(1) TRIGGER

Select CURRENT or VOLTAGE.

When the TRIGGER setting is changed, START MEASUREMENT, MEASUREMENT RANGE, MEASUREMENT INTERVAL, START TIME, and END TIME may be initialized. Set START MEASUREMENT, MEASUREMENT RANGE, MEASUREMENT INTERVAL, START TIME, and END TIME again. (Refer to "s-1. SEAM SETUP (1) Screen.")

(2) TIME

Select from CYC-AC, ms-AC, CYC-DC, ms-DC, and SHORT ms-DC.

The selectable item varies depending on the TRIGGER setting.

(Note) When CURRENT is selected for TRIGGER, CYC-AC or ms-AC can be selected for TIME. When VOLTAGE is for TRIGGER selected, ms-DC, CYC-DC, or SHORT ms-DC can be selected for TIME.

When the TIME setting is changed, START MEASUREMENT, MEASUREMENT RANGE, MEASUREMENT INTERVAL, START TIME, and END TIME may be initialized. Set START MEASUREMENT, MEASUREMENT RANGE, MEASUREMENT INTERVAL, START TIME, and END TIME again. (Refer to "s-1. SEAM SETUP (1) Screen.")

(3) CALCULATION

Select the calculation system.

RMS: Calculated the RMS in the whole measurement range.

AVERAGE RMS: Calculates the RMS every half cycle or 1 ms and calculates the arithmetic mean value within the measurement range.

Refer to (Note 1) Difference between the original measurement mode and the ISO17657-compliant measurement mode for RMS calculation in “c. VIEW Screen.”

(4) CURRENT RANGE

Select from the following five ranges. Select one which is larger than the maximum current of welding current actually measured and close to the measured current.

The current ranges change as follows depending on the TOROIDAL COIL setting in the BASIC SETUP (3) screen

- When the TOROIDAL COIL setting is 1: 2.000 kA range, 6.00 kA range, 20.00 kA range, 60.0 kA range, 200.0 kA range
- When the TOROIDAL COIL setting is 10: 0.200 kA range, 0.600 kA range, 2.000 kA range, 6.00 kA range, 20.00 kA range

(5) VOLTAGE RANGE

Select from the following two ranges. Select one which is larger than the maximum voltage of welding current actually measured and close to the measured voltage.

6.00 V: 6.00 V range
20.0 V: 20.0 V range

(6) CURRENT TRIGGER LEVEL

The sensitivity increases as you increase the value. Excessively increasing the sensitivity may cause malfunction. If set to around 99, the current trigger may not be complete. At the time, decrease the value.

(7) TOROIDAL COIL

Set as follows depending on the type of toroidal coil connected:

When 1x sensitivity coil is used: 1
When 10x sensitivity coil is used: 10

(8) END LEVEL

You can measure the current flow time till the End Level setting is reached. Set the End Level as the ratio to the used current range (1.5 to 15.0%).

(9) Function keys

MENU: Touching this displays the MENU screen.

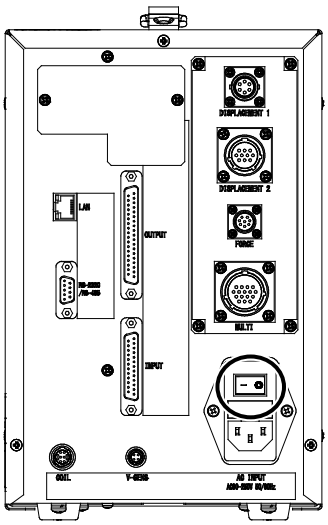
PREV: Touching this displays the SEAM SETUP (2) screen.

9. Measurement

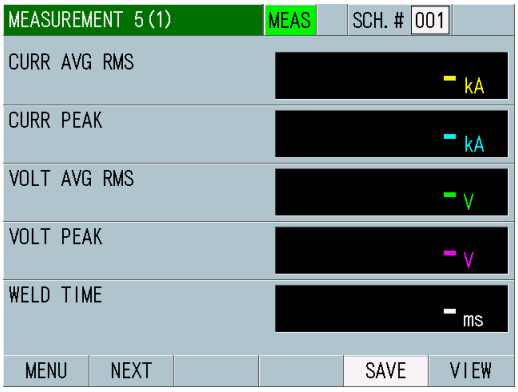
(1) Measuring Current (Current Flow Time)/Voltage

1) Connect the **MM-400A** to a power supply, and plug the toroidal coil and the voltage detection cable to the **MM-400A**. (For more information, refer to (2) a 1) and 2) in Chapter 6.)

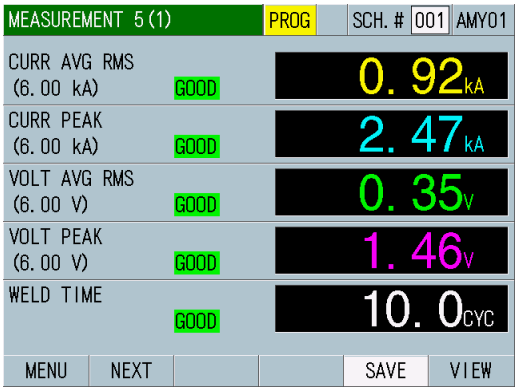
2) Set the main power switch on the rear panel to the ON position (– side) to start the **MM-400A**.



3) The MEASUREMENT 5(1) or MEASUREMENT 10 screen appears on the display after a while.



To change or check the setting, touch MEAS to change it to PROG.
(Alternately switched by touching.)

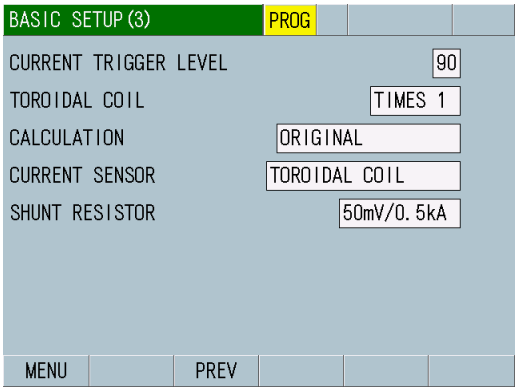


4) Touch the MENU key.

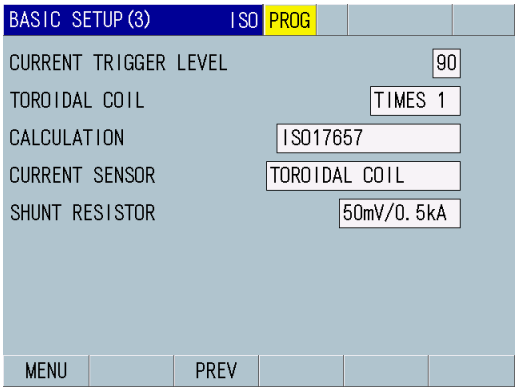
The MENU screen appears. Select BASIC SETUP.

5) For ISO17657-compliant calculation, change ORIGINAL to ISO17657 in the BASIC SETUP (3) screen.

When ISO17657 is selected, the upper-left portion of the screen changes from green to blue on all screens and “ISO” is displayed.

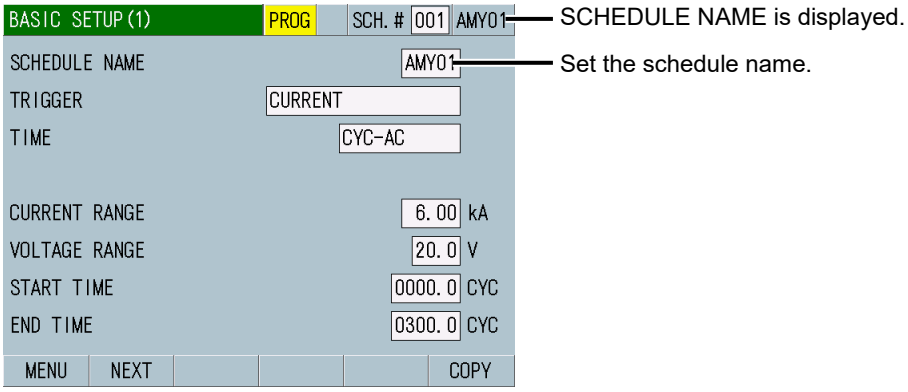


Original mode

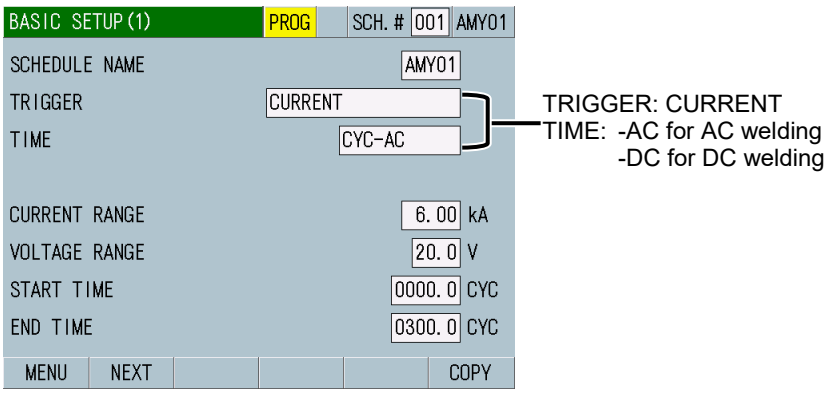


ISO17657 mode

6) The BASIC SETUP (1) screen appears. You can set the schedule name for a schedule.



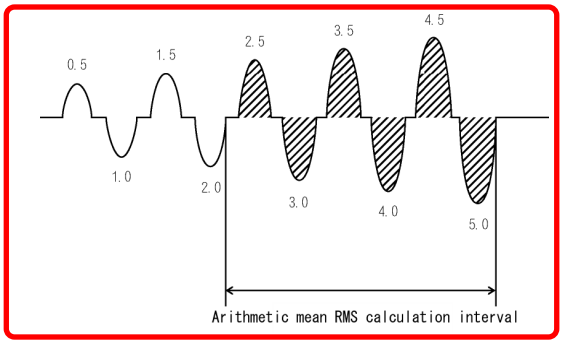
7) Select CURRENT for TRIGGER in the BASIC SETUP (1) screen, and select a type of welding current to measure and the measurement time unit. (For more information, refer to (2) I-1 in Chapter 8.)



8) Set up the **MM-400A** as follows according to the type of welding power supply used:

- Single-phase AC welding power supply

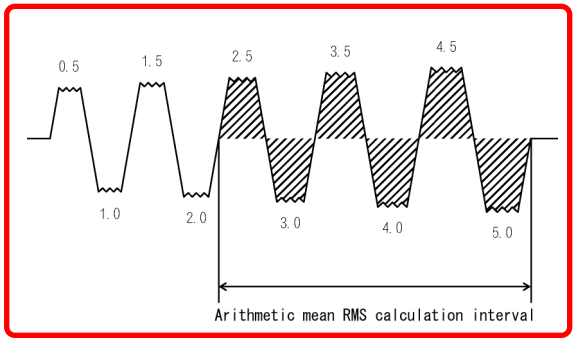
Set the following items in the BASIC SETUP (1) screen. (For more information, refer to (2) I-1 in Chapter 8.)

Item	Setting
TIME	CYC-AC
START TIME/ END TIME	Referring to the figure shown below, set the current calculation interval. 

- AC inverter welding power supply

Set the following items in the BASIC SETUP (1) screen. (For more information, refer to (2) I-1 in Chapter 8.)

Item	Setting
TIME	When making measurement by setting a frequency: CYC***Hz-AC When measuring current flow time in units of ms: ms-AC

Item	Setting
START TIME/ END TIME	Referring to the figure shown below, set the current calculation interval. 
FREQUENCY	Set the frequency of the current to be measured. When using our AC inverter welding power supply, set the frequency referring to the table shown below “Correlation between Frequencies of the Welding Power Supply and the **MM-400A**.”

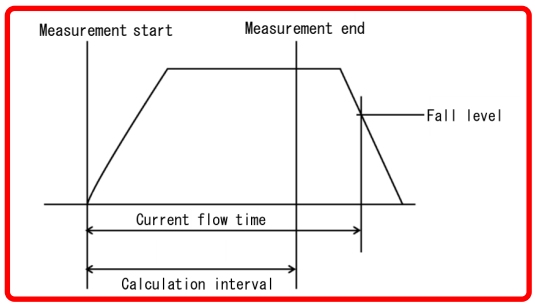
Correlation between Frequencies of the Welding Power Supply and the **MM-400A**

Welding power supply frequency setting	MM-400A frequency setting	Welding power supply frequency setting	MM-400A frequency setting
50 Hz	M050	100 Hz	M100
53 Hz	M053	111 Hz	M111
56 Hz	M056	125 Hz	M125
59 Hz	M059	143 Hz	M143
63 Hz	M063	167 Hz	M167
67 Hz	M067	200 Hz	M200
71 Hz	M071	250 Hz	M250
77 Hz	M077	294 Hz	M294
83 Hz	M083	417 Hz	M417
91 Hz	M091	500 Hz	M500

- DC inverter welding power supply

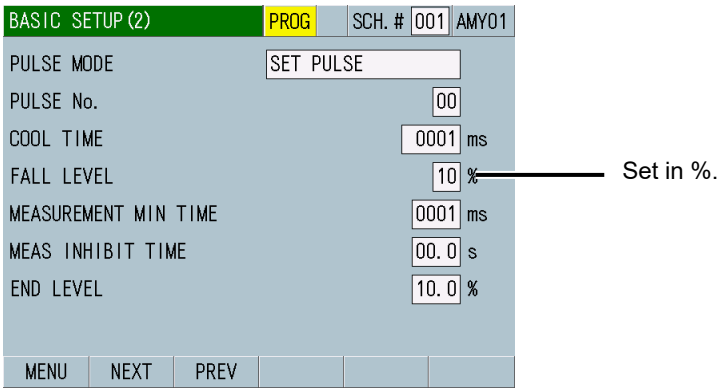
  (1) Set the following items in the BASIC SETUP (1) screen. (For more information, refer to (2) I-1 in Chapter 8.)

Item	Setting
TIME	When making measurement in units of cycle: CYC-DC When making measurement in units of ms: ms-DC

Item	Setting
START TIME/ END TIME	Referring to the figure shown below, set the current calculation interval.  Set FALL LEVEL in the BASIC SETUP (2) screen for the current flow time. *1

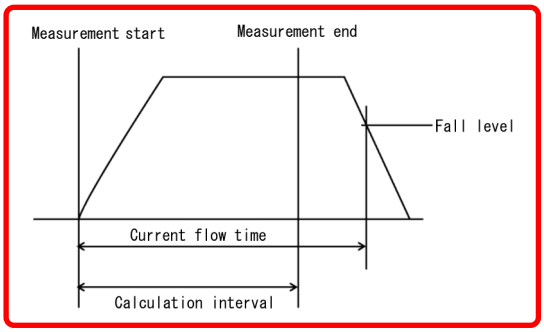
*1: The calculation end time becomes FALL LEVEL set in the BASIC SETUP (2) screen when END TIME is longer than the current flow time. FALL LEVEL is a peak value when ORIGINAL is selected for CALCULATION, and a ratio from the maximum RMS when ISO17657.

(2) FALL LEVEL setting
Select the BASIC SETUP (2) screen to set FALL LEVEL.



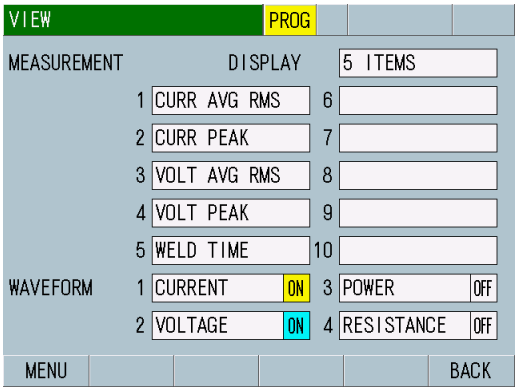
- Transistor welding power supply

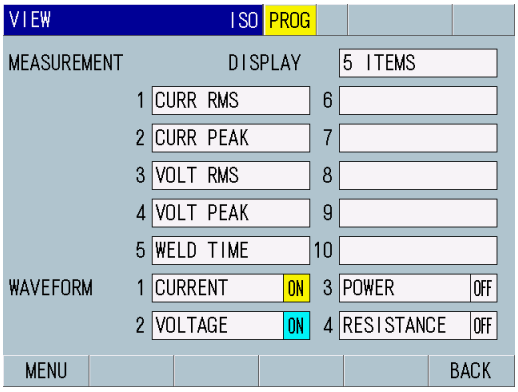
Set the following items in the BASIC SETUP (1) screen. (For more information, refer to (2) I-1 in Chapter 8.)

Item	Setting
TIME	SHORT ms-DC
START TIME/ END TIME	Set the current calculation interval. 

9) Touch the MENU key to select VIEW.

According to the desired measurement item, set the following in one of MEASUREMENT 1 to 5 or 1 to 10. The settable items are different between ORIGINAL and ISO17657. (For information on measurement items other than the following, refer to (2) c in Chapter 8.)





To measure RMS current (ISO17657 mode): CURR RMS
To measure average RMS current (original mode): CURR AVG RMS
To measure peak current during current flow: CURR PEAK
To measure RMS voltage (ISO17657 mode): VOLT RMS
To measure average RMS voltage (original mode): VOLT AVG RMS
To measure peak voltage during current flow: VOLT PEAK
To measure current flow time: WELD TIME
To measure max. conduction angle during current flow time: COND ANGLE

When the measurement item is changed, upper and lower limits for the changed measurement item are initialized. Set upper and lower limits again on the COMPARATOR screen. (Refer to (2) m in Chapter 8.)

10) To display the waveforms of the measured items, set those items in WAVEFORM 1 to 4. (For more information, refer to (2) c in Chapter 8.)

11) Touch the MENU key to select MEASUREMENT or WAVEFORM.

12) Select a schedule number to measure.

When setting by the touch panel, set a schedule number to measure in “SCH.#” without inputting a signal to the external input (SCH1 to 64).

When selecting by the external input (SCH1 to 64), input a signal in the external input (SCH1 to 64). (Refer to (1) (2) in Chapter 10.)

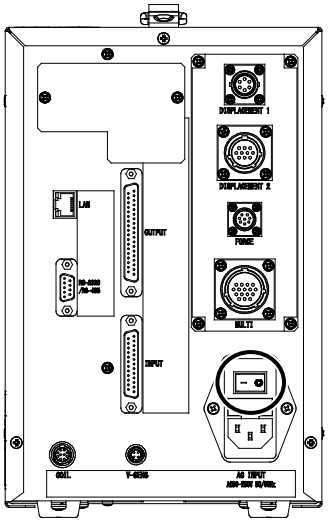
13) Touch PROG to change it to MEAS, putting the **MM-400A** into wait state until measurement starts (the signal selected as trigger is input).

14) When the trigger signal is input to the **MM-400A**, the [TRIGGER] lamp lights up and measurement starts. Confirm the measurement results on the MEASUREMENT and WAVEFORM screens. You can also print measured values and waveforms from the PRINT screen, as necessary.

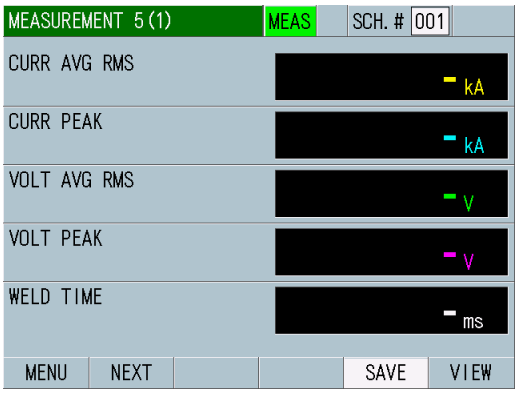
(2) Measuring Displacement (Force/displacement-equipped specification function)

1) Connect the **MM-400A** to a power supply, and plug the displacement sensor to the **MM-400A**. (For more information, refer to (2) b 1) and 2) in Chapter 6.)

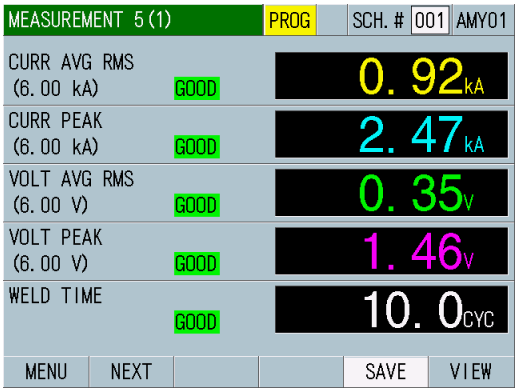
2) Set the main power switch on the rear panel to the ON position (– side) to start the **MM-400A**.



3) The MEASUREMENT 5(1) or MEASUREMENT 10 screen appears on the display after a while.



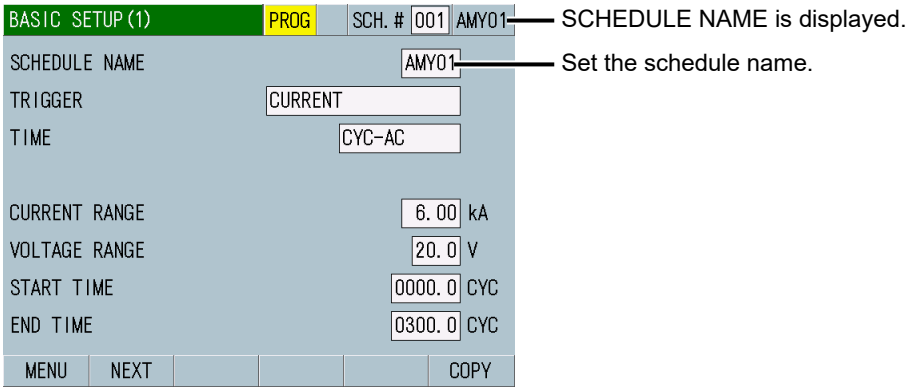
To change or check the setting, touch MEAS to change it to PROG. (Alternately switched by touching.)



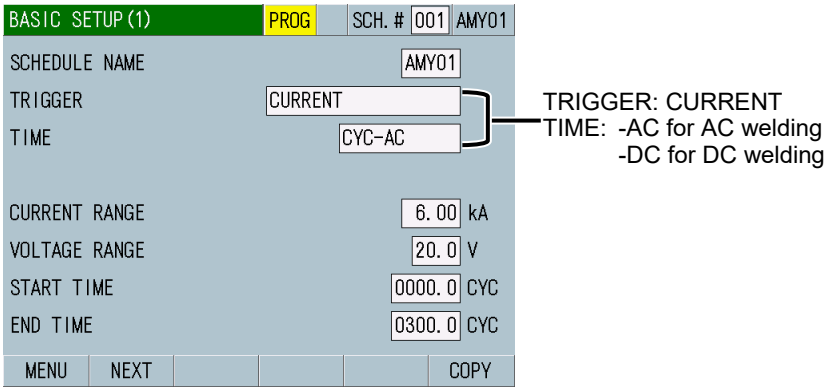
4) Touch the MENU key.

The MENU screen appears. Select BASIC SETUP.

5) The BASIC SETUP (1) screen appears. You can set the schedule name for a schedule.

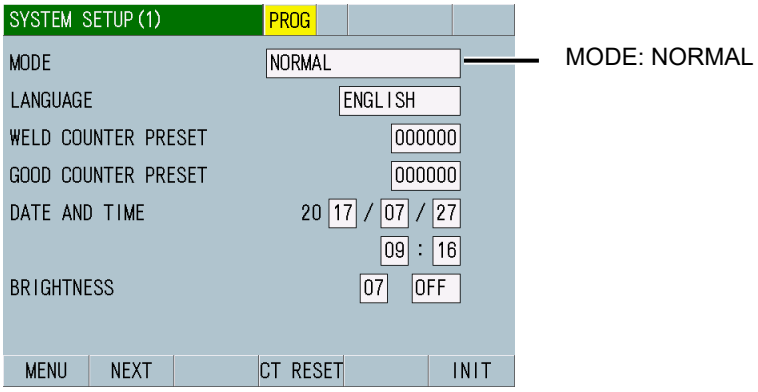


6) Select CURRENT for TRIGGER in the BASIC SETUP (1) screen, and select a time of welding current to select. (For more information, refer to (2) I-1 in Chapter 8.)



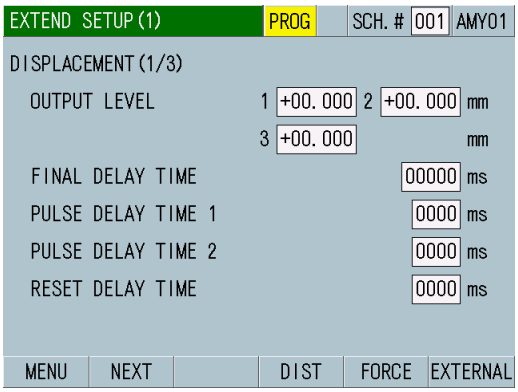
7) Touch the MENU key and select SYSTEM SETUP.

Select NORMAL for MODE in the SYSTEM SETUP (1) screen. (For more information, refer to (2) n-1 in Chapter 8.)



8) Touch the MENU key and select EXTEND SETUP.

Set the following items in the EXTEND SETUP (1) screen. (For more information, refer to (2) m-1 in Chapter 8.)



Item	Setting
DELAY TIMEs (FINAL, PULSE 1/2, RESET)	0 to 999 ms
OUTPUT LEVEL 1/2/3	• When a sensor with 1 µm resolution or less is used Displacement level 1: -30.000 mm Displacement level 2: +30.000 mm • When a sensor with 1.1 µm resolution or more is used Displacement level 1: -300.00 mm Displacement level 2: +300.00 mm

9) Touch the NEXT key to display the EXTEND SETUP (2) screen.

Item	Setting
INITIAL MEASUREMENT	Set the timing to measure the displacement before welding. CURRENT START: Immediately before the welding current is detected. EXTERNAL INPUT: Determined by the external signal.
MEAS AFTER PULSE	Set the timing to make measurement after the end of the current flow pulse. CURRENT START: Immediately before the next current flow pulse is detected. DELAY TIME: After the elapse of the delay time following the end of the current flow pulse.
FINAL MEASUREMENT	Set the timing to measure the displacement after welding. DELAY TIME: After the elapse of the delay time following the end of the final current flow pulse. EXTERNAL INPUT: Determined by the external signal.

Item	Setting
PULSE 2 RESET	Valid when you have selected REFERENCE for MEASUREMENT MODE. ON: Perform a zero reset of the displacement after the elapse of the time set in RESET DELAY TIME following the end of the first step (WELD1) pulse. *1 OFF: The PULSE 2 RESET function does not work.

*1: Set RESET DELAY TIME in the EXTEND SETUP (1) screen.

10) Touch the NEXT key to display the EXTEND SETUP (3) screen.

Item	Setting
MEASUREMENT MODE	REFERENCE: Performs a zero reset during measurement. ABSOLUTE1 to 4: Performs a zero reset in advance.
SENSOR	Specify the manufacturer of the displacement sensor connected. Select among Mitutoyo, Ono Sokki, KEYENCE, and HEIDENHAIN.
SENSOR STEP	Enter the displacement sensor resolution. Set the value between 0.1 to 10.0 μm. Ex.) GS-1830A, GS-1813A: 1.0 μm LGK-110, LG200-110: 1.0 μm ST1278: 0.5 μm
POLARITY	Set the displacement polarity. FORWARD: Plus (+) in the direction of sensor retraction) REVERSE: Minus (-) in the direction of sensor retraction)
UNITS	Select mm or inch.
OUTPUT RANGE	Select an analog output range for displacement. 32.767: Outputs ±32.767 mm with ±5 V. 8.191: Outputs ±8.191 mm with ±5 V. 2.047: Outputs ±2.047 mm with ±5 V.

11) Touch the MENU key to select VIEW.

According to the desired measurement item, set the following in one of MEASUREMENT 1 to 5 or 1 to 10:

To measure displacement before welding current flow: DIST INITIAL
To measure displacement after pulse1 (WELD1) current flow: DIST PULSE1
To measure displacement after pulse2 (WELD2) current flow: DIST PULSE2
To measure final displacement: DIST FINAL
To measure displacement constantly by the constant trigger: DIST REAL TIME

12) To display the waveforms of displacement, set those items in WAVEFORM 1 to 4.

13) Touch the MENU key to select MEASUREMENT or WAVEFORM.

14) Select a schedule number to measure.

    When setting by the touch panel, set a schedule number to measure in “SCH.#” without inputting a signal to the external input (SCH1 to 64).

    When selecting by the external input (SCH1 to 64), input a signal in the external input (SCH1 to 64). (Refer to (1) (2) in Chapter 10.)

15) Touch PROG to change it to MEAS, putting the **MM-400A** into wait state until measurement starts (the signal selected as trigger is input).

16) When the trigger signal is input to the **MM-400A**, the [TRIGGER] lamp lights up and measurement starts. Confirm the measurement results on the MEASUREMENT and WAVEFORM screens. You can also print measured values and waveforms from the PRINT screen, as necessary. (For more information, refer to (1) and (2) in Chapter 8.)

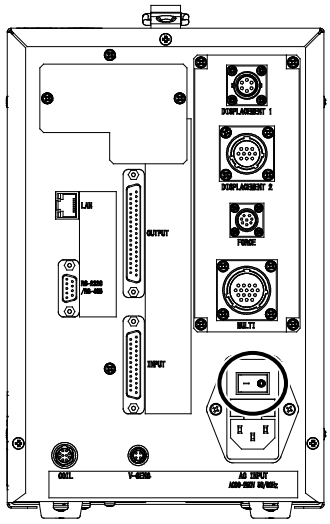
(3) Measuring Force (Force/displacement-equipped specification function)

CAUTION

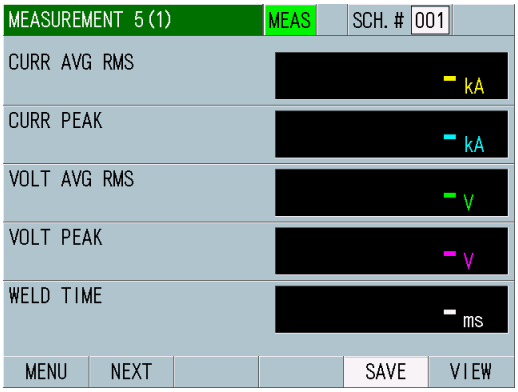
- Before using the force sensor **MA-520B/521B/522B**, be sure to turn off the power of the welding machine and confirm that no welding current is flowing.
- Select an appropriate force sensor according to the force range you wish to measure.
- Before measuring force, be sure to set the force sensor's offset to "0." You can set the offset to "0" by touching the FORCE 0 key on the SYSTEM SETUP (2) screen. At this time make sure that no force is applied to the sensor.

1) Connect the **MM-400A** to a power supply, and plug the force or current/force sensor to the **MM-400A**. If you wish to measure the current and voltage as well as the force at the same time, use the pressure follow-up mechanism element P unit or the current/force sensor. (For more information, refer to (2) c 1) and 2) in Chapter 6.)

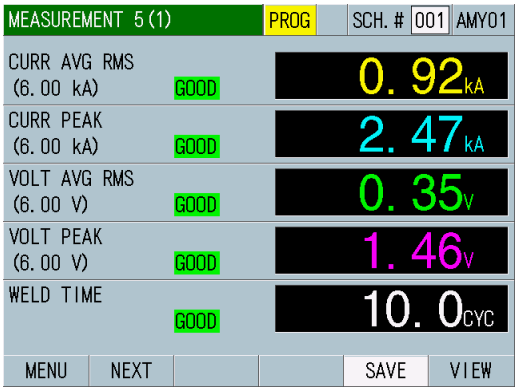
2) Set the main power switch on the rear panel to the ON position (– side) to start the **MM-400A**.



3) The MEASUREMENT 5(1) or MEASUREMENT 10 screen appears on the display after a while.



To change or check the setting, touch MEAS to change it to PROG.
(Alternately switched by touching.)

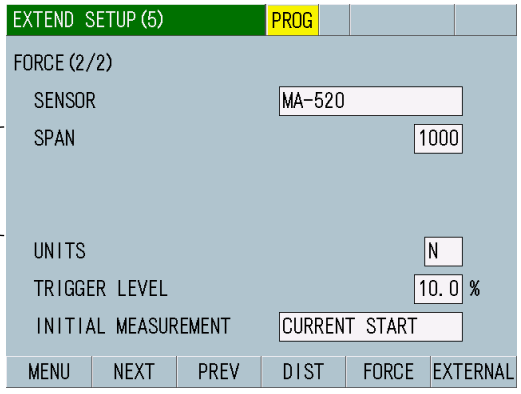


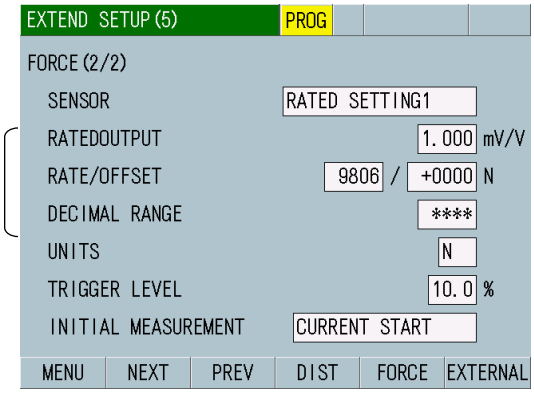
4) Touch the MENU key.

The MENU screen appears. Select EXTEND SETUP.

5) Select the EXTEND SETUP (5) screen.

The setting items differ according to the SENSOR setting.





6) Set the following items. (For more information, refer to (2) m-5 in Chapter 8.)

Item	Setting
SENSOR	Select the force sensor connected. When using sensors other than **MA-520B/521B/522B/770A/771A**, select RATED SETTING1.
SPAN*1	500 to 1500 (when selecting MA-520/521/522/770/771)
RATE / RATED OUTPUT *2	0.75 to 2.00 mV/V (when selecting RATED SETTING1)
UNITS	N, kgf, lbf
TRIGGER LEVEL	Measures while the trigger level is exceeded. Set in % from full scale: 1.0 to 99.9%

*1: Value and force span to correct it are listed on the label of **MA-520B/521B/522B/770A/771A**. Set the value of force span on the label to the SPAN.

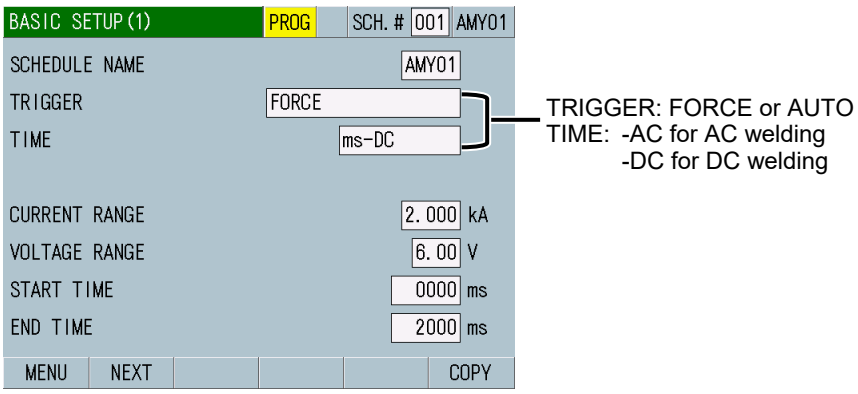
*2: The rated output means the output voltage when the maximum load is applied to and the output voltage per 1 V of applied voltage.

7) Touch the MENU key.

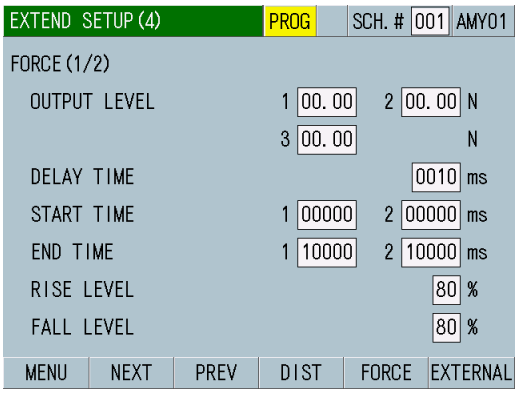
The MENU screen appears. Select BASIC SETUP.

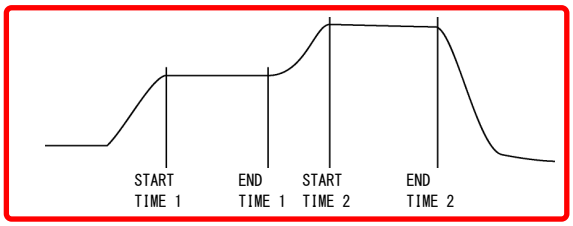
The BASIC SETUP (1) screen appears.

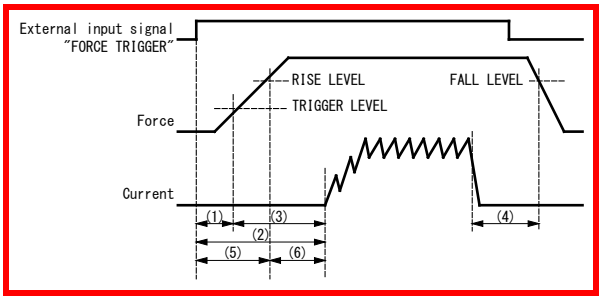
8) Select FORCE or AUTO for TRIGGER in the BASIC SETUP (1) screen, and select a time of welding current to select. (For more information, refer to (2) I-1 in Chapter 8.)



9) Set the following items in the EXTEND SETUP (4) screen.



Item	Setting
OUTPUT LEVEL 1/2/3	Signal can be output from external outputs FORCE LEV1, FORCE LEV2 and FORCE LEV3.
DELAY TIME	Measures force at the end of the delay time after the current flow end.
START TIME 1/2 END TIME 1/2	Referring to the figure shown below, set a force calculation interval by the START TIME and END TIME. 

Item	Setting
RISE LEVEL FALL LEVEL	Set RISE LEVEL and FALL LEVEL as the ratio to the peak (10 to 90%). This setting applies to the time measurements in the FORCE TIMING screen. 

10) According to the desired measurement item, set the following in one of MEASUREMENT 1 to 5: (For information on measurement items other than the following, refer to (2) c in Chapter 8.)

To measure mean force of measurement interval 1: FORCE AVG1
To measure mean force of measurement interval 2: FORCE AVG2
To measure peak force: FORCE PEAK
To measure force before the start of current flow: FORCE INITIAL
To measure force after the end of welding: FORCE FINAL
To measure force constantly by the constant trigger: FORCE REAL TIME

To measure the force time (from when the force signal exceeds the force start level to when the signal falls below the force end level): FORCE TIME

When the measurement item is changed, upper and lower limits for the changed measurement item are initialized. Set upper and lower limits again on the COMPARATOR screen. (Refer to (2) e in Chapter 8.)

11) To display the waveforms of force, set those items in WAVEFORM 1 to 4.

12) Touch the MENU key to select MEASUREMENT or WAVEFORM.

13) Select a schedule number to measure.

When setting by the touch panel, set a schedule number to measure in “SCH.#” without inputting a signal to the external input (SCH1 to 64).

When selecting by the external input (SCH1 to 64), input a signal in the external input (SCH1 to 64). (Refer to (1) (2) in Chapter 10.)

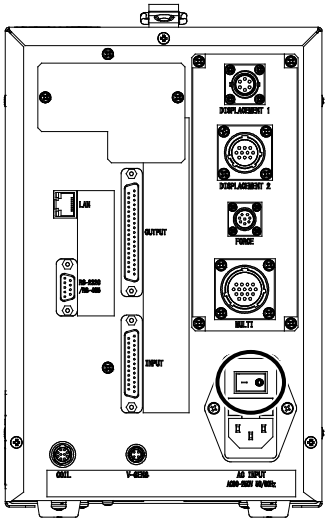
14) Touch PROG to change it to MEAS, putting the **MM-400A** into wait state until measurement starts (the signal selected as trigger is input).

15) When the trigger signal is input to the **MM-400A**, the [TRIGGER] lamp lights up and measurement starts. Confirm the measurement results on the MEASUREMENT and WAVEFORM screens. You can also print measured values and waveforms from the PRINT screen, as necessary.

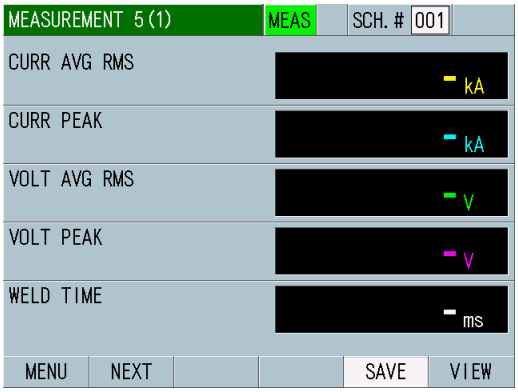
(4) Measuring Current/Voltage after FORCE INITIAL

1) Connect the **MM-400A** to a power supply and the external I/O connector, and connect the pressure follow-up mechanism element P unit to the toroidal coil and the voltage detection cable. (Refer to (2) a 1) and 2) in Chapter 6 for the toroidal coil and the voltage detection cable, (2) c 1) and 2) in Chapter 6 for the force sensor, and (3) in Chapter 10 for the external I/O connector.)

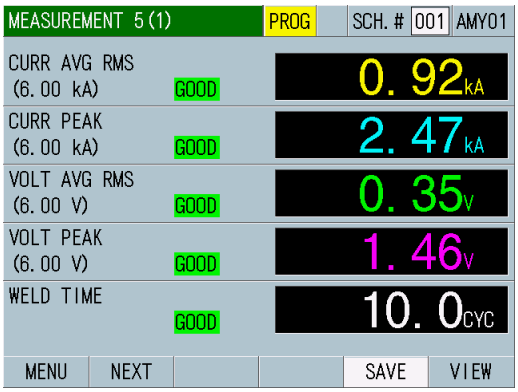
2) Set the main power switch on the rear panel to the ON position (– side) to start the **MM-400A**.



3) The MEASUREMENT 5(1) or MEASUREMENT 10 screen appears on the display after a while.



To change or check the setting, touch MEAS to change it to PROG. (Alternately switched by touching.)

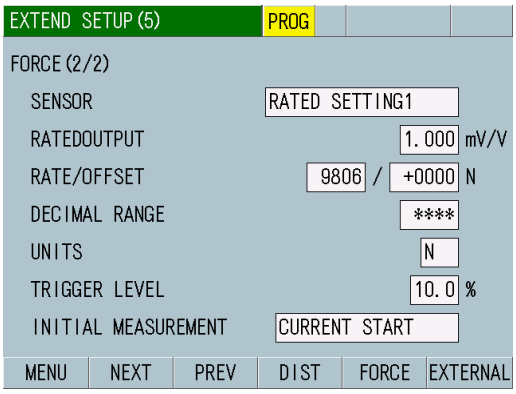


4) Touch the MENU key.

The MENU screen appears. Select EXTEND SETUP.

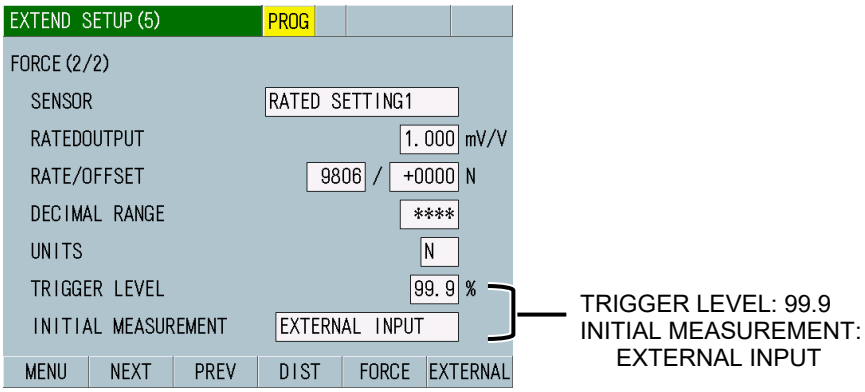
5) Select the EXTEND SETUP (5) screen.

Select RATED SETTING1 for SENSOR. (For more information, refer to (2) m-5 in Chapter 8.)



6) Set items RATED OUTPUT to UNITS. (For more information, refer to (2) m-5 in Chapter 8 and (3) 6) in Chapter 9.)

7) Select 99.9 for TRIGGER LEVEL and EXTERNAL INPUT for INITIAL MEASUREMENT on the EXTEND SETUP (5) screen. (For more information, refer to (2) m-5 in Chapter 8.)

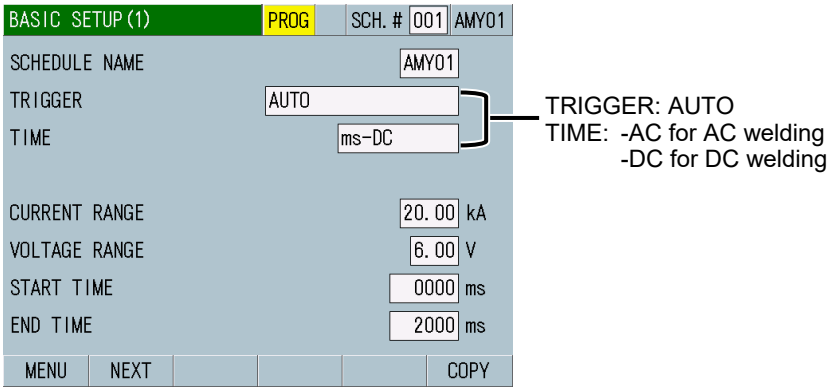


8) Touch the MENU key.

The MENU screen appears. Select BASIC SETUP.

The BASIC SETUP (1) screen appears.

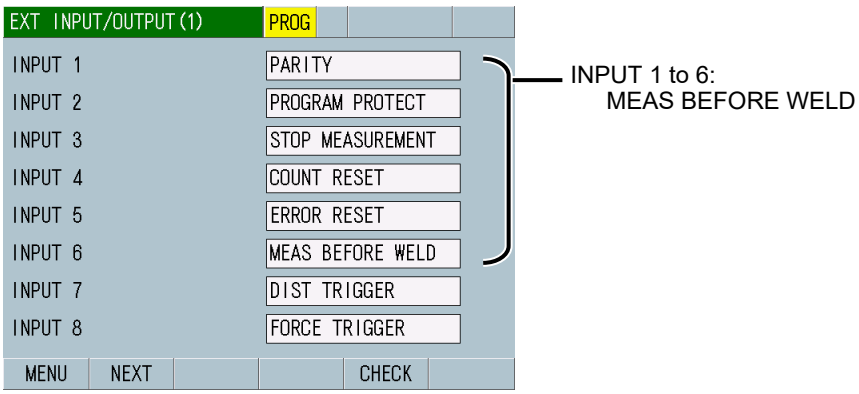
9) Select AUTO for TRIGGER in the BASIC SETUP (1) screen, and select a type of welding current to measure and the measurement time unit. (For more information, refer to (2) l-1 in Chapter 8.)



10) Set items in the BASIC SETUP screen according to the type of welding power supply used. (For more information, refer to (2) I-1 in Chapter 8 and (1) 8) in Chapter 9.)

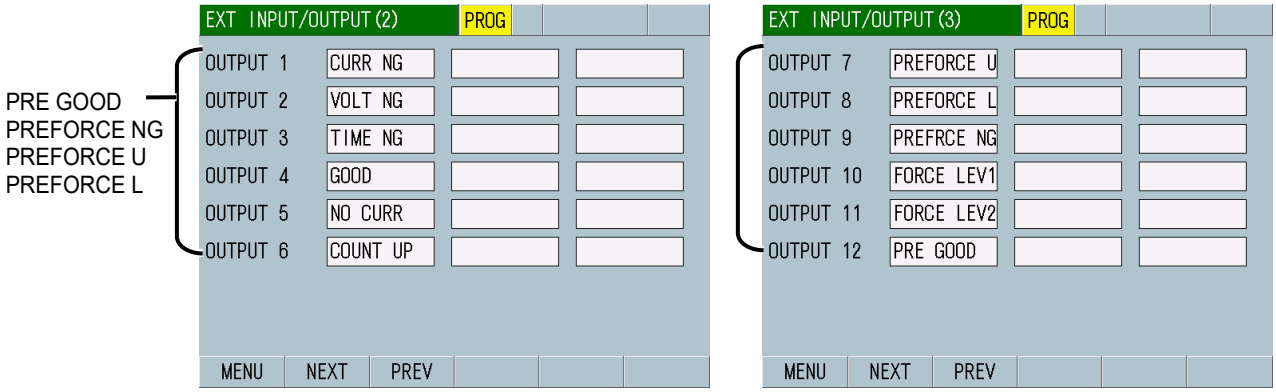
11) Touch the MENU key to select EXT INPUT/OUTPUT.

Set MEAS BEFORE WELD in one of INPUT 1 to 6 on the EXT INPUT/OUTPUT (1) screen. (For more information, refer to (2) o-1 in Chapter 8.)



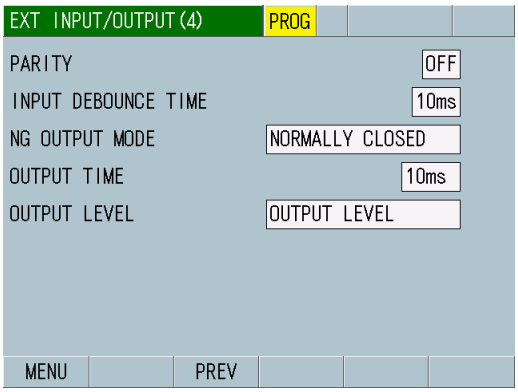
12) Select the EXT INPUT/OUTPUT (2) or (3) screen.

Set the following items in one of OUTPUT 1 to 12, as necessary. (For more information, refer to (2) o-2 in Chapter 8.)



Item	Setting
PRE GOOD: Normal before welding	Output when the measured value before a welding start is within the upper and lower limits.
PREFORCE NG: Force before welding error	Output when the force before a welding start exceeds the upper limit or falls below the lower limit.
PREFORCE U: Force before welding upper limit error	Output if the force before a welding start exceed the upper limits.
PREFORCE L: Force before welding lower limit error	Output if the force before a welding start fall below the lower limits.

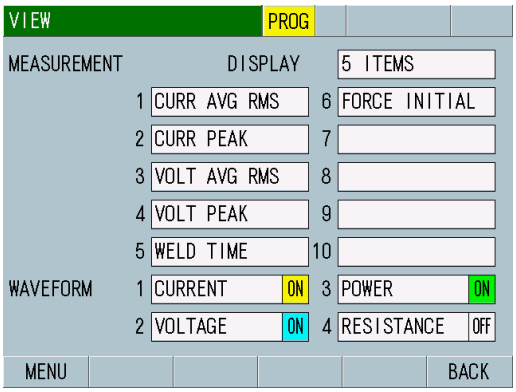
13) Set the following items in the EXT INPUT/OUTPUT (4) screen. (For more information, refer to (2) o-3 in Chapter 8.)



Item	Setting
PARITY	Select whether to use parity terminals. When you select ON, be sure that the total number of schedule selection and parity terminals that are closed is odd.
INPUT DEBOUNCE TIME	Set a delay time from the signal input to when the signal settles down to 1 ms or 10 ms.
NG OUTPUT MODE	Set a mode for the output terminals GOOD, PREGOOD, COUNT, POWER ON, READY, and force/displacement/external level signal work as NORMALLY OPEN irrespective of the NG OUTPUT MODE setting. NORMALLY CLOSED: Open at output NORMALLY OPEN: Closed at output
OUTPUT TIME	Select an output time. 10ms: Output time of 10 ms 100ms: Output time of 100 ms HOLD: Holds output and cancels output at the start of next measurement, the start of no-current check, or in the event of an error reset.
OUTPUT LEVEL	Select the output method of force/displacement/external level signal. The pulse output time is in conformity with OUTPUT TIME, but it becomes 100 ms when HOLD is selected. OUTPUT PULSE: Pulse output OUTPUT LEVEL: Level output

14) Touch the MENU key to select VIEW.

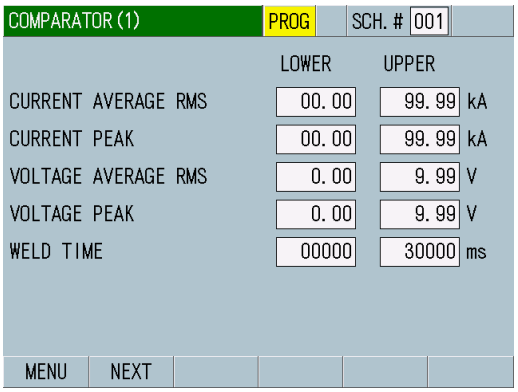
Set FORCE INITIAL in one of MEASUREMENT 1 to 10 on the VIEW screen. (For more information, refer to (2) c in Chapter 8.)

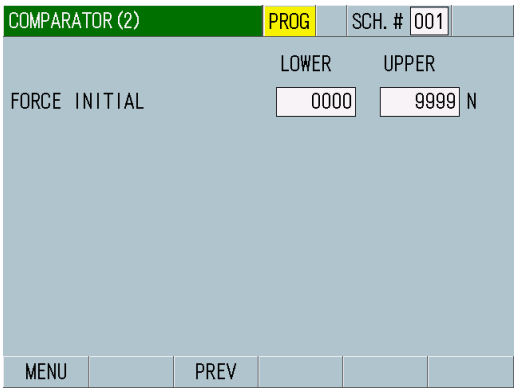


15) To display the waveforms of the measured items, set those items in WAVEFORM 1 to 4. (Refer to (2) c in Chapter 8.)

16) Touch the MENU key to select COMPARATOR.

Set upper and lower limits on the COMPARATOR screen. (For more information, refer to (2) e in Chapter 8.)





17) Touch the MENU key to select MEASUREMENT or WAVEFORM.

18) Select a schedule number to measure.

When setting by the touch panel, set a schedule number to measure in “SCH.#” without inputting a signal to the external input (SCH1 to 64).

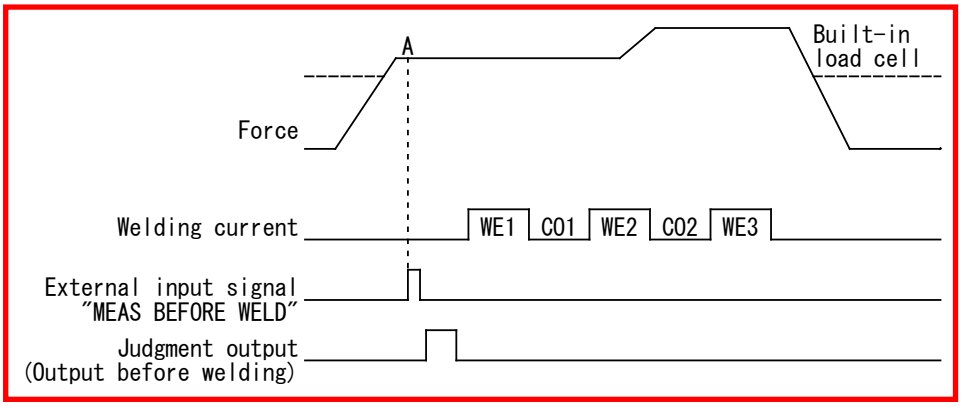
When selecting by the external input (SCH1 to 64), input a signal in the external input (SCH1 to 64). (Refer to (1) and (2) in Chapter 10.)

19) Touch PROG to change it to MEAS, putting the **MM-400A** into wait state until measurement starts (the signal selected as trigger is input).

20) When the external input signal that sets it to MEAS BEFORE WELD is closed, FORCE INITIAL is measured. After measurement, a signal is output from the external output number of the item set in step 12).

21) Start welding from the welding power supply by using the external output signals.

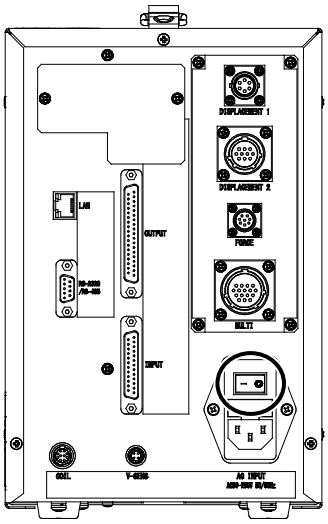
22) When the trigger signal is input to the **MM-400A**, the [TRIGGER] lamp lights up and measurement starts. Confirm the measurement results on the MEASUREMENT and WAVEFORM screens. You can also print measured values and waveforms from the PRINT screen, as necessary.



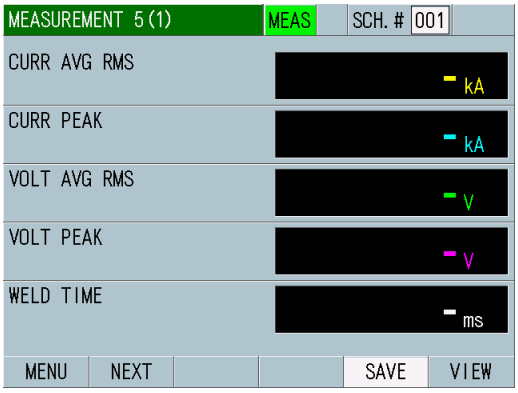
(5) Continuously Measuring Displacement, Force and External Input (Force/displacement-equipped specification function)

1) Connect the **MM-400A** to a power supply, and plug any of the following sensors to measure to the **MM-400A**: the displacement sensor, force sensor, external ±10 V voltage input, or external 4 to 20 mA current input. (For more information, refer to (2) b to e in Chapter 6.)

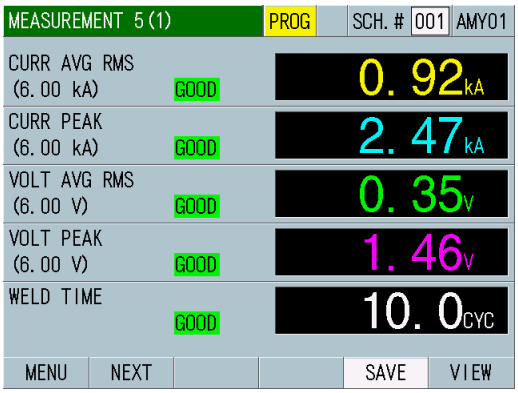
2) Set the main power switch on the rear panel to the ON position (– side) to start the **MM-400A**.



3) The MEASUREMENT 5(1) or MEASUREMENT 10 screen appears on the display after a while.



To change or check the setting, touch MEAS to change it to PROG. (Alternately switched by touching.)

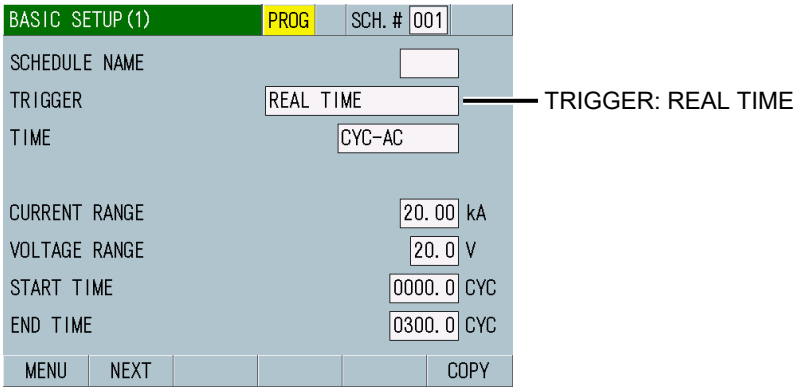


4) Touch the MENU key.

The MENU screen appears. Select BASIC SETUP.

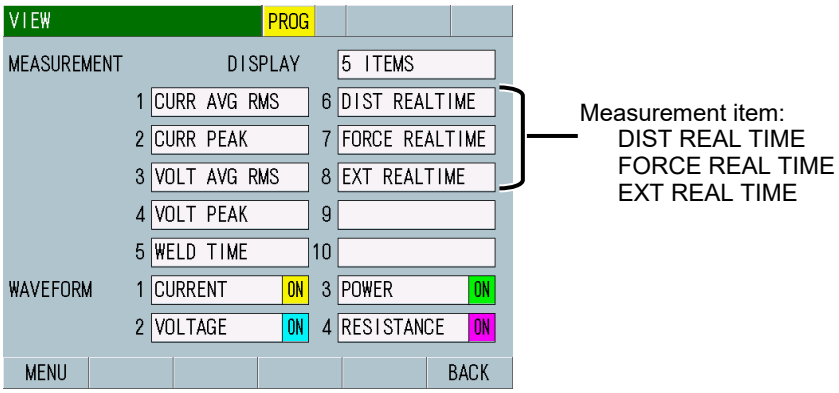
5) Select REAL TIME for TRIGGER in the BASIC SETUP (1) screen. (For more information, refer to (2) I-1 in Chapter 8.)

When the TRIGGER setting is changed if the TIME setting is SHORT ms-DC or LONG CYC-AC, upper and lower limits for measurement items WELD TIME and FLOW TIME and TIME, START TIME, END TIME, COOL TIME, and MEASUREMENT MIN TIME on the BASIC SETUP screens are initialized. Save settings in the USB memory as necessary so that you can restore the settings by reading them. (For saving schedules and reading them, refer to (2) i in Chapter 8.)



6) Touch the MENU key to select VIEW.

Set items to measure to DIST REAL TIME, FORCE REAL TIME and EXT REAL TIME in any of MEASUREMENT 1 to 10 on the VIEW screen. (For more information, refer to (2) c in Chapter 8.)



7) Touch the MENU key to select MEASUREMENT.

8) Touch PROG to change it to MEAS. Measured values of the respective sensors are displayed in items of DIST REAL TIME, FORCE REAL TIME and EXT REAL TIME.

9) By specifying the number of the schedule which REAL TIME is set for TRIGGER in the BASIC SETUP (1) screen with SCH of external input/output signals, measurement can be performed constantly.

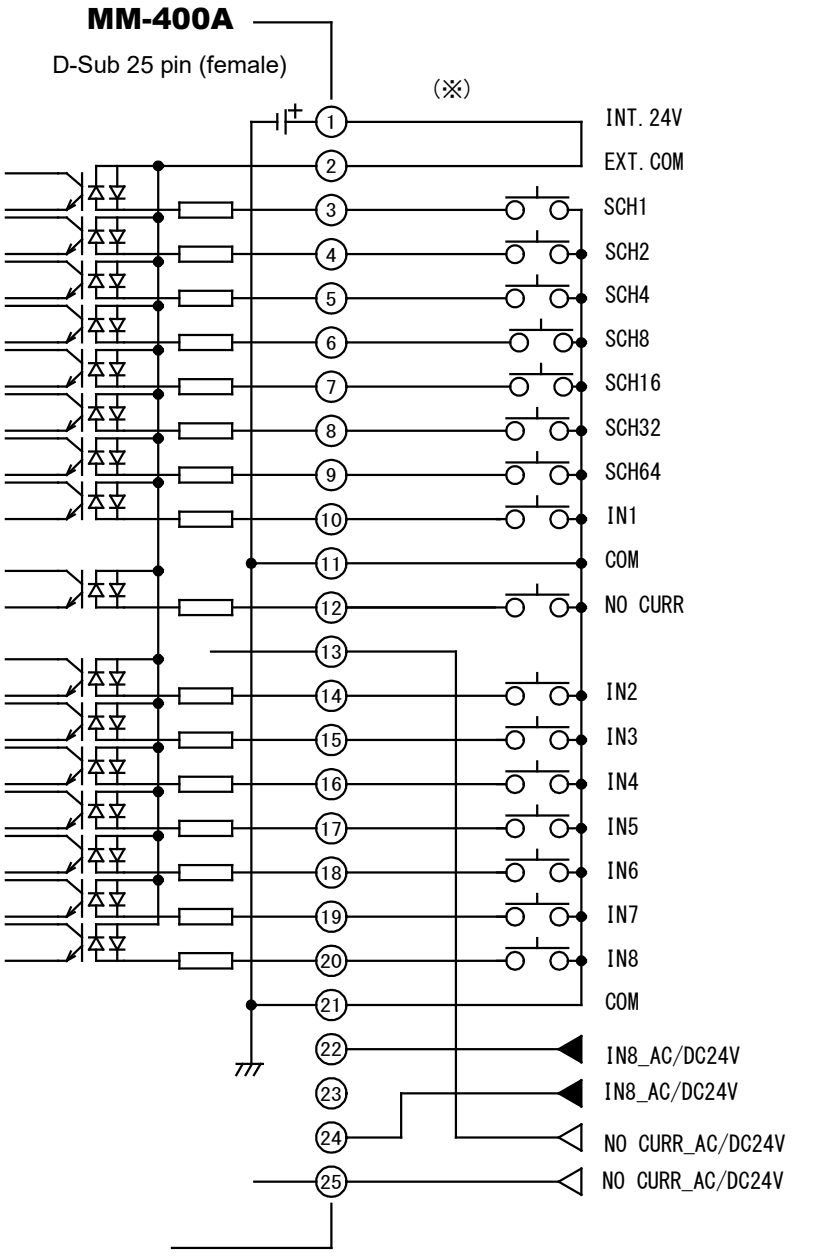
10. Interface

This chapter explains about the pins of the I/O connectors.
Input signals are described as contact inputs.

(1) Connection Diagram of the External I/O Signals

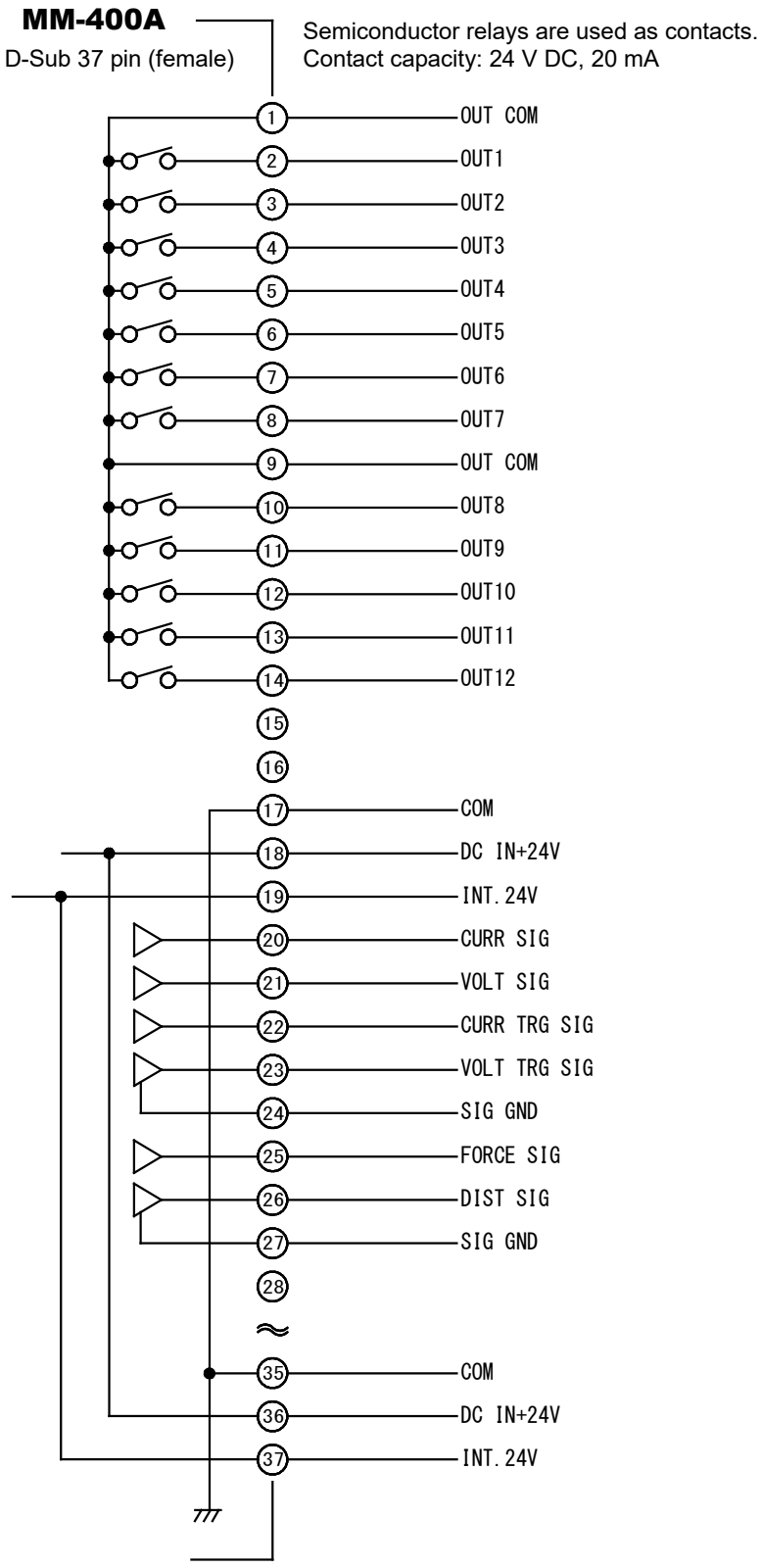
a. Input Connector

[Refer to (2) Rear ① in Chapter 4 “Name and Functions of Each Section.”]



(※) Example of contact input when using internal power supply

b. Output Connector (D-Sub, 37-pin, female)



COM terminal is connected to chassis.
Do not connect to Pins 15, 16, and 28 to 34.

(2) Description of the External I/O Signals

a. Input Connector (D-Sub, 25-pin, female)

Pin No.	Name	Function
1	INT.24	Pins 1 and 2 are INT.24V and EXT.COM pins. Connect them as follows depending on the usage: When using contacts or open-collector (sink-type) PLC (Programmable Logic Controller) as input signals to the I/O connectors, connect pins 1 and 2. When using a voltage-output (source type) PLC as input signals to the I/O connectors, connect pin 2 to the COM terminal of the PLC. Refer to “(3) Connection of Input Signals.”
2	EXT.COM	
3	SCH1	Select the schedule No. by the binary combination of closed pin numbers among pins 3 to 9. The schedule No. selected by the I/O connectors has precedence over that selected on screen. If you wish to select the schedule No. through on-screen manipulation, leave all pins 3 to 9 open. For timing, refer to Chapter 11, “(1) Schedule Number Selection.” You cannot change schedule No. during measurement operation.
4	SCH2	
5	SCH4	
6	SCH8	
7	SCH16	
8	SCH32	
9	SCH64	
10	IN1	User input terminals. Refer to Chapter 8, “o-1. EXT INPUT/OUTPUT (1) Screen” for function and setting.
14	IN2	
15	IN3	
16	IN4	
17	IN5	
18	IN6	
19	IN7	User input trigger terminals. Refer to Chapter 8, “o-1. EXT INPUT/OUTPUT (1) Screen” for function and setting. (Trigger detection by IN8 input can also be performed with pins 22 and 24.)
20	IN8	
11, 21	COM	COM terminal for input signals.
12	NO CURR	Input terminal for the NO CURR signal. Be sure that it closes at least the flow of welding current and opens after the flow of welding current. If no welding current flows while this pin is closed, a lack-of-current error occurs when the pin opens. For timing, refer to Chapter 11, “(2) No CURR Operation.”
13, 25	NO CURR _AC/DC24V	These pins are used to detect lack of current using voltage. Input 24 V AC or DC voltage at least 10 ms prior to the flow of welding current, and stop the input after the current flow. If no welding current flows while this terminal is supplied with voltage, a lack of current error is displayed when the voltage input stops.
23	-	Unused.

Pin No.	Name	Function
22, 24	IN8 _AC/DC24V	These pins are used to detect trigger input set by IN8 using voltage. Input 24V AC or DC voltage at least 10 ms prior to the flow of welding current, and stop the input after the current flow. If no welding current flows while this terminal is supplied with voltage, a lack of current error is displayed when the voltage input stops.

b. Output Connector (D-Sub, 37-pin, female)

Pin No.	Name	Function
1	OUT COM	COM terminal for outputs.
9	OUT COM	
2	OUT1	Contact output terminals. (Semiconductor relay. Capacity: 24 V AC/DC, 20 mA) The contacts close according to the function. Refer to Chapter 8, “o-2. EXT. INPUT/OUTPUT Screen (2) (3) Screen” for function and setting.
3	OUT2	
4	OUT3	
5	OUT4	
6	OUT5	
7	OUT6	
8	OUT7	
10	OUT8	
11	OUT9	
12	OUT10	
13	OUT11	
14	OUT12	
17	COM	COM terminal for pins 18 and 36 for 24 V DC input and pins 19 and 37 for INT.24V.
35	COM	
18	DC IN +24V	Can be used without inputting 90 to 250 V AC by inputting 24 V DC from external device. When using with the 24 V DC power supply, be sure to make connections of pins 18 and 36 to 24 V DC and pins 17 and 35 to 0 V. (Note) When inputting 24 V DC, do not connect input power supply to the power cable connector. When connected at the same time, they are short-circuited and it results in malfunction
36	DC IN +24V	
19	INT.24V	Connected to INT.24V of input connector.
37	INT.24V	
20	CURR SIG	Analog current signal terminal (approx. 2 V/range max. value)
21	VOLT SIG	Analog voltage signal terminal (approx. 2 V/range max. value)
22	CURR TRG SIG	Analog current trigger signal terminal (3.3 V) Goes to approx. 3.3 V if a current flows.
23	VOLT TRG SIG	Analog voltage trigger signal terminal (3.3 V) Goes to approx. 3.3 V if a voltage occurs.
24	SIG GND	COM terminal for analog signals.
25	FORCE SIG	Analog force signal terminal. Approx. 5 V/sensor rating max. (at 1 mV/V rating)
26	DIST SIG	Analog displacement signal terminal. (Note) Refer to “About the analog displacement signal.”
27	SIG GND	COM terminal for analog signals.
28 to 34	-	Unused.

(Note) About the analog displacement signal

The displacement analog output changes depending on the sensor step.
Based on 1 um of sensor step, perform approx. 5 V output for 2.047 mm (0.0805 inch), approx. 5 V output for 8.191 mm (0.3224 inch), and approx. 5 V output for 32.767 mm (1.2900 inch) in a range of ±5 V max.
The displacement analog output is obtained by the following formula: measured value ÷ output range × output maximum voltage (5 V) ÷ sensor step.

Ex. 1)
For output voltage with 2 mm of measured value, 2.047 mm of output range, and 1.0 um of sensor step, 2 mm ÷ 2.047 mm × 5 V ÷ 1 um = approx. 4.885 V.

Ex. 2)
For output voltage with 1 mm of measured value, 2.047 mm of output range, and 0.5 um of sensor step, 1 mm ÷ 2.047 mm × 5 V ÷ 0.5 um = approx. 4.885 V.

Ex. 3)
For output voltage with 2 mm of measured value, 2.047 mm of output range, and 00.5 um of sensor step, 2 mm ÷ 2.047 mm × 5 V ÷ 0.5 um = approx. 9.770 V. However, it is 5 V max. since the maximum value is ±5 V. (Change the output range to 8.191 mm or more.)

Ex. 4)
For output voltage with 2 mm of measured value, 2.047 mm of output range, and 10.0 um of sensor step, 2 mm ÷ 2.047 mm × 5 V ÷ 10 um = approx. 0.489 V.

The displacement analog output does not change even when the setting of displacement polarity is changed.
For the displacement polarity, refer to Chapter 8, “m-3. EXTEND SETUP (3) Screen.”

The force analog output changes depending on the rated output of the sensor

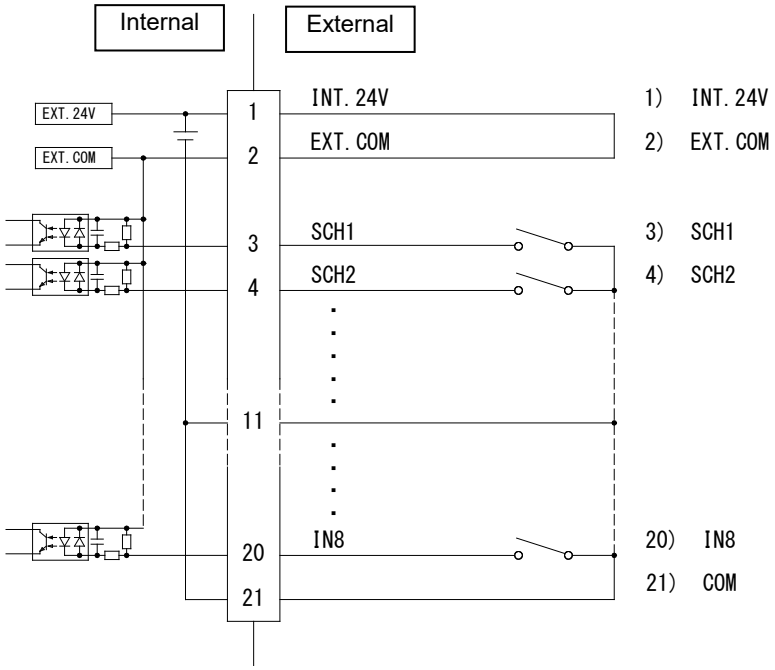
Ex. 1)
When the rated output of the sensor is 1 mV/V, the force analog output is approx. 5 V at the rated maximum force.

Ex. 2)
When the rated output of the sensor is 2 mV/V, the force analog output is approx. 10 V at the rated maximum force.

(3) Connection of Input Signals

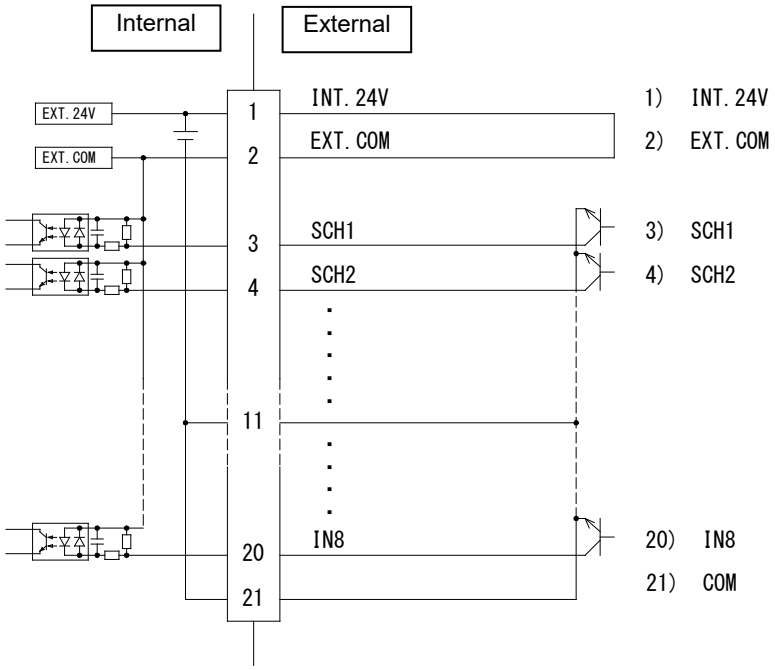
a. Connection with device having a contact input (when using internal power supply)

Connect pins 1 and 2.



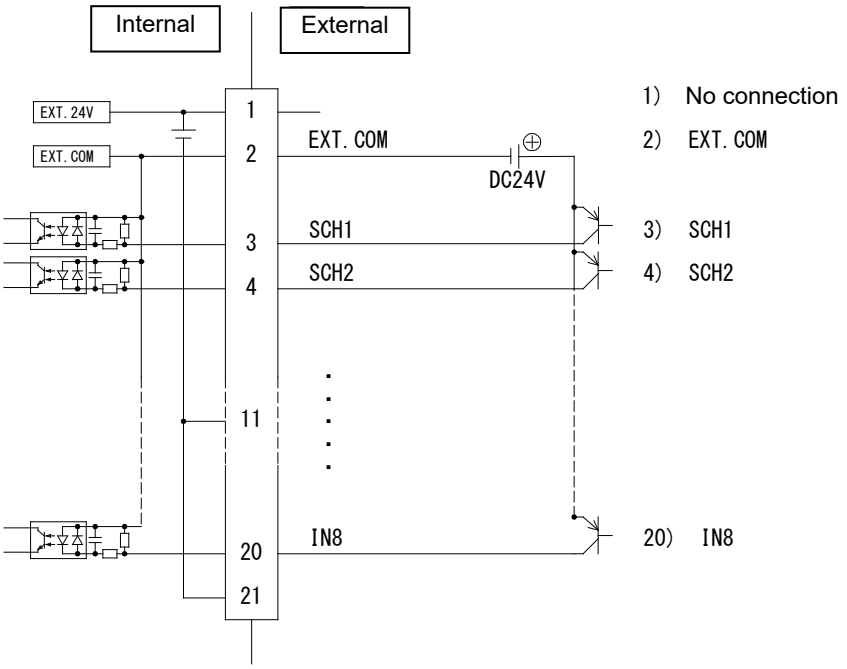
b. Connection with device featuring NPN open collector output (when using internal power supply)

Connect pins 1 and 2.



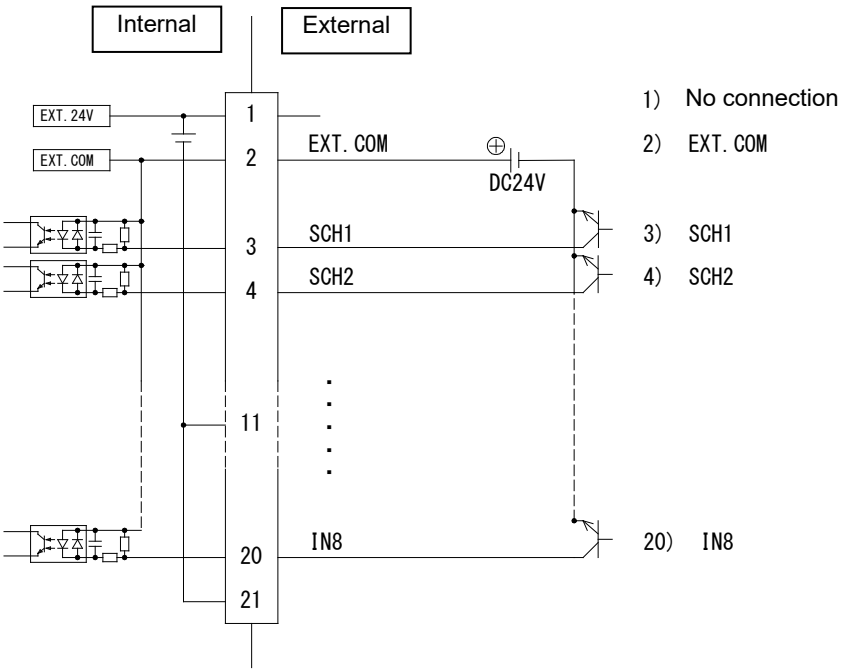
c. Connection with device featuring PNP current output (when using external power supply)

Connect the negative side of an external 24 V DC power supply to pin 2.



d. Connection with device featuring NPN open collector output (when using external power supply)

Connect the positive side of an external 24 V DC power supply to pin 2.



(4) Interface of Other Connectors

a. Displacement sensor connector

[Refer to (2) Rear ⑥ in Chapter 4 “Name and Functions of Each Section.”]

1 +5V
2 A SIG
3 B SIG
4 _A SIG
5 GND
6 _B SIG

b. Displacement connector (Mitutoyo, Ono Sokki, KEYENCE, HEIDENHAIN, 10-pin)

[Refer to (2) Rear ⑦ in Chapter 4 “Name and Functions of Each Section.”]

01 +24V (KEYENCE)
02 +5V (Mitutoyo, Ono Sokki, HEIDENHAIN)
03 GND (Mitutoyo, Ono Sokki, KEYENCE, HEIDENHAIN)
04 A SIG (Ono Sokki)
05 B SIG (Ono Sokki)
06 A SIG (Mitutoyo, KEYENCE, HEIDENHAIN)
07 _A SIG (Mitutoyo, KEYENCE, HEIDENHAIN)
08 B SIG (Mitutoyo, KEYENCE, HEIDENHAIN)
09 _B SIG (Mitutoyo, KEYENCE, HEIDENHAIN)
10 Present position (KEYENCE)

c. Force sensor connector

[Refer to (2) Rear ⑧ in Chapter 4 “Name and Functions of Each Section.”]

A NC
B NC
C NC
D FORCE IN1(+)
E FORCE IN2(-)
F GND
G FG
H +5V

d. Multiconnector

[Refer to (2) Rear ⑨ in Chapter 4 “Name and Functions of Each Section.”]

01	(Do not connect.)	
02	(Do not connect.)	
03	COIL1	(MA-770A, MA-771A)
04	COIL2	(MA-770A, MA-771A)
05	FORCE IN1(-)	(MA-770A, MA-771A)
06	FORCE IN2(+)	(MA-770A, MA-771A)
07	+5V	(MA-770A, MA-771A)
08	GND	(EXTERNAL, SHUNT, MA-770A, MA-771A)
09	CURRENT1	(SHUNT)
10	VOLT1	(MA-770A, MA-771A)
11	VOLT2	(MA-770A, MA-771A)
12	(Do not connect.)	
13	EXT IN [CURRENT]	(EXTERNAL)
14	EXT IN [VOLT]	(EXTERNAL)
15	CURRENT2	(SHUNT)
16	FG	(MA-770A, MA-771A)

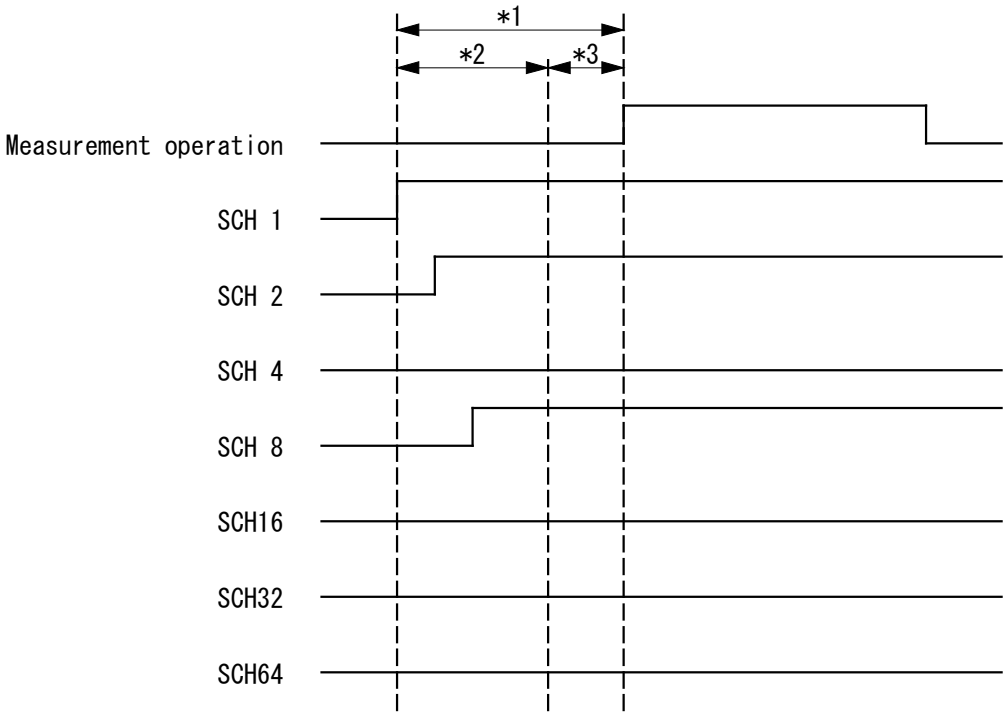
e. Communication connector (RS-232C/485)

[Refer to (2) Rear ③ in Chapter 4 “Name and Functions of Each Section.”]

1	NC	
2	RXD	(RS-232C)
3	TXD	(RS-232C)
4	NC	
5	GND	(RS-232C)
6	RS+	(RS-485)
7	RTS	(RS-232C)
8	NC	
9	RS-	(RS-485)

11. Timing Chart

(1) Schedule Number Selection



*1: Schedule number selection
After SCH1 to 64 signals are switched, the time set for INPUT DEBOUNCE TIME in the EXT INPUT/OUTPUT (4) screen + 2 ms is required. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The required time is at least 3 ms in “1ms” and 12 ms in “10ms.” Switch the SCH1 to 64 signals before measuring start.

*2: Schedule number establishment time
After SCH1 to 64 signals are closed, the schedule is established at the time set for INPUT DEBOUNCE TIME in the EXT INPUT/OUTPUT (4) screen. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The time is 3 ms in “1ms” and 12 ms in “10ms.”
Change SCH1 to 64 into the schedule number to change during the input debounce time.
The input debounce time starts at the point SCH is switched first. When SCH1 to 64 signals change after the establishment time, the establishment time and the setting time is required again.
In the above example, SCH1, 2, and 8 are turned ON, and measurement is performed with the schedule number 11.

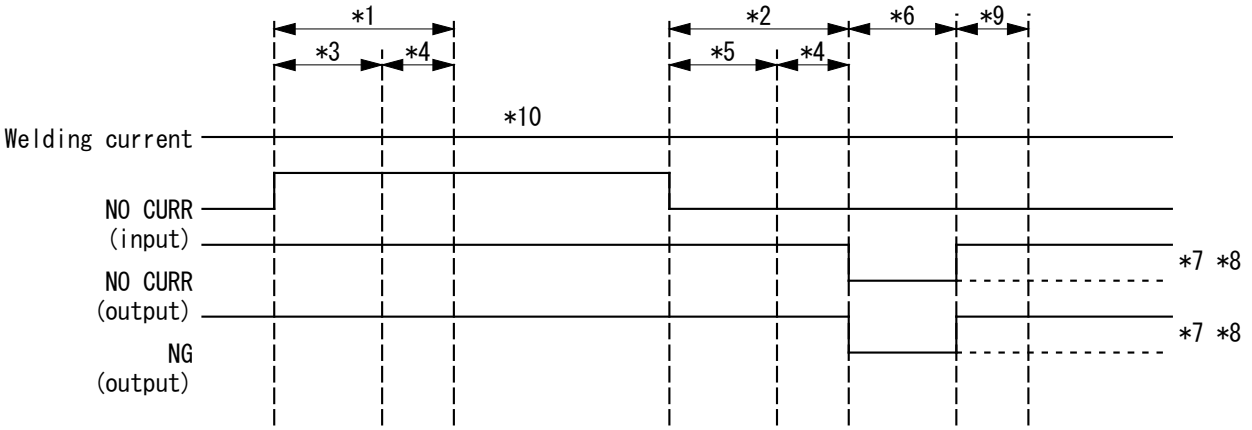
*3: Schedule number setting time

(2) NO CURR Operation

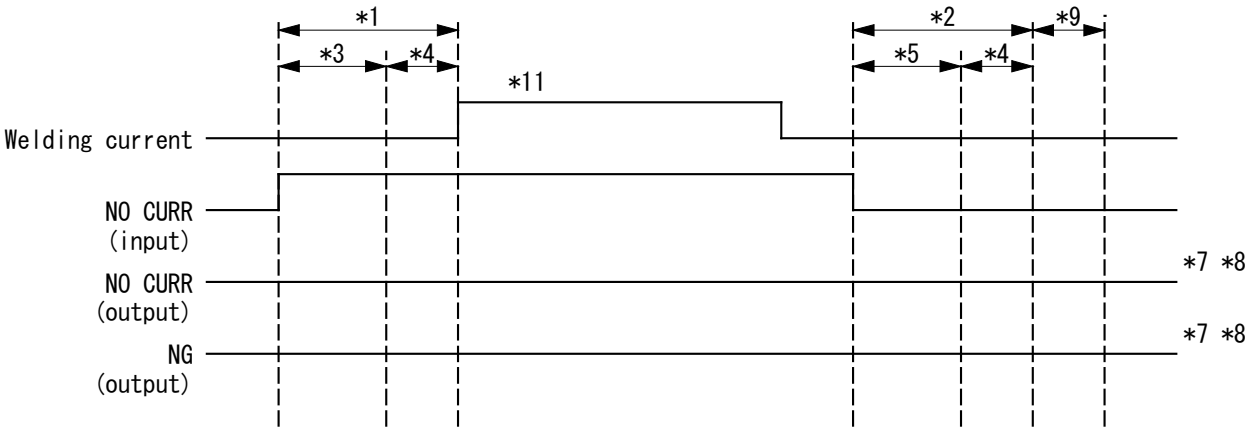
The no current judgment function can be used by using the NO CURR signal.

When the no current error is detected, NO CURR and NG are output.

When the welding current does not flow



When the welding current flows



*1: No current monitoring start
After the NO CURR signal is closed, the no current monitoring is started at the time set for INPUT DEBOUNCE TIME in the EXT INPUT/OUTPUT (4) screen + 2 ms. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The required time is at least 3 ms in “1ms” and 12 ms in “10ms.” Close the NO CURR signal before measuring start.

*2: No current monitoring end
After the NO CURR signal is opened, the no current monitoring is ended at the time set for INPUT DEBOUNCE TIME in the EXT INPUT/OUTPUT (4) screen + 2 ms and judgment is performed. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The time is 3 ms in “1ms” and 12 ms in “10ms.”

*3: NO CURR input time (No current monitoring start)
After the NO CURR signal is closed, closing of the NO CURR input is established at time set for INPUT DEBOUNCE TIME in the EXT INPUT/OUTPUT (4) screen. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The time is 1 ms in “1ms” and 10 ms in “10ms.”

*4: No current monitoring processing time

*5: NO CURR input time (No current monitoring end)
After the NO CURR signal is closed, opening of the NO CURR input is established at the time set for INPUT DEBOUNCE TIME in the EXT INPUT/OUTPUT (4) screen. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The time is 1 ms in “1ms” and 10 ms in “10ms.”

*6: Judgment output time
Output for the time set for OUTPUT TIME in the EXT INPUT/OUTPUT (4) screen. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The output is held for 10 ms in “10ms”, 100 ms in “100ms”, and until the next measurement is performed or until the error reset of the external input is closed in “HOLD.”

*7: Judgment item
Output to the output terminal set for OUTPUT 1 to 12 in the EXT INPUT/OUTPUT (2) and (3) screens. (Refer to Chapter 8, “o-2. EXT INPUT/OUTPUT (2) (3) Screen.”)
The above example is when NO CURR and NG are set.

*8: Judgment output
Output with the setting for NG OUTPUT MODE in the EXT INPUT/OUTPUT (4) screen.
Open at output in NORMALLY CLOSED, and closed at output in NORMALLY OPEN. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The above example is when NORMALLY CLOSED is set.

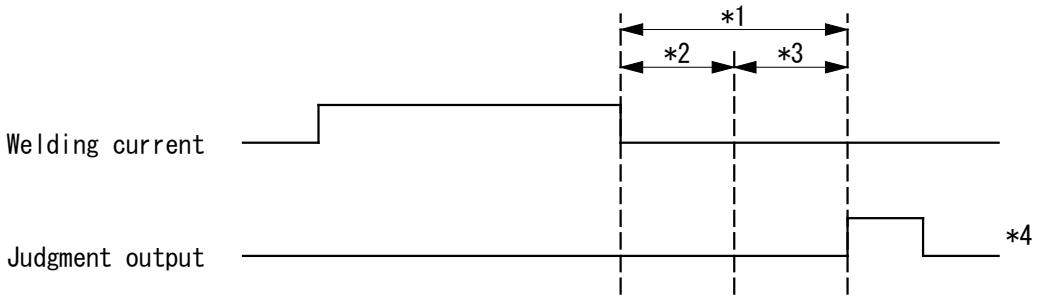
*9: Next measurement preparation time
When “ms-***” is selected for TIME in the BASIC SETUP (1) screen, at least 2 ms required.
When “CYC-***” is selected for TIME, at least 5 ms is required.
To check that the measurement signal set as trigger is not input, the longer time is required when it is input.

*10: When the welding current does not flow
Since welding is not performed (the welding current does not flow) while the NO CURR signal is input, NO CURR occurs.

*11: When the welding current flows
Since welding is performed (the welding current flows) while the NO CURR signal is input, NO CURR does not occur.

(3) Internal Processing Time

When TIME is changed from the initial setting and CYC-AC, ms-DC, CYC-DC, or ms-AC is selected (refer to Chapter 8, “I-1. BASIC SETUP (1) Screen), the judgment result is output after the measurement operation.



*1: Internal processing time

*2: End judgment time
Time set for the cooling time (Refer to Chapter 8, “I-2. BASIC SETUP (2) Screen.”)

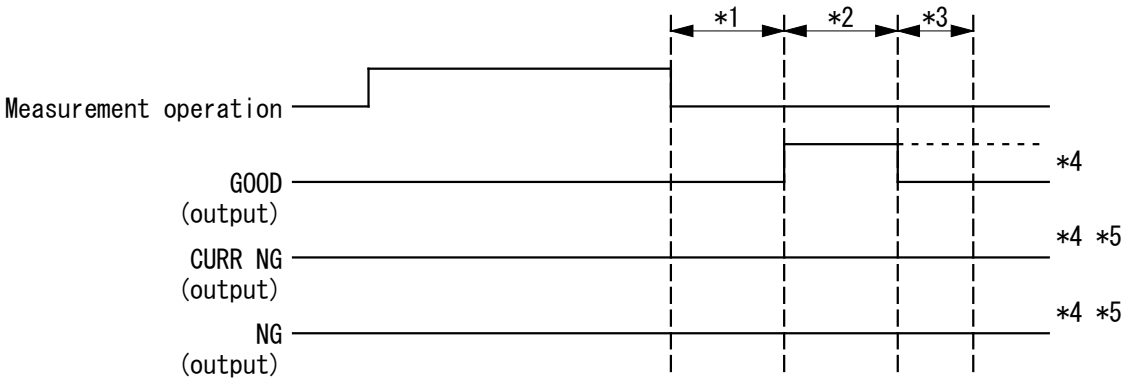
*3: Calculation time
30 ms

*4: Judgment output
Output to the output terminal set for OUTPUT 1 to 12 in the EXT INPUT/OUTPUT (2) and (3) screens. (Refer to Chapter 8, “o-2. EXT INPUT/OUTPUT (2) (3) Screen.”)
The above example is when the judgment result is normal and GOOD is set.

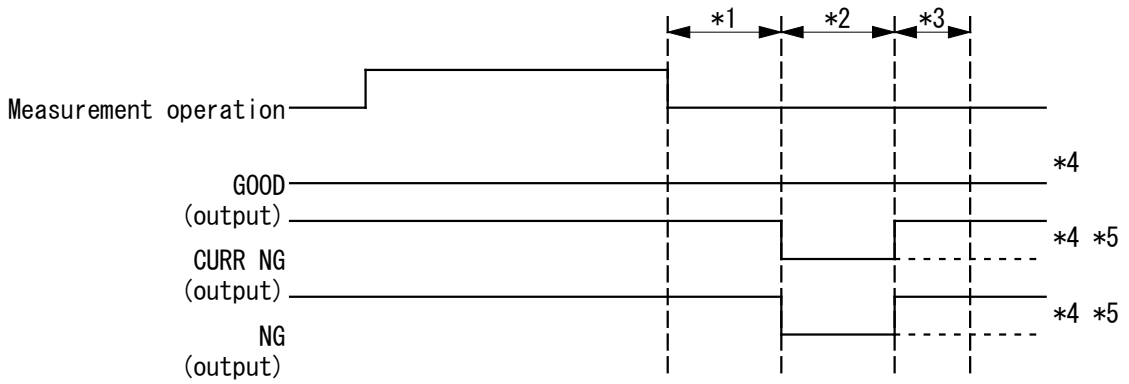
(4) Judgment Output

The judgment result is output after the measurement operation.

Within the upper/lower limit judgment



Outside the upper/lower limit judgment



*1: Internal processing time
(Refer to “(3) Internal Processing Time.”)

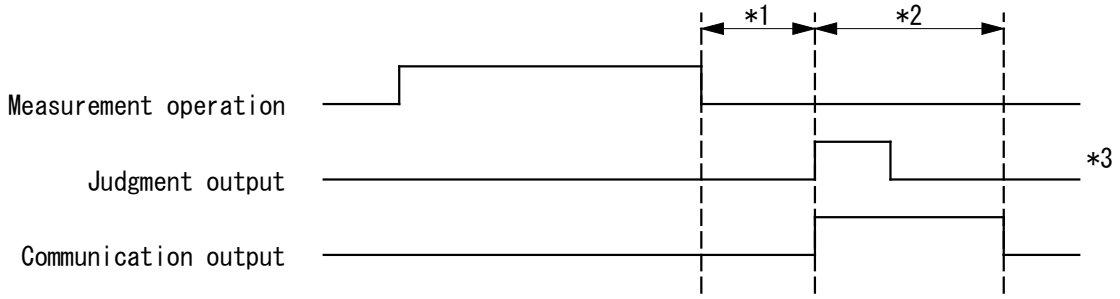
*2: Judgment output time
Output for the time set for OUTPUT TIME in the EXT INPUT/OUTPUT (4) screen. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
The output is held for 10 ms in “10ms”, 100 ms in “100ms”, and until the next measurement is performed or until the error reset of the external input is closed in “HOLD.”

*3: Next measurement preparation time
When “ms-***” is selected for TIME in the BASIC SETUP (1) screen, at least 2 ms required.
When “CYC-***” is selected for TIME, at least 5 ms is required.
To check that the measurement signal set as trigger is not input, the longer time is required when it is input.

*4: judgment item
Output to the output terminal set for OUTPUT 1 to 12 in the EXT INPUT/OUTPUT (2) and (3) screens. (Refer to Chapter 8, “o-2. EXT INPUT/OUTPUT (2) (3) Screen.”)
The above example is when GOOD, CURR NG and NG are set.

*5: Judgment output
Output with the setting for NG OUTPUT MODE in the EXT INPUT/OUTPUT (4) screen. (Refer to Chapter 8, “o-3. EXT INPUT/OUTPUT (4) Screen.”)
Open at output in NORMALLY CLOSED, and closed at output in NORMALLY OPEN.
The above example is when NORMALLY CLOSED is set.

(5) Single-Directional Communication, Single-Directional Communication Time of Measured Value



*1: Internal processing time
(Refer to “(3) Internal Processing Time.”)

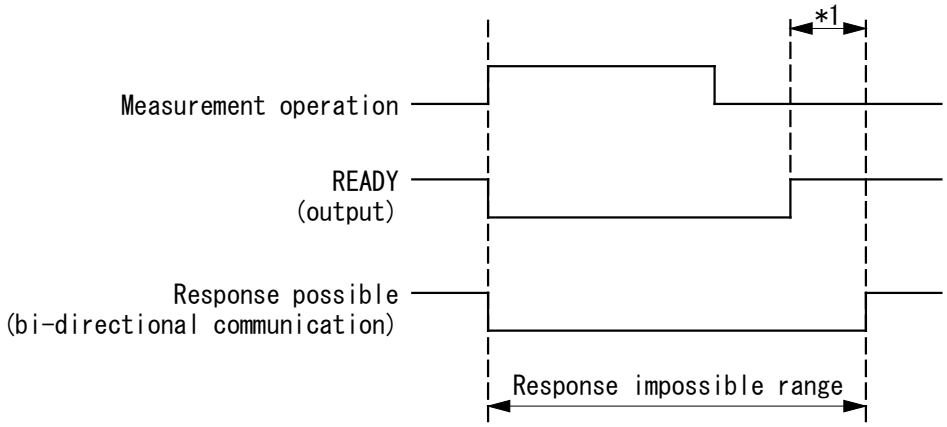
*2: Communication time
When MEASUREMENT is selected for ITEM (Refer to Chapter 8, “p-1. Communication (1) Screen.”)

MODE	SPEED	Communication time
RS-232C or RS-485 ONE WAY	9600 bps	229 ms
	19200 bps	130 ms
	38400 bps	81 ms
ETHERNET	-	56 ms

(Refer to Chapter 8, “c. VIEW Screen” for MEASUREMENT in the VIEW screen and “p-2. Communication (2) Screen” for MODE and SPEED.)

*3: Judgment output
Output to the output terminal set for OUTPUT 1 to 12 in the EXT INPUT/OUTPUT (2) and (3) screens. (Refer to Chapter 8, “o-2. EXT INPUT/OUTPUT (2) (3) Screen.”)
The above example is when the judgment result is normal and GOOD is set.

(6) Bi-Directional Communication after Measurement



*1: Screen rewrite time

- MEASUREMENT screen

Display screen	Rewrite time
MEASUREMENT 5 screen	109 ms
MEASUREMENT 10 screen	77 ms

The bi-directional communication. The range from the start of measurement to the end of the screen rewriting (response impossible range). Start the bi-directional communication after the screen rewriting is completed.

- WAVEFORM screen, ALL CYCLE screen and ENVELOPE screen

Since the rewrite time changes depending on the selected screen and measurement result, start the bi-directional communication after the screen rewriting is completed.

12. Data Communication

Monitoring data can be loaded from the **MM-400A** into the external PC. Also, schedule settings can be written from the external PC into the **MM-400A**.

(1) Data Transfer

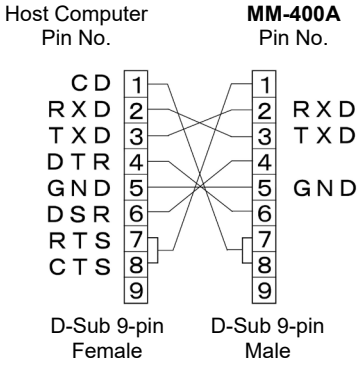
Item	Description
System	Select one option in the COMMUNICATION screen. RS-485-compliant, start-stop, half duplex RS-232C-compliant, start-stop, full duplex Ethernet IEEE 802.3-compliant (10BASE-T/100BASE-TX protocol TCP/IP)
Transfer rate	Select one option in the COMMUNICATION screen. (RS-485/232C only) 9600, 19200, 38400 bps
Data format	1 start bit, 8 data bits 1 stop bit, even parity (RS-485/232C only)
Character code	ASCII
Checksum data	None
Connector	(1) RS-485/232C: D-Sub 9-pin connector Pin layout RS-485 5: SG, 6: RS+, 9: RS- RS-232C 2: RXD, 3: TXD, 5: SG (2) Ethernet: RJ45 connector

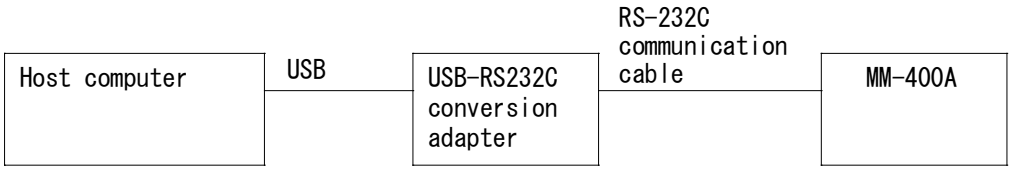
CAUTION

To perform a setting by connecting a network, ask a network manager.

(2) Configuration

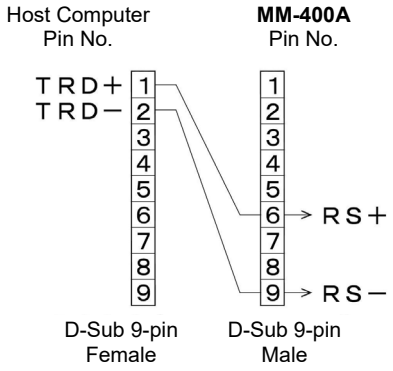
a. RS-232C

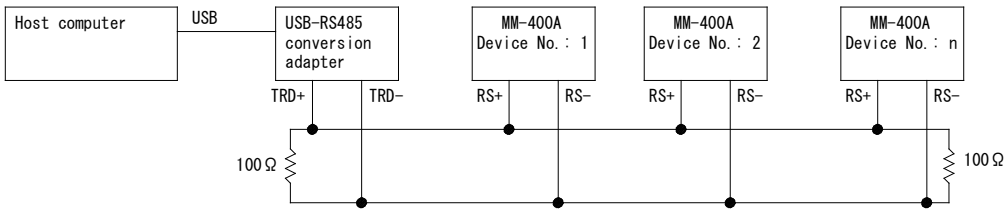




* Prepare the USB-RS232C conversion adapter at customer's side.
* The RS-232C communication cable is optional.

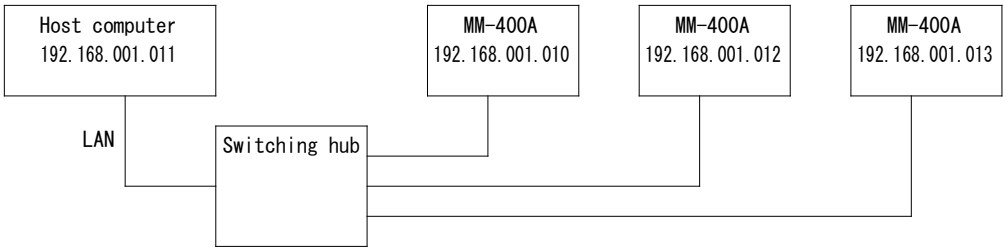
b. RS-485





* Prepare the USB-RS232C conversion adapter and cable at customer's side. The above diagram is an example. The connector on the host computer side changes according to the conversion adapter.
* Mount 100 Ω of termination resistance at either end of the RS-485 cable.
* The RS-485 connector (with termination resistance) is optional.
* Up to 31 devices can be connected.
* In the single-directional communication, only one device can be connected.

c. Ethernet



* Prepare the switching hub at customer's side.
* The LAN cable is optional (straight). Use a cable of Category 6 or higher. In a high noise environment, a cable of Category 7 is recommended.
* How to establish communication

Establish connection from the host computer to the **MM-400A**. Connect it to IP address and Port No. set in the **MM-400A**. Use TCP/IP for communication protocol.

Example)

Host computer

IP address: 192.168.1.11, Subnet mask: 255.255.255.0

MM-400A

IP address: 192.168.1.10, Subnet mask: 255.255.255.0, Port No.: 1024

Establish connection from the host computer to the **MM-400A** with settings of IP address: 192.168.1.10 and Port No.: 1024.

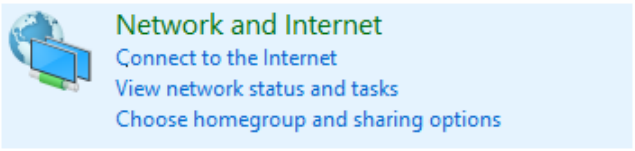
Since connection is released when the settings of the **MM-400A** (MODE, ID NUMBER, IP ADDRESS, SUBNET MASK, DEFAULT GATEWAY, and PORT NUMBER) are changed, the power supply of the **MM-400A** is turned off, and communication from the **MM-400A** cannot be made, establish connection again.

The number of connectable **MM-400A**s changes according to the host computer.

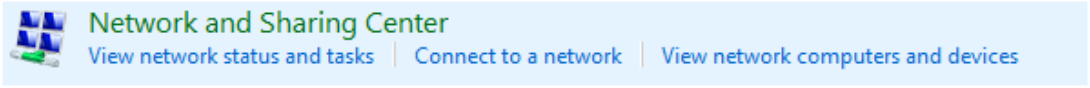
[IP address setting]
Set the IP address of the host computer.
The IP address of the **MM-400A** has been set to [192.168.1.10] at the factory. Use [192.168.1.11] or later for the IP address of the host computer. However, do not set the IP address to the same as the default gateway.

Setting procedure (for Windows 10)
The setting procedure depends on the operating system to use. Check the setting method for your operating system.

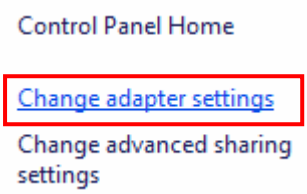
1) From the control panel, select the [Network and Internet].



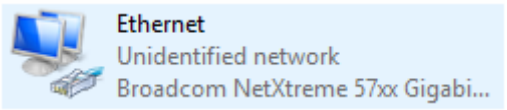
2) Select the [Network and Sharing Center].



3) Select the [Change adapter settings].

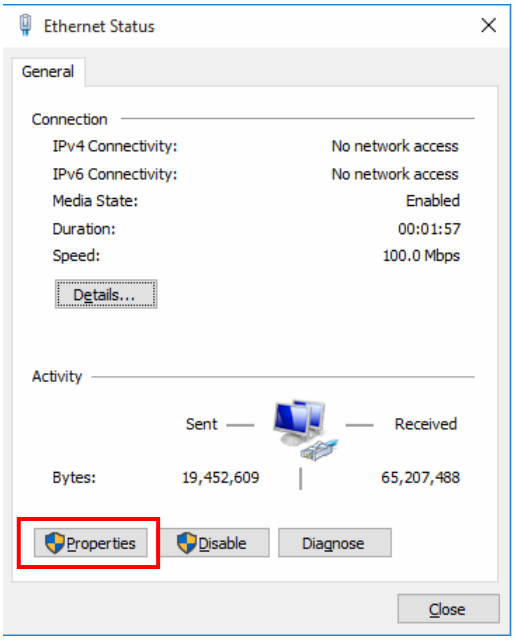


4) Select a network card to use.

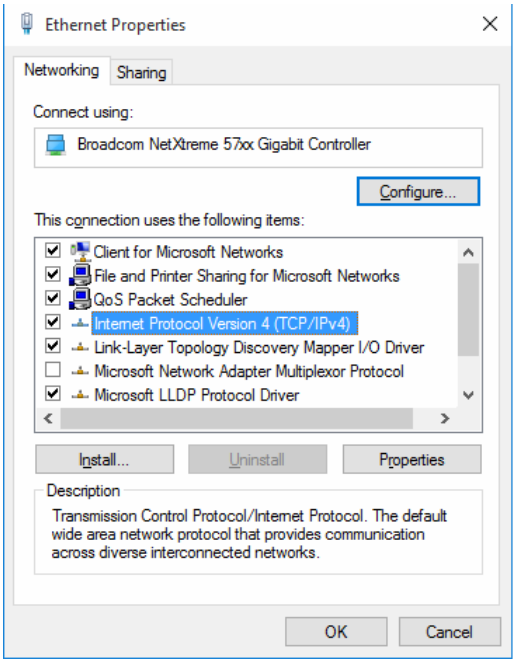


* Displays vary according to the personal computer or network card in use.

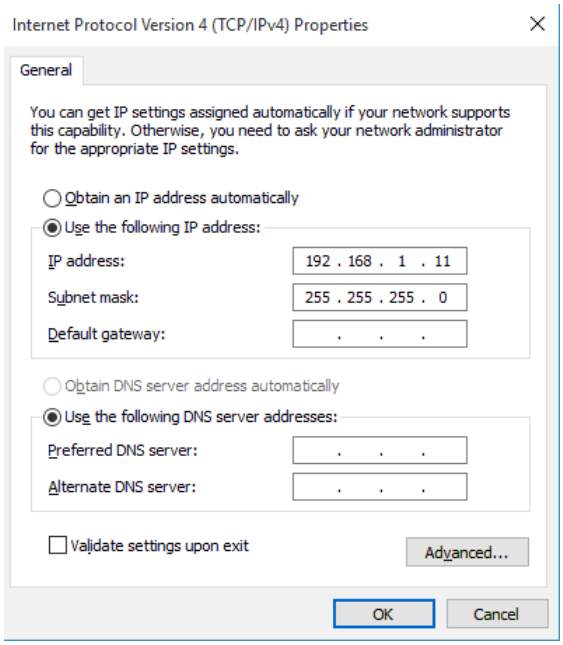
5) Click the [Properties].



6) Select the [Internet Protocol Version 4(TCP/IPv4)] and click the [Properties].

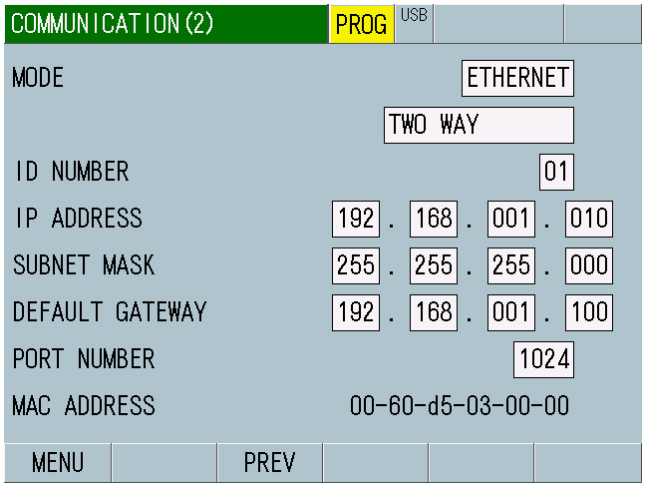


7) Input the IP address. Set the IP address as shown below and click the [OK] button.



Now the IP address setting is completed.

Set 1024 or later for PORT NUMBER. When you change the setting of the **MM-400A** or turn off the power supply, connect the **MM-400A** again.



(3) Communication Protocol (Single-Directional Communication)

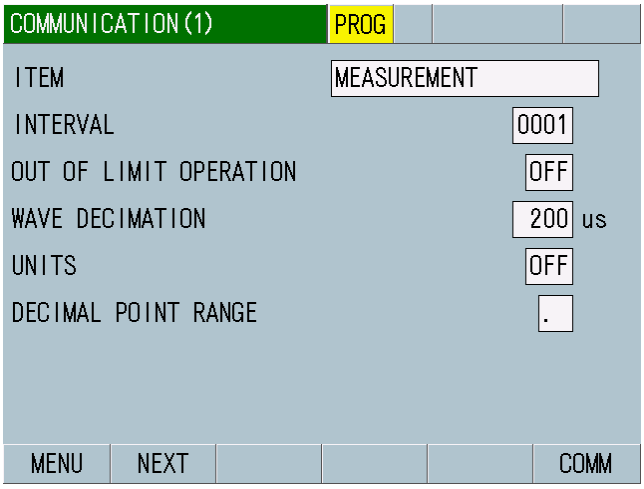
When ONE WAY is selected for MODE in the COMMUNICATION (2) screen, data of MEASUREMENT, WAVEFORM, CURR ALL CYCLE, FORCE ALL CYCLE, HISTORY, HISTORY OUT OF LIM, and SCHEDULE set for ITEM is one-sidedly transmitted for each measurement with the conditions set for INTERVAL and OUT OF LIMIT OPERATION. (Refer to “8. (2) p. COMMUNICATION Screen.”)

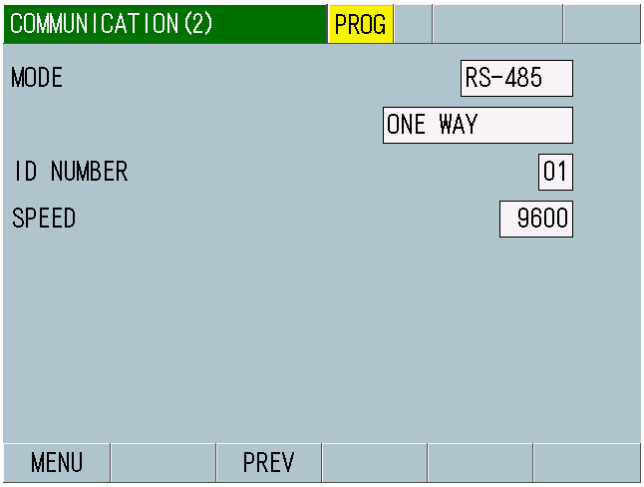
Also, when the COMM key is touched on the COMMUNICATION (1) screen, data set for ITEM is transmitted every time.

(Note 1) When the decimal point setting is changed from “.” (period) to “,” (comma), delimiter between items is changed from “,” (comma) to “:” (colon).

(Note 2) Only for WAVEFORM, CURR ALL CYCLE, and FORCE ALL CYCLE, [EOT] is added at an end of the data.

(Note 3) When SEAM is selected for MODE in the SYSTEM SETTING (1) screen, the measurement data of 1) MEASUREMENT, 2) WAVEFORM, 3) CURR ALL CYCYLE, 4) FORCE ALL CYCLE, 5) HISTORY, and 6) HISTORY OUT OF LIM cannot be transmitted.





1) MEASUREMENT

	Item	Display example	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	01		2
6	Delimiter	:		1
7	Year	16	16 to 77	2
8	Delimiter	/		1
9	Month	01	01 to 12	2
10	Delimiter	/		1
11	Day	01	01 to 31	2
12	Delimiter	_	(Space)	1
13	Hour	00	00 to 23	2
14	Delimiter	:		1
15	Minute	00	00 to 59	2
16	Delimiter	:		1
17	Second	00	00 to 59	2
18	Delimiter	,		1
19	Measurement item code 1	Refer to the measurement code table (Item code).		2
20	Delimiter	,		1
21	Judgment 1	Refer to the judgment code table (Display).		1
22	Delimiter	,		1
23	MEAS 1	Refer to the measurement code table (Measured value).		1 to 7
24	Unit 1	Refer to the measurement code table (Unit).		0 to 4
25	Delimiter	,		1
26	Measurement item code 2	Refer to the measurement code table (Item code).		2
27	Delimiter	,		1
28	Judgment 2	Refer to the judgment code table (Display).		1
29	Delimiter	,		1
30	MEAS 2	Refer to the measurement code table (Measured value).		1 to 7
31	Unit 2	Refer to the measurement code table (Unit).		0 to 4
32	Delimiter	,		1
33	Measurement item code 3	Refer to the measurement code table (Item code).		2
34	Delimiter	,		1
35	Judgment 3	Refer to the judgment code table (Code).		1
36	Delimiter	,		1

	Item	Display example	Range	Length
37	MEAS 3	Refer to the measurement code table (Measured value).		1 to 7
38	Unit 3	Refer to the measurement code table (Unit).		0 to 4
39	Delimiter	,		1
40	Measurement item code 4	Refer to the measurement code table.		2
41	Delimiter	,		1
42	Judgment 4	Refer to the judgment code table.		1
43	Delimiter	,		1
44	MEAS 4	Refer to the measurement code table (Measured value).		1 to 7
45	Unit 4	Refer to the measurement code table (Unit).		0 to 4
46	Delimiter	,		1
47	Measurement item code 5	Refer to the measurement code table (Item code).		2
48	Delimiter	,		1
49	Judgment 5	Refer to the judgment code table (Code).		1
50	Delimiter	,		1
51	MEAS 5	Refer to the measurement code table (Measured value).		1 to 7
52	Unit 5	Refer to the measurement code table (Unit).		0 to 4
53	Delimiter	,		1
54	Measurement item code 6	Refer to the measurement code table (Item code).		2
55	Delimiter	,		1
56	Judgment 6	Refer to the judgment code table (Code).		1
57	Delimiter	,		1
58	MEAS 6	Refer to the measurement code table (Measured value).		1 to 7
59	Unit 6	Refer to the measurement code table (Unit).		0 to 4
60	Delimiter	,		1
61	Measurement item code 7	Refer to the measurement code table (Item code).		2
62	Delimiter	,		1
63	Judgment 7	Refer to the judgment code table (Code).		1
64	Delimiter	,		1
65	MEAS 7	Refer to the measurement code table (Measured value).		1 to 7
66	Unit 7	Refer to the measurement code table (Unit).		0 to 4
67	Delimiter	,		1
68	Measurement item code 8	Refer to the measurement code table (Item code).		2
69	Delimiter	,		1
70	Judgment 8	Refer to the judgment code table (Code).		1
71	Delimiter	,		1

	Item	Display example	Range	Length
72	MEAS 8	Refer to the measurement code table (Measured value).		1 to 7
73	Unit 8	Refer to the measurement code table (Unit).		0 to 4
74	Delimiter	,		1
75	Measurement item code 9	Refer to the measurement code table (Item code).		2
76	Delimiter	,		1
77	Judgment 9	Refer to the judgment code table (Code).		1
78	Delimiter	,		1
79	MEAS 9	Refer to the measurement code table (Measured value).		1 to 7
80	Unit 9	Refer to the measurement code table (Unit).		0 to 4
81	Delimiter	,		1
82	Measurement item code 10	Refer to the measurement code table (Item code).		2
83	Delimiter	,		1
84	Judgment 10	Refer to the judgment code table (Code).		1
85	Delimiter	,		1
86	MEAS 10	Refer to the measurement code table (Measured value).		1 to 7
87	Unit 10	Refer to the measurement code table (Unit).		0 to 4
88	Delimiter	,		1
89	ENVELOPE#1 Waveform item code	Refer to the waveform code table (Item code).		1
90	Delimiter	,		1
91	ENVELOPE#1 SEGMENT#1 Judgment	Refer to the judgment code table.		1
92	Delimiter	,		1
93	ENVELOPE#1 SEGMENT#2 Judgment	Refer to the judgment code table.		1
94	Delimiter	,		1
95	ENVELOPE#1 SEGMENT#3 Judgment	Refer to the judgment code table.		1
96	Delimiter	,		1
97	ENVELOPE#2 Waveform item code	Refer to the waveform code table (Item code).		1
98	Delimiter	,		1
99	ENVELOPE#2 SEGMENT#1 Judgment	Refer to the judgment code table.		1
100	Delimiter	,		1
101	ENVELOPE#2 SEGMENT#2 Judgment	Refer to the judgment code table.		1
102	Delimiter	,		1

	Item	Display example	Range	Length
103	ENVELOPE#2 SEGMENT#3 Judgment	Refer to the judgment code table.		1
104	Return code	[CR]	(0x0d)	1
105	Feed code	[LF]	(0x0a)	1

Communication example

Measurement data (without unit, decimal point is period) of ID NO. 01 and SCH.# 1 is transmitted from the **MM-400A**.

"**MM-400A** → Host computer"

!01001S01:17/12/31_23:59:59,02,G,01.00,00,G,01.10,05,G,02.0,03,G,02.2,09,G,0300.0,06,-,060,07,G,080.00,08,G,100.00,16,G,+01.000,18,G,20.00,0,G,G,-,1,G,G,-[CR][LF]

(Note) A space falls into "_".

2) WAVEFORM

Data is transmitted in the order of i), ii) and iii).

i) Measurement data part

	Item	Display example	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	02		2
6	Delimiter	:		1
7 “Year” to 103 “ENVELOPE#2 SEGMENT#3 Judgment” in 1) MEASUREMENT				
104	Return code	[CR]	(0x0d)	1
105	Feed code	[LF]	(0x0a)	1

ii) Item code part

	Item	Display example	Range	Length
1	Waveform item code 1	Refer to the waveform code table (Item code).		0 to 1
2	Delimiter	,		0 to 1
3	Waveform item code 2	Refer to the waveform code table (Item code).		0 to 1
4	Delimiter	,		0 to 1
5	Waveform item code 3	Refer to the waveform code table (Item code).		0 to 1
6	Delimiter	,		0 to 1
7	Waveform item code 4	Refer to the waveform code table (Item code).		0 to 1
8	Return code	[CR]	(0x0d)	1
9	Feed code	[LF]	(0x0a)	1

(Note) Omitted when ITEM is not set.

iii) Waveform data part

	Item	Display example	Range	Length
1	TIME	00000.00	00000.00 to 10000.00	8
2	Unit of TIME	ms		2
3	Delimiter	,		1
4	MEAS 1	Refer to the waveform code table (Measured value).		0 to 7
5	Unit 1	Refer to the waveform code table (Unit).		0 to 4
6	Delimiter	,		0 to 1
7	MEAS 2	Refer to the waveform code table (Measured value).		0 to 7
8	Unit 2	Refer to the waveform code table (Unit).		0 to 4
9	Delimiter	,		0 to 1
10	MEAS 3	Refer to the waveform code table (Measured value).		0 to 7

	Item	Display example	Range	Length
11	Unit 3	Refer to the waveform code table (Unit).		0 to 4
12	Delimiter	,		0 to 1
13	MEAS 4	Refer to the waveform code table (Measured value).		0 to 7
14	Unit 4	Refer to the waveform code table (Unit).		0 to 4
15	Return code	[CR]	(0x0d)	1
16	Feed code	[LF]	(0x0a)	1
1 to 16 are output by the number of waveform data.				
17	End of transmission	[EOT]	(0x04)	1

Communication example

Measurement, item and waveform data (without unit, decimal point is period, waveform output: current, voltage, power, and resistance) of ID NO .01 and SCH.# 1 is transmitted from the **MM-400A**.

"**MM-400A** → Host computer"

```
!01001S01:17/12/31_23:59:59,02,G,01.00,00,
G,01.10,05,G,02.0,03,G,02.2,09,0300.0,06,
060,07,G,080.00,08,G,100.00,16,G,+01.000,
18,G,00020.00,0,G,G,-,1,G,G,-[CR][LF]
```
i) Measurement data part

```
0,1,2,3[CR][LF]
```
ii) Item data part

```
00000.00,00.00,00.0,000.00,000.00[CR][LF]
00000.02,00.20,00.2,000.04,001.00[CR][LF]
.
.
.
00010.00,00.20,02.2,010.04,001.00[CR][LF][EOT]
```
iii) Waveform data part

3) CURR ALL CYCLE

Data is transmitted in the order of i) and ii).

i) Measurement data part

	Item	Display example	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	03		2
6	Delimiter	:		1
7 “Year” to 103 “ENVELOPE#2 SEGMENT#3 Judgment” in 1) MEASUREMENT				
104	Return code	[CR]	(0x0d)	1
105	Feed code	[LF]	(0x0a)	1

ii) All cycle data part

	Item	Display example	Range	Length
1	TIME	0000.0 0000	0000.0 to 2000.0 (0.5-CYC increment) 0000 to 5000 (1-ms increment)	6 4
2	Unit of TIME	CYC ms		3 2
3	Delimiter	,		1
4	Measurement range	* _	*: Within measurement range _: Outside of measurement range	1
5	Delimiter	,		1
6	CURRENT	0.000 00.00 000.0	0.000 to 9.999 00.00 to 99.99 000.0 to 999.9	5
7	Unit of CURRENT	kA		2
8	Delimiter	,		1
9	VOLTAGE	0.00 00.0	0.00 to 9.99 00.0 to 99.9	4
10	Unit of VOLTAGE	V		1
11	Delimiter	,		0 to 1
12	ANGLE	000	000 to 180	0 to 3
13	Unit of ANGLE	deg		0 to 3
14	Return code	[CR]	(0x0d)	1
15	Feed code	[LF]	(0x0a)	1
1 to 15 are output by the number of all cycle data. ANGLE is not occasionally output. In that case, 11 Delimiter, 12 ANGLE and 13 Unit of ANGLE are not output.				
16	End of transmission	[EOT]	(0x04)	1

Communication example

Measurement (with unit, decimal point is period) of ID NO. 01 and SCH. #1 and current all cycle data (start 3 CYC) are transmitted from the **MM-400A**.

"**MM-400A** → Host computer"

```
!01001S03:01/17_04:24:31,02,G,01.20kA,00,
G,01.76kA,05,G,00.0V,03,G,00.0V,09,G,
0008.0CYC,19,G,0812N,34,-,0,34,-,0,34,-,
0,34,-,0,0,G,G,-,1,G,G,-[CR] [LF]
```

i) Measurement data part

```
0000.5CYC, ,01.42kA,00.0V,180deg[CR][LF]
0001.0CYC, ,01.47kA,00.0V,180deg[CR][LF]
0001.5CYC, ,01.47kA,00.0V,180deg[CR][LF]
0002.0CYC, ,01.46kA,00.0V,180deg[CR][LF]
0002.5CYC, ,01.42kA,00.0V,180deg[CR][LF]
0003.0CYC,*,01.45kA,00.0V,180deg[CR][LF]
0003.5CYC,*,01.46kA,00.0V,180deg[CR][LF]
0004.0CYC,*,01.49kA,00.0V,180deg[CR][LF]
.
.
.
0008.0CYC,*,01.48kA,00.0V,180deg[CR][LF][EOT]
```

ii) Current all cycle data part

(Note) A space falls into "_".

4) FORCE ALL CYCLE

Data is transmitted in the order of i) and ii).

i) Measurement data part

	Item	Display example	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	04		2
6	Delimiter	:		1
7 “Year” to 103 “ENVELOPE#2 SEGMENT#3 Judgment” in 1) MEASUREMENT				
104	Return code	[CR]	(0x0d)	1
105	Feed code	[LF]	(0x0a)	1

ii) All cycle data part

	Item	Display example	Range	Length
1	TIME	00000	00000 to 10000	5
2	Unit of TIME	ms		2
3	Delimiter	,		1
4	Measurement range of FORCE	* _	*: Within measurement range _: Outside of measurement range	1
5	Delimiter	,		1
6	FORCE	00.00 000.0 00000	00.00 to 99.99 000.0 to 999.9 00000 to 09999	5
7	Unit of FORCE	N kgf lbf		1 3 3
8	Delimiter	,		1
9	Measurement range of EXTERNAL	* _	*: Within measurement range _: Outside of measurement range	1
10	Delimiter	,		1
11	EXTERNAL	+0.000 +00.00 +000.0 +00000	-9.999 to +9.999 -99.99 to +99.99 -999.9 to +999.9 -09999 to +09999	6

	Item	Display example	Range	Length
12	Unit of EXTERNAL	 V N kgf lbf degC degF Mpa bar psi		0 1 1 3 3 4 4 3 3 3
13	Return code	[CR]	(0x0d)	1
14	Feed code	[LF]	(0x0a)	1
1 to 14 are output by the number of all cycle data.				
15	End of transmission	[EOT]	(0x04)	1

Communication example

Measurement of ID NO. 03 and SCH.# 2 and force all cycle data (start 0 CYC) is transmitted from the **MM-400A**.

"**MM-400A** → Host computer"

!03002S01:17/09/09_03:04:05,02,G,00.00kA,
00,G,01.76kA,05,G,00.0V,03,G,00.0V,09,G,
0008.0CYC,19,G,0812N,34,-,0,34,-,0,34,-, } i) Measurement data part
0,34,-,0,0,G,G,-,1,G,G,-[CR][LF]
00010ms,*,0812N,-0056[CR][LF]
00020ms,*,0812N,+0077[CR][LF]
00030ms,*,0812N,-0028[CR][LF]
00040ms,*,0811N,-0061[CR][LF]
.
.
. } ii) Force all cycle data part
00170ms,*,0812N,-0012[CR][LF][EOT]

(Note) A space falls into "_".

5) HISTORY

	Item	Display example	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	06		2
6	Delimiter	:		1
7 “Year” to 103 “ENVELOPE#2 SEGMENT#3 Judgment” in 1) MEASUREMENT				
104	Return code	[CR]	(0x0d)	1
105	Feed code	[LF]	(0x0a)	1
Data transmission of 1 to 105 is repeated by the number of measurement histories (including the judgment error).				
106	End of transimission	[EOT]	(0x04)	1

6) HISTORY OUT OF LIM

	Item	Display example	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	07		2
6	Delimiter	:		1
7 “Year” to 103 “ENVELOPE#2 SEGMENT#3 Judgment” in 1) MEASUREMENT				
104	Return code	[CR]	(0x0d)	1
105	Feed code	[LF]	(0x0a)	1
Data transmission of 1 to 105 is repeated by the number of error histories.				
106	End of transimission	[EOT]	(0x04)	1

If there is no error history, data transmission is not performed.

Communication example

① Measurement history data of ID NO. 01 and SCH.# 1 is transmitted from the **MM-400A**.

"**MM-400A** → Host computer"

!01001S07:17/01/17_06:10:16,02,L,01.46kA,00,L,01.78kA,05,
G,00.0V,03,G,00.0V,09,G,0008.0CYC,19,G,0810N,34,-,0,34,
-,0,34,-,0,34,-,0,0,G,G,L,1,G,G,L[CR][LF]

} One data

!01001S07:17/01/17_06:10:09,02,L,01.46kA,00,L,01.79kA,05,
G,00.0V,03,G,00.0V,09,G,0008.0CYC,19,G,0810N,34,-,0,34
,-,0,34,-,0,34,-,0,0,G,G,L,1,G,G,L[CR][LF]
!01001S06:17/01/17_04:24:31,02,G,00.00kA,00,G,01.76kA,05,
G,00.0V,03,G,00.0V,09,G,0008.0CYC,19,G,0812N,34,-,0,34,
-,0,34,-,0,34,-,0,0,G,G,G,1,G,G,G[CR][LF]
!01001S06:17/01/17_04:24:00,02,G,01.45kA,00,G,01.76kA,05,
G,00.0V,03,G,00.0V,09,G,0008.0CYC,19,G,0815N,34,-,0,34,
-,0,34,-,0,34,-,0,0,G,G,G,1,G,G,G[CR][LF]
!01001S06:17/01/17_03:55:52,02,G,01.40kA,00,G,01.70kA,05,
G,00.0V,03,G,00.0V,09,G,0008.0CYC,19,G,0811N,34,-,0,34
,-,0,34,-,0,34,-,0,0,G,G,G,1,G,G,G[CR][LF]

② Error history data of ID NO. 01 is transmitted from the **MM-400A**.

"**MM-400A** → Host computer"

!01001S07:17/01/17_06:10:16,02,L,01.46kA,00,L,01.78kA,05,
G,00.0V,03,G,00.0V,09,G,0008.0CYC,19,G,0810N,34,-,0,34,
-,0,34,-,0,34,-,0,0,G,G,L,1,G,G,L[CR][LF]

} One data

!01001S07:17/01/17_06:10:09,02,L,01.46kA,00,L,01.79kA,05,
G,00.0V,03,G,00.0V,09,G,0008.0CYC,19,G,0810N,34,-,0,34,
-,0,34,-,0,34,-,0,0,G,G,L,1,G,G,L[CR][LF]

(Note) A space falls into "_".

7) SCHEDULE

Regardless of standard specification (no force/displacement), specification with force/displacement specification, or seam specification, data is transmitted in order of a) b) c)... as follows.

For data contents, refer to data contents of each item number.

a) Item No. 11 VIEW

b) Item No. 12 BASIC SETUP (common to all schedules), BASIC SETUP (schedules 1 to 127)

c) Item No. 13 EXTEND SETUP (common to all schedules), EXTEND SETUP (schedules 1 to 127)

d) Item No. 14 SYSTEM SETUP

e) Item No. 15 SEAM SETUP (common to all schedules), SEAM SETUP (schedules 1 to 127)

f) Item No. 16 COMPARATOR (schedules 1 to 127)

g) Item No. 17 ENVELOPE (common to all schedules), ENVELOPE (schedules 1 to 20)

h) Item No. 18 EXT INPUT/OUTPUT

i) Item No. 21 PRINT

j) Item No. 22 COMMUNICATION

k) Item No. 23 USB

l) Item No. 24 INTERNAL MEMORY

Communication example

!01000S11:0,02,00,05,03,09,34,34,34,34,34,0,1,2,3,1,1,0,0[CR][LF]
!01000S12:90,0,0,0,0[CR][LF] } a)

!01001S12:ay001,0,1,050,0,0,000000ms,002000ms,0,00,0.000kA,00001ms,80%,0005ms,00.0s,05.0%[CR][LF]
...
!01127S12:ay127,0,0,050,2,1,0000.0CYC,0300.0CYC,0,00,00.00kA,000.5CYC,80%,01.0CYC,00.0s,05.0%[CR][LF] } b)

!01000S13:0,0,0,0,0,0,01.0um,1,0,2,2,1000,1.000mV/V,09806N,0,0,10.0%,0,0,09999,0,0,10.0%,0,+00000N[CR][LF]
!01001S13:+00.000mm,+00.000mm,+00.000mm,00000ms,0000ms,0000ms,0000ms,00000N,00000N,00000N,0000ms...[CR][LF]
...
!01127S13:+00.000mm,+00.000mm,+00.000mm,00000ms,0000ms,0000ms,0000ms,00000N,00000N,00000N,0000ms...[CR][LF] } c)

!01000S14:0,4,000000,000000,07,0,2,227.0mV/kA,0[CR][LF] } d)

!01000S15:0,0,2,2,1,90,90,0,05.0%[CR][LF]
!01001S15:ay001,000.0CYC,0.5CYC,00.5CYC,00000.0CYC,18000.0CYC,00000.0CYC,18000.0CYC,00000.0CYC,18000.0CYC,99.99kA...[CR][LF]
...
!01127S15:ay127,000.0CYC,0.5CYC,00.5CYC,00000.0CYC,18000.0CYC,00000.0CYC,18000.0CYC,00000.0CYC,18000.0CYC...[CR][LF] } e)

!01001S16:009.999kA,000.000kA,009.999kA,000.000kA,0009.99V,0000.00V,0009.99V,0000.00V,0030000ms, ...[CR][LF]
...
!01127S16:0099.99kA,0000.00kA,0099.99kA,0000.00kA,00099.9V,00000.0V,00099.9V,00000.0V,03000.0CYC, ...[CR][LF] } f)

!01000S17:1,3[CR][LF]
!01001S17:+000.000kA,+000.000kA,+000.000kA,+0000.00V,+0000.00V,+0000.00V,+000.000kA,+000.000kA, ...[CR][LF]
...
!01020S17:+0000.00kA,+0000.00kA,+0000.00kA,+0000.00kA,+0000.00kA,+0000.00kA,+0000.00kA,+0000.00kA, ...[CR][LF] } g)

!01000S18:0,1,2,3,4,8,0,1,00,62,62,01,62,62, ...[CR][LF] } h)

!01000S21:0,0001,0[CR][LF] } i)

!01000S22:7,0001,0,3,0,0,2,0,01,0,192 168 001 010,255 255 255 000,192 168 001 100,1024[CR][LF] } j)

!01000S23:9,0001,0,2,0,0[CR][LF] } k)

!01000S24:0,0001,0,3[CR][LF] } l)

(4) Communication Protocol (Bi-Directional Communication)

When TWO WAY is selected for MODE in the COMMUNICATION (2) screen, data is read or written according to the call from the host computer side. However, data can be read or written in unit of screen and cannot be done in unit of item.

Readable data

1) MEASUREMENT to 6) HISTORY OUT OF LIM of (3) Communication Protocol (Single-Directional Communication)

1) BASIC SETUP to 12) ENVELOPE of (4) Communication Protocol (Bi-Directional Communication)

Writable data

1) BASIC SETUP to 11) INTERNAL MEMORY of (4) Communication Protocol (Bi-Directional Communication)

In data writing, a newly set data is returned from the **MM-400A** for check. The returned data is the output data. When a wrong data is written, currently set value is returned for check. Perform the next communication after confirming that the data is returned. (When a part of telegraphic message is wrong, normal data is converted and sent back, and the wrong data returnes the setting value.)

(Note 1) When the decimal point setting is changed from "." (period) to "," (comma), delimiter between items is changed from "," (comma) to ":" (colon).

(Note 2) Only for WAVEFORM, CURR ALL CYCLE, and FORCE ALL CYCLE, [EOT] is added at an end of the data.

(Note 3) When using the bi-directional communication, check the following restrictions.

- PROG mode

Timing for the bi-directional data communication	Restrictions
Not during screen operation	None
During the bi-directional data communication	After completing the response of the previous data communication, perform the next data communication.

- MEAS mode

Timing for the bi-directional data communication	Restrictions
During measurement	Do not perform communication.
After measurement	Do not perform communication while rewriting the screen. - The rewrite time changes depending on the item to display. Start communication after the rewriting is completed. (Refer to Chapter 11, "(6) Bi-Directional Communication after Measurement.") Do not perform communication while sroting in the USB or the internal memory. - The storage time of the USB changes depending on the item to store. Start communication after the storing dislay ("USB" displayed in orange at the upper part of the screen) is turned off. - The storage time of the internal memory changes depending on the item to store. Start communication after the storing dislay ("MEM" displayed in orange at the upper part of the screen) is turned off.

Timing for the bi-directional data communication	Restrictions
Not during measurement	None
During the bi-directional data communication	After completing the response of the previous data communication, perform the next data communication.

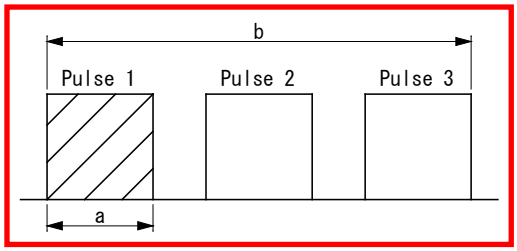
(Note 4) In response to a write request, writing in the flash memory starts. The flash memory has the rewriting limit (about 100,000 times). Be careful when writing frequency.

(Note 5) When SEAM is selected for MODE in the SYSTEM SETTING (1) screen, data of 1) MEASUREMENT to 6) HISTORY OUT OF LIM of (3) Communication Protocol (Single-Directional Communication) cannot be read.

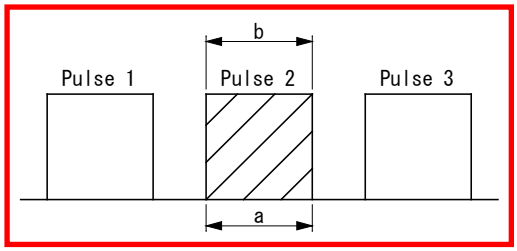
(Note 6) When reading data of 1) MEASUREMENT to 4) FORCE ALL CYCLE of (3) Communication Protocol (Single-Directional Communication), only data displayed on the MEASUREMENT, WAVEFORM or ALL CYCLE screen is output. When reading past measured values on the HISTORY screen, the read out data is output. Also, when measuring the multi-step welding with SET PULSE, data of the specified step is taken out. When measuring the multi-step welding with ALL PULSE settings, data of the 1-step welding is taken out. To output all measured data, use the single-directional communication.

Ex.) When measuring the 3-step welding in the impulse setting

ALL PULSE settings



SET PULSE with PULSE No. “2”



a: Data of 1) MEASUREMENT, 3) CURR ALL CYCLE and 4) FORCE ALL CYCLE
b: Data of 2) WAVEFORM

- Reading request data

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Read code	R	R: read	1
4	SCH.#	001	000: (measurement data in the last MEASUREMENT, WAVEFORM, CURR ALL CYCLE, FORCE ALL CYCLE, HISTORY, and HISTORY OUT OF LIM. Setting data of common to all schedules) 001 to 127: (schedule data of each schedule)	3
5	Screen code	S		1
6	Item No.	01	01 to 24 (Refer to the Item number data table.)	2
7	All contents	*		1
8	Return code	[CR]	(0x0d)	1
9	Feed code	[LF]	(0x0a)	1

- Writing request and output data

  1) BASIC SETUP [Item No. 12]

  ① Writing request data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	001	001 to 127	3
5	Screen code	S		1
6	Item No.	12		2
7	Delimiter	:		1
8	SCHEDULE NAME	ABCDE	A to Z, 0 to 9	5
9	Delimiter	,		1
10	TRIGGER	0	0: CURRENT 1: AUTO 2: FORCE 3: EXTERNAL 4: REAL TIME 5: DISPLACEMENT (EXT) 6: FORCE (EXT) 7: EXTERNAL (EXT)	1
11	Delimiter	,		1
12	TIME	0	0: CYC-AC 1: ms-DC 2: CYC***Hz-AC 3: CYC-DC 4: ms-AC 5: SHORT ms-DC 6: LONG CYC-AC	1
13	Delimiter	,		1
14	FREQUENCY	050	030 to 250 030:M050 031:M053 032:M056 033:M059 034:M063 035:M067 036:M071 037:M077 038:M083 039:M091 040:M100 041:M111 042:M125 043:M143 044:M167 045:M200 046:M250 047:M294 048:M417 049:M500 050 to 250:050 to 250Hz	3
15	Delimiter	,		1
16	CURRENT RANGE	0	1x sensitivity coil 0: 2.000kA 1: 6.00kA 2: 20.00kA 3: 60.0kA 4: 200.0kA 10x sensitivity coil 0: 0.200kA 1: 0.600kA 2: 2.000kA 3: 6.00kA 4: 20.00kA	1
17	Delimiter	,		1
18	VOLTAGE RANGE	0	0: 6.00V 1: 20.0V	1
19	Delimiter	,		1

	Item	Display	Range	Length
20	START TIME	0000.0CYC	0000.0 to 0300.0CYC (TIME CYC-AC, in 0.5 CYC steps) 0000.0 to 2000.0CYC (TIME CYC***Hz-AC, in 0.5 CYC steps) 0000.0 to 0120.0CYC (TIME CYC-DC, in 0.5 CYC steps) 0000.0 to 0600.0CYC (TIME LONG CYC-AC, in 0.5 CYC steps) 000000 to 002000ms (TIME ms-DC) 000000 to 005000ms (TIME ms-AC) 000.00 to 300.00ms (TIME SHORT ms-DC)	9
21	Delimiter	,		1
22	END TIME	0000.0CYC	0000.0 to 0300.0CYC (TIME CYC-AC, in 0.5 CYC steps) 0000.0 to 2000.0CYC (TIME CYC***Hz-AC, in 0.5 CYC steps) 0000.0 to 0120.0CYC (TIME CYC-DC, in 0.5 CYC steps) 0000.0 to 0600.0CYC (TIME LONG CYC-AC, in 0.5 CYC steps) 000000 to 002000ms (TIME ms-DC) 000000 to 005000ms (TIME ms-AC) 000.00 to 300.00ms (TIME SHORT ms-DC)	9
23	Delimiter	,		1
24	PULSE MODE	0	0: SET PULSE 1: ALL PULSE (SET) 2: ALL PULSE (NO SET) 3: NO COOL 4: ALL PULSE (SET2)	1
25	Delimiter	,		1
26	PULSE NO.	00	00 to 20	2
27	Delimiter	,		1
28	PULSE 2 TRIG LEVEL	00.00kA	0.000 to 9.999kA (CURRENT RANGE 0.200, 0.600, 2.000kA) 00.00 to 99.99kA (CURRENT RANGE 6.00, 20.00kA) 000.0 to 999.9kA (CURRENT RANGE 60.0, 200.0kA)	7
29	Delimiter	,		1
30	COOL TIME	000.5CYC	000.5 to 100.0CYC (in 0.5 CYC steps) 00001 to 02000ms_ 000.1 to 200.0ms_	8
31	Delimiter	,		1
32	FALL LEVEL	10%	10 to 90%	3
33	Delimiter	,		1
34	MEASUREMENT MIN TIME	000.5CYC	00.5 to 050.0CYC (in 0.5 CYC steps) 00001 to 01000ms_ 000.1 to 100.0ms_	8
35	Delimiter	,		1

	Item	Display	Range	Length
36	MEAS INHIBIT TIME	00.0s	00.0 to 10.0s	5
37	Delimiter	,		1
38	END LEVEL	01.5%	01.5 to 15.0%	5
39	Return code	[CR]	(0x0d)	1
40	Feed code	[LF]	(0x0a)	1

A space falls into "_" for digit matching.

② Output data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	12		2
6	Delimiter	:		1
8 "SCHEDULE NAME" to 38 "END LEVEL" in BASIC SETUP ① Writing request data for schedule				
38	Return code	[CR]	(0x0d)	1
39	Feed code	[LF]	(0x0a)	1

③ Writing request data common to all schedules (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	12		2
7	Delimiter	:		1
8	CURRENT TRIGGER LEVEL	01	01 to 99	2
9	Delimiter	,		1
10	Toroidal coil	0	0: TIMES 1 1: TIMES 10	1
11	Delimiter	,		1
12	CALCULATION	0	0: ORIGINAL 1: ISO17657	1
13	Delimiter	,		1
14	CURRENT SENSOR	0	0: TOROIDAL COIL 1: SHUNT RESISTOR	1
15	Delimiter	,		1

	Item	Display	Range	Length
16	SHUNT RESISTOR	0	0: 50mV/0.5kA 1: 50mV/1kA 2: 100mV/0.5kA 3: 100mV/1kA	1
17	Return code	[CR]	(0x0d)	1
18	Feed code	[LF]	(0x0a)	1

④ Output data common to all schedules (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	12		2
6	Delimiter	:		1
8 “CURRENT TRIGGER LEVEL” to 16 “SHUNT RESISTOR” in BASIC SETUP ③ Writing request data for schedule				
16	Return code	[CR]	(0x0d)	1
17	Feed code	[LF]	(0x0a)	1

Communication example

① Reads the setting data of ID NO. 01 and SCH.# 2.
“Host computer → **MM-400A**”
#01R002S12*[CR][LF]
“**MM-400A** → Host computer”
!01001S12:ABCDE,0,0,050,0,0,0000.0CYC,0000.0CYC,0,00,00.00kA,000.5CYC,10%,00.5CYC,00.0s,01.5%[CR][LF]

② Writes the setting data in ID NO. 01 and SCH.# 1.
“Host computer → **MM-400A**”
#01W001S12:ABCDE,0,0,050,0,0,0000.0CYC,0000.0CYC,0,00,00.00kA,000.5CYC,10%,00.5CYC,00.0s,01.5%[CR][LF]
“**MM-400A** → Host computer” (sent for check when the written data is within the range.)
!01001S12:ABCDE,0,0,050,0,0,0000.0CYC,0000.0CYC,0,00,00.00kA,000.5CYC,10%,00.5CYC,00.0s,01.5%[CR][LF]

③ Reads the setting data of ID NO. 01 and part common to schedules.
“Host computer → **MM-400A**”
#01R000S12*[CR][LF]
“**MM-400A** → Host computer”
!01000S12:99,0,0,0,0[CR][LF]

④ Changes the current trigger level of ID NO.01 and part common to schedules to “90.”
“Host computer → **MM-400A**”
#01W000S12:90,0,0,0,0[CR][LF]
“**MM-400A** → Host computer” (sent for check when the written data is within the range.)
!01000S12:90,0,0,0,0[CR][LF]

2) EXTEND SETUP [Item No. 13]

① Writing request data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	001	001 to 127	3
5	Screen code	S		1
6	Item No.	13		2
7	Delimiter	:		1
DISPLACEMENT				
8	LEVEL OUTPUT 1	+00.000mm	-30.000 to +30.000mm__ -300.00 to +300.00mm__ -3.0000 to +3.0000inch -30.000 to +30.000inch	11 *
9	Delimiter	,		1
10	LEVEL OUTPUT 2	+00.000mm	-30.000 to +30.000mm__ -300.00 to +300.00mm__ -3.0000 to +3.0000inch -30.000 to +30.000inch	11 *
11	Delimiter	,		1
12	LEVEL OUTPUT 3	+00.000mm	-30.000 to +30.000mm__ -300.00 to +300.00mm__ -3.0000 to +3.0000inch -30.000 to +30.000inch	11 *
13	Delimiter	,		1
14	FINAL DELAY TIME	00000ms	00000 to 10000ms	7
15	Delimiter	,		1
16	PULSE DELAY TIME 1	0000ms	0000 to 1000ms	6
17	Delimiter	,		1
18	PULSE DELAY TIME 2	0000ms	0000 to 1000ms	6
19	Delimiter	,		1
20	RESET DELAY TIME	0000ms	0000 to 1000ms	6
21	Delimiter	,		1
FORCE				
22	LEVEL OUTPUT 1	00000N__	00000 to 09999N__ 000.0 to 999.9N__ 00.00 to 99.99N__ 00000 to 09999kgf 000.0 to 999.9kgf 00.00 to 99.99kgf 00000 to 09999lbf 000.0 to 999.9lbf 00.00 to 99.99lbf	8 *
23	Delimiter	,		1

	Item	Display	Range	Length
24	LEVEL OUTPUT 2	00000N	00000 to 09999N__ 000.0 to 999.9N__ 00.00 to 99.99N__ 00000 to 09999kgf 000.0 to 999.9kgf 00.00 to 99.99kgf 00000 to 09999lbf 000.0 to 999.9lbf 00.00 to 99.99lbf	8 *
25	Delimiter	,		1
26	LEVEL OUTPUT 3	00000N	00000 to 09999N__ 000.0 to 999.9N__ 00.00 to 99.99N__ 00000 to 09999kgf 000.0 to 999.9kgf 00.00 to 99.99kgf 00000 to 09999lbf 000.0 to 999.9lbf 00.00 to 99.99lbf	8 *
27	Delimiter	,		1
28	DELAY TIME	0000ms	0000 to 1000ms	6
29	Delimiter	,		1
30	TIME BEGIN 1	00000ms	00000 to 10000ms (in 10 ms steps)	7
31	Delimiter	,		1
32	TIME END 1	00000ms	00000 to 10000ms (in 10 ms steps)	7
33	Delimiter	,		1
34	TIME BEGIN 2	00000ms	00000 to 10000ms (in 10 ms steps)	7
35	Delimiter	,		1
36	TIME END 2	00000ms	00000 to 10000ms (in 10 ms steps)	7
37	Delimiter	,		1
38	RISE LEVEL	10%	10 to 90%	3
39	Delimiter	,		1
40	FALL LEVEL	10%	10 to 90%	3
41	Delimiter	,		1
EXTERNAL				

	Item	Display	Range	Length
42	LEVEL OUTPUT 1	+00000____ +00000V___ +00000N___ +00000kfg_ +00000lbf_ +00000degC +00000degF +00000Mpa_ +00000bar_ +00000psi_	-09999 to +09999 -999.9 to +999.9 -99.99 to +99.99 -9.999 to +9.999 Unit (Range is the same as above.) ____ (No unit) V___ N___ kgf_ lbf_ degC degF Mpa_ bar_ psi_	10 *
43	Delimiter	,		1
44	LEVEL OUTPUT 2	+00000____ +00000V___ +00000N___ +00000kfg_ +00000lbf_ +00000degC +00000degF +00000Mpa_ +00000bar_ +00000psi_	-09999 to +09999 -999.9 to +999.9 -99.99 to +99.99 -9.999 to +9.999 Unit (Range is the same as above.) ____ (No unit) V___ N___ kgf_ lbf_ degC degF Mpa_ bar_ psi_	10 *
45	Delimiter	,		1
46	LEVEL OUTPUT 3	+00000____ +00000V___ +00000N___ +00000kfg_ +00000lbf_ +00000degC +00000degF +00000Mpa_ +00000bar_ +00000psi_	-09999 to +09999 -999.9 to +999.9 -99.99 to +99.99 -9.999 to +9.999 Unit (Range is the same as above.) ____ (No unit) V___ N___ kgf_ lbf_ degC degF Mpa_ bar_ psi_	10 *
47	Delimiter	,		1
48	DELAY TIME	0000ms	0000 to 1000ms	6
49	Delimiter	,		1
50	TIME BEGIN 1	00000ms	00000 to 10000ms (in 10 ms steps)	7
51	Delimiter	,		1

	Item	Display	Range	Length
52	TIME END 1	00000ms	00000 to 10000ms (in 10 ms steps)	7
53	Delimiter	,		1
54	TIME BEGIN 2	00000ms	00000 to 10000ms (in 10 ms steps)	7
55	Delimiter	,		1
56	TIME END 2	00000ms	00000 to 10000ms (in 10 ms steps)	7
57	Return code	[CR]	(0x0d)	1
58	Feed code	[LF]	(0x0a)	1

* A space falls into "_" for digit matching.

② Output data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	13		2
6	Delimiter	:		1
8 "LEVEL OUTPUT 1" to 56 "TIME END 2" in EXTEND SETUP ① Writing request data for schedule				
56	Return code	[CR]	(0x0d)	1
57	Feed code	[LF]	(0x0a)	1

③ Writing request data common to all schedules (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	13		2
7	Delimiter	:		1
DISPLACEMENT				
8	INITIAL MEASUREMENT	0	0: CURRENT START 1: EXTERNAL INPUT	1
9	Delimiter	,		1
10	MEAS AFTER PULSE	0	0: CURRENT START 1: DELAY TIME	1
11	Delimiter	,		1
12	FINAL MEASUREMENT	0	0: DELAY TIME 1: EXTERNAL INPUT	1
13	Delimiter	,		1

	Item	Display	Range	Length
14	PULSE 2 RESET	0	0: OFF, 1: ON	1
15	Delimiter	,		1
16	MEASUREMENT MODE	0	0: REFERENCE 1: ABSOLUTE1 2: ABSOLUTE2 3: ABSOLUTE3 4: ABSOLUTE4	1
17	Delimiter	,		1
18	SENSOR	0	0: Mitutoyo 1: Ono Sokki 2: KEYENCE 3: HEIDENHAIN	1
19	Delimiter	,		1
20	SENSOR STEP	00.1um	00.1 to 10.0um	6
21	Delimiter	,		1
22	POLARITY	0	0: FORWARD 1: REVERSE	1
23	Delimiter	,		1
24	UNIT	0	0: mm 1: inch	1
25	Delimiter	,		1
26	OUTPUT RANGE	0	0: 2.047 1: 8.191 2: 32.767	1
27	Delimiter	,		1
FORCE				
28	SENSOR	0	0: MA-520 1: MA-521 2: MA-522 3: MA-770 4: MA-771 5: RATED SETTING1 6: RATED SETTING2	1
29	Delimiter	,		1
30	SPAN	0500	0500 to 1500	4
31	Delimiter	,		1
32	RATED OUTPUT	0.750mV/V	0.750 to 2.000mV/V	9
33	Delimiter	,		1
34	RATE	09806N__	00490 to 09806N__ 049.0 to 980.6N__ 04.90 to 98.06N__ 00050 to 01000kgf 005.0 to 100.0kgf 00.50 to 10.00kgf 00110 to 02204lbf 011.0 to 220.4lbf 01.10 to 22.04lbf	8

	Item	Display	Range	Length
35	Delimiter	,		1
36	DECIMAL RANGE	0	0: **** 1: ***.* 2: **.**	1
37	Delimiter	,		1
38	UNIT	0	0: N 1: kgf 2: lbf	1
39	Delimiter	,		1
40	TRIGGER LEVEL	02.0%	01.0 to 99.9%	5
41	Delimiter	,		1
42	INITIAL MEASUREMENT	0	0: CURRENT START 1: EXTERNAL INPUT	1
43	Delimiter	,		1
EXTERNAL				
44	INPUT	0	0: VOLTAGE 1: CURRENT	1
45	Delimiter	,		1
46	RATE	00500____ 00500V___ 00500N___ 00500kfg_ 00500lbf_ 00500degC 00500degF 00500Mpa_ 00500bar_ 00500psi_	00500 to 09999 050.0 to 999.9 05.00 to 99.99 0.500 to 9.999 Unit (Range is the same as above.) ____ (No unit) V___ N___ kgf_ lbf_ degC degF Mpa_ bar_ psi_	9
47	Delimiter	,		1
48	DECIMAL RANGE	0	0: **** 1: ***.* 2: **.** 3: *.***	1
49	Delimiter	,		1
50	UNIT	0	0: No unit 1: V 2: N 3: kgf 4: lbf 5: degC 6: degF 7: Mpa 8: bar 9: psi	1

	Item	Display	Range	Length
51	Delimiter	,		1
52	TRIGGER LEVEL	02.0%	02.0 to 99.9%	5
53	Delimiter	,		1
54	INITIAL MEASUREMENT	0	0: CURRENT START 1: EXTERNAL INPUT	1
FORCE				
55	OFFSET	+00000N__	00490 to 09806N__ 049.0 to 980.6N__ 04.90 to 98.06N__ 00050 to 01000kgf 005.0 to 100.0kgf 00.50 to 10.00kgf 00110 to 02204lbf 011.0 to 220.4lbf 01.10 to 22.04lbf	9
56	Return code	[CR]	(0x0d)	1
57	Feed code	[LF]	(0x0a)	1

* A space falls into "_" for digit matching.

④ Output data common to all schedules (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	13		2
6	Delimiter	:		1
8 "INITIAL MEASUREMENT" to 55 "OFFSET" in EXTEND SETUP ③ Writing request data for schedule				
54	Return code	[CR]	(0x0d)	1
55	Feed code	[LF]	(0x0a)	1

3) SEAM SETUP [Item No. 15]

① Writing request data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	001	001 to 127	3
5	Screen code	S		1
6	Item No.	15		2
7	Delimiter	:		1
8	SCHEDULE NAME	ABCDE	A to Z, 0 to 9	5
9	Delimiter	,		1
10	START MEASUREMENT	000.0CYC	000.0 to 120.0CYC (in 0.5 CYC steps) 00000 to 02000ms_ (in 10 ms steps) 00000 to 00200ms_	8
11	Delimiter	,		1
12	MEASUREMENT RANGE	0.5CYC	0.5 to 6.0CYC (in 0.5 CYC steps) 010 to 100ms_ (in 10 ms steps) 001 to 010ms_	6 *
13	Delimiter	,		1
14	MEASUREMENT INTERVAL	00.5CYC	00.5 to 12.0CYC (in 0.5 CYC steps) 0010 to 0200ms_ (in 10 ms steps) 0001 to 0020ms_	7 *
15	Delimiter	,		1
16	TIME BEGIN 1	00000.0CYC	00000.0 to 18000.0CYC (in 0.5 CYC steps) 0000000 to 0300000ms_ (in 10 ms steps) 0000000 to 0030000ms_	10 *
17	Delimiter	,		1
18	TIME END 1	18000.0CYC	00000.0 to 18000.0CYC (in 0.5 CYC steps) 0000000 to 0300000ms_ (in 10 ms steps) 0000000 to 0030000ms_	10 *
19	Delimiter	,		1
20	TIME BEGIN 2	00000.0CYC	00000.0 to 18000.0CYC (in 0.5 CYC steps) 0000000 to 0300000ms_ (in 10 ms steps) 0000000 to 0030000ms_	10 *
21	Delimiter	,		1
22	TIME END 2	18000.0CYC	00000.0 to 18000.0CYC (in 0.5 CYC steps) 0000000 to 0300000ms_ (in 10 ms steps) 0000000 to 0030000ms_	10 *
23	Delimiter	,		1
24	TIME BEGIN 3	00000.0CYC	00000.0 to 18000.0CYC (in 0.5 CYC steps) 0000000 to 0300000ms_ (in 10 ms steps) 0000000 to 0030000ms_	10 *
25	Delimiter	,		1

	Item	Display	Range	Length
26	TIME END 3	18000.0CYC	00000.0 to 18000.0CYC (in 0.5 CYC steps) 0000000 to 0300000ms_ (in 10 ms steps) 0000000 to 0030000ms_	10 *
27	Delimiter	,		1
28	CURRENT UPPER 1	99.99kA	0.000 to 9.999kA 00.00 to 99.99kA 000.0 to 999.9kA	7
29	Delimiter	,		1
30	CURRENT LOWER 1	00.00kA	0.000 to 9.999kA 00.00 to 99.99kA 000.0 to 999.9kA	7
31	Delimiter	,		1
32	CURRENT UPPER 2	99.99kA	0.000 to 9.999kA 00.00 to 99.99kA 000.0 to 999.9kA	7
33	Delimiter	,		1
34	CURRENT LOWER 2	00.00kA	0.000 to 9.999kA 00.00 to 99.99kA 000.0 to 999.9kA	7
35	Delimiter	,		1
36	CURRENT UPPER 3	99.99kA	0.000 to 9.999kA 00.00 to 99.99kA 000.0 to 999.9kA	7
37	Delimiter	,		1
38	CURRENT LOWER 3	00.00kA	0.000 to 9.999kA 00.00 to 99.99kA 000.0 to 999.9kA	7
39	Delimiter	,		1
40	VOLTAGE UPPER 1	9.99V	0.00 to 9.99V 00.0 to 99.9V	5
41	Delimiter	,		1
42	VOLTAGE LOWER 1	0.00V	0.00 to 9.99V 00.0 to 99.9V	5
43	Delimiter	,		1
44	VOLTAGE UPPER 2	9.99V	0.00 to 9.99V 00.0 to 99.9V	5
45	Delimiter	,		1
46	VOLTAGE LOWER 2	0.00V	0.00 to 9.99V 00.0 to 99.9V	5
47	Delimiter	,		1
48	VOLTAGE UPPER 3	9.99V	0.00 to 9.99V 00.0 to 99.9V	5
49	Delimiter	,		1
50	VOLTAGE LOWER 3	0.00V	0.00 to 9.99V 00.0 to 99.9V	5
51	Return code	[CR]	(0x0d)	1

	Item	Display	Range	Length
52	Feed code	[LF]	(0x0a)	1

② Output data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	15		2
6	Delimiter	:		1
8 “SCHEDULE NAME” to 50 “VOLTAGE LOWER 3” in SEAM SETUP ① Writing request data for schedule				
50	Return code	[CR]	(0x0d)	1
51	Feed code	[LF]	(0x0a)	1

③ Writing request data common to all schedules (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	15		2
7	Delimiter	:		1
8	TRIGGER (Note)	0	0: CURRENT 1: VOLTAGE	1
9	Delimiter	,		1
10	TIME (Note)	0	0: CYC-AC 1: ms-AC 2: ms-DC 3: CYC-DC 4: SHORT ms-DC	1
11	Delimiter	,		1
12	CALCULATION	0	0: PEAK 1: RMS 2: AVERAGE RMS	1
13	Delimiter	,		1
14	CURRENT RANGE	0	1x sensitivity coil 0: 2.000kA 1: 6.00kA 2: 20.00kA 3: 60.0kA 4: 200.0kA 10x sensitivity coil 0: 0.200kA 1: 0.600kA 2: 2.000kA 3: 6.00kA 4: 20.00kA	1
15	Delimiter	,		1

	Item	Display	Range	Length
16	VOLTAGE RANGE	0	0: 6.00V 1: 20.0V	1
17	Delimiter	,		1
18	CURRENT TRIGGER LEVEL	01	01 to 99	2
19	Delimiter	,		1
20	VOLTAGE TRIGGER LEVEL	01	01 to 99	2
21	Delimiter	,		1
22	TOROIDAL COIL	0	0: TIMES 1 1: TIMES 10	1
23	Delimiter	,		1
24	END LEVEL	01.5%	01.5 to 15.0%	5
25	Return code	[CR]	(0x0d)	1
26	Feed code	[LF]	(0x0a)	1

(Note) When CURRENT is selected for TRIGGER, 0: CYC-AC or 1: ms-AC can be selected for TIME. When VOLTAGE is for TRIGGER selected, 2: ms-DC, 3: CYC-DC, or 4: SHORT ms-DC can be selected for TIME.

④ Output data common to all schedules (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	15		2
6	Delimiter	:		1
8 “TRIGGER” to 24 “END LEVEL” in SEAM SETUP ③ Writing request data for schedule				
24	Return code	[CR]	(0x0d)	1
25	Feed code	[LF]	(0x0a)	1

4) COMPARATOR [Item No. 16]

① Writing request data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	001	001 to 127	3
5	Screen code	S		1
6	Item No.	16		2
7	Delimiter	:		1
8	UPPER 1	(Refer to the upper/lower limit table.)		11
9	Delimiter	,		1
10	LOWER 1	(Refer to the upper/lower limit table.)		11
11	Delimiter	,		1
12	UPPER 2	(Refer to the upper/lower limit table.)		11
13	Delimiter	,		1
14	LOWER 2	(Refer to the upper/lower limit table.)		11
15	Delimiter	,		1
16	UPPER 3	(Refer to the upper/lower limit table.)		11
17	Delimiter	,		1
18	LOWER 3	(Refer to the upper/lower limit table.)		11
19	Delimiter	,		1
20	UPPER 4	(Refer to the upper/lower limit table.)		11
21	Delimiter	,		1
22	LOWER 4	(Refer to the upper/lower limit table.)		11
23	Delimiter	,		1
24	UPPER 5	(Refer to the upper/lower limit table.)		11
25	Delimiter	,		1
26	LOWER 5	(Refer to the upper/lower limit table.)		11
27	Delimiter	,		1
28	UPPER 6	(Refer to the upper/lower limit table.)		11
29	Delimiter	,		1
30	LOWER 6	(Refer to the upper/lower limit table.)		11
31	Delimiter	,		1
32	UPPER 7	(Refer to the upper/lower limit table.)		11
33	Delimiter	,		1
34	LOWER 7	(Refer to the upper/lower limit table.)		11
35	Delimiter	,		1
36	UPPER 8	(Refer to the upper/lower limit table.)		11
37	Delimiter	,		1

	Item	Display	Range	Length
38	LOWER 8	(Refer to the upper/lower limit table.)		11
39	Delimiter	,		1
40	UPPER 9	(Refer to the upper/lower limit table.)		11
41	Delimiter	,		1
42	LOWER 9	(Refer to the upper/lower limit table.)		11
43	Delimiter	,		1
44	UPPER 10	(Refer to the upper/lower limit table.)		11
45	Delimiter	,		1
46	LOWER 10	(Refer to the upper/lower limit table.)		11
47	Return code	[CR]	(0x0d)	1
48	Feed code	[LF]	(0x0a)	1

② Output data for each schedule 001 to 127

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 127	3
4	Screen code	S		1
5	Item No.	16		2
6	Delimiter	:		1
8 “UPPER 1” to 46 “LOWER 10” in COMPARATOR ① Writing request data for schedule				
46	Return code	[CR]	(0x0d)	1
47	Feed code	[LF]	(0x0a)	1

5) VIEW [Item No. 11]

① Writing request data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	11		2
7	Delimiter	:		1
8	MEASUREMENT DISPLAY	0	0: 5 ITEMS 1: 10 ITEMS	1
9	Delimiter	,		1
10	MEAS 1	00	00 to 34 (Refer to the measurement code table.)	2
11	Delimiter	,		1
12	MEAS 2	00	00 to 34 (Refer to the measurement code table.)	2
13	Delimiter	,		1
14	MEAS 3	00	00 to 34 (Refer to the measurement code table.)	2
15	Delimiter	,		1
16	MEAS 4	00	00 to 34 (Refer to the measurement code table.)	2
17	Delimiter	,		1
18	MEAS 5	00	00 to 34 (Refer to the measurement code table.)	2
19	Delimiter	,		1
20	MEAS 6	00	00 to 34 (Refer to the measurement code table.)	2
21	Delimiter	,		1
22	MEAS 7	00	00 to 34 (Refer to the measurement code table.)	2
23	Delimiter	,		1
24	MEAS 8	00	00 to 34 (Refer to the measurement code table.)	2
25	Delimiter	,		1
26	MEAS 9	00	00 to 34 (Refer to the measurement code table.)	2
27	Delimiter	,		1
28	MEAS 10	00	00 to 34 (Refer to the measurement code table.)	2
29	Delimiter	,		1
30	WAVE 1	0	0 to 7 (Refer to the waveform code table.)	1

	Item	Display	Range	Length
31	Delimiter	,		1
32	WAVE 2	0	0 to 7 (Refer to the waveform code table.)	1
33	Delimiter	,		1
34	WAVE 3	0	0 to 7 (Refer to the waveform code table.)	1
35	Delimiter	,		1
36	WAVE 4	0	0 to 7 (Refer to the waveform code table.)	1
37	Delimiter	,		1
38	Waveform display 1	0	0: OFF, 1: ON	1
39	Delimiter	,		1
40	Waveform display 2	0	0: OFF, 1: ON	1
41	Delimiter	,		1
42	Waveform display 3	0	0: OFF, 1: ON	1
43	Delimiter	,		1
44	Waveform display 4	0	0: OFF, 1: ON	1
45	Return code	[CR]	(0x0d)	1
46	Feed code	[LF]	(0x0a)	1

② Output data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	11		2
6	Delimiter	:		1
7	MEASUREMENT DISPLAY	0	0: 5 ITEMS 1: 10 ITEMS	1
8	Delimiter	,		1
9	MEAS 1	00	00 to 34 (Refer to the measurement code table.)	2
10	Delimiter	,		1
11	MEAS 2	00	00 to 34 (Refer to the measurement code table.)	2
12	Delimiter	,		1
13	MEAS 3	00	00 to 34 (Refer to the measurement code table.)	2
14	Delimiter	,		1
15	MEAS 4	00	00 to 34 (Refer to the measurement code table.)	2
16	Delimiter	,		1
17	MEAS 5	00	00 to 34 (Refer to the measurement code table.)	2

	Item	Display	Range	Length
18	Delimiter	,		1
19	MEAS 6	00	00 to 34 (Refer to the measurement code table.)	2
20	Delimiter	,		1
21	MEAS 7	00	00 to 34 (Refer to the measurement code table.)	2
22	Delimiter	,		1
23	MEAS 8	00	00 to 34 (Refer to the measurement code table.)	2
24	Delimiter	,		1
25	MEAS 9	00	00 to 34 (Refer to the measurement code table.)	2
26	Delimiter	,		1
27	MEAS 10	00	00 to 34 (Refer to the measurement code table.)	2
28	Delimiter	,		1
29	WAVE 1	0	0 to 7 (Refer to the waveform code table.)	1
30	Delimiter	,		1
31	WAVE 2	0	0 to 7 (Refer to the waveform code table.)	1
32	Delimiter	,		1
33	WAVE 3	0	0 to 7 (Refer to the waveform code table.)	1
34	Delimiter	,		1
35	WAVE 4	0	0 to 7 (Refer to the waveform code table.)	1
36	Delimiter	,		1
37	Waveform display 1	0	0: OFF, 1: ON	1
38	Delimiter	,		1
39	Waveform display 2	0	0: OFF, 1: ON	1
40	Delimiter	,		1
41	Waveform display 3	0	0: OFF, 1: ON	1
42	Delimiter	,		1
43	Waveform display 4	0	0: OFF, 1: ON	1
44	Return code	[CR]	(0x0d)	1
45	Feed code	[LF]	(0x0a)	1

6) SYSTEM SETUP [Item No. 14]

① Writing request data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	14		2
7	Delimiter	:		1
8	MODE	0	0: NORMAL 1: SEAM 2: NORMAL TRACE 3: SINGLE TRACE	1
9	Delimiter	,		1
10	LANGUAGE	0	0: ENGLISH 1: GERMAN 2: FRENCH 3: SPANISH 4: JAPANESE 5: KOREAN 6: CHINESE	1
11	Delimiter	,		1
12	WELD COUNTER PRESET	000000	000000 to 999999	6
13	Delimiter	,		1
14	GOOD COUNTER PRESET	000000	000000 to 999999	6
15	Delimiter	,		1
16	BRIGHTNESS	01	01 to 10	2
17	Delimiter	,		1
18	BRIGHTNESS	0	0: OFF 1: AUTO	1
19	Delimiter	,		1
CURRENT				
20	SAMPLING INTERVAL	0	0: 20us 1: 50us 2: 100us 3: 200us	1
21	Delimiter	,		1
22	CONVERSION COEFFICIENT	100.0mV/kA	100.0 to 250.0mV/kA	10
23	Delimiter	,		1
FORCE / EXTERNAL				
24	SAMPLING INTERVAL	0	0: 100us 1: 200us 2: 500us	1
25	Return code	[CR]	(0x0d)	1

	Item	Display	Range	Length
26	Feed code	[LF]	(0x0a)	1

② Output data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	14		2
6	Delimiter	:		1
7	MODE	0	0: NORMAL 1: SEAM 2: NORMAL TRACE 3: SINGLE TRACE	1
8	Delimiter	,		1
9	LANGUAGE	0	0: ENGLISH 1: GERMAN 2: FRENCH 3: SPANISH 4: JAPANESE 5: KOREAN 6: CHINESE	1
10	Delimiter	,		1
11	WELD COUNTER PRESET	000000	000000 to 999999	6
12	Delimiter	,		1
13	GOOD COUNTER PRESET	000000	000000 to 999999	6
14	Delimiter	,		1
15	BRIGHTNESS	01	01 to 10	2
16	Delimiter	,		1
17	BRIGHTNESS	0	0: OFF 1: AUTO	1
18	Delimiter	,		1
CURRENT				
19	SAMPLING INTERVAL	0	0: 20us 1: 50us 2: 100us 3: 200us	1
20	Delimiter	,		1
21	CONVERSION COEFFICIENT	100.0mV/kA	100.0 to 250.0mV/kA	10
22	Delimiter	,		1
FORCE / EXTERNAL				
23	SAMPLING INTERVAL	0	0: 100us 1: 200us 2: 500us	1

	Item	Display	Range	Length
24	Return code	[CR]	(0x0d)	1
25	Feed code	[LF]	(0x0a)	1

7) EXT INPUT/OUTPUT [Item No. 18]

① Writing request data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	18		2
7	Delimiter	:		1
8	Input 1	0	(External input 1 to 6 code table)	1
9	Delimiter	,		1
10	Input 2	1	(External input 1 to 6 code table)	1
11	Delimiter	,		1
12	Input 3	2	(External input 1 to 6 code table)	1
13	Delimiter	,		1
14	Input 4	3	(External input 1 to 6 code table)	1
15	Delimiter	,		1
16	Input 5	4	(External input 1 to 6 code table)	1
17	Delimiter	,		1
18	Input 6	8	(External input 1 to 6 code table)	1
19	Delimiter	,		1
20	Input 7	1	(External input 7 to 8 code table)	1
21	Delimiter	,		1
22	Input 8	3	(External input 7 to 8 code table)	1
23	Delimiter	,		1
24	Output 1 -1	00	(External output 1 to 12 code table)	2
25	Delimiter	,		1
26	Output 1 -2	62	(External output 1 to 12 code table)	2
27	Delimiter	,		1
28	Output 1 -3	62	(External output 1 to 12 code table)	2
29	Delimiter	,		1
30	Output 2 -1	01	(External output 1 to 12 code table)	2
31	Delimiter	,		1
32	Output 2 -2	62	(External output 1 to 12 code table)	2
33	Delimiter	,		1
34	Output 2 -3	62	(External output 1 to 12 code table)	2
35	Delimiter	,		1
36	Output 3 -1	02	(External output 1 to 12 code table)	2
37	Delimiter	,		1

	Item	Display	Range	Length
38	Output 3 -2	62	(External output 1 to 12 code table)	2
39	Delimiter	,		1
40	Output 3 -3	62	(External output 1 to 12 code table)	2
41	Delimiter	,		1
42	Output 4 -1	13	(External output 1 to 12 code table)	2
43	Delimiter	,		1
44	Output 4 -2	62	(External output 1 to 12 code table)	2
45	Delimiter	,		1
46	Output 4 -3	62	(External output 1 to 12 code table)	2
47	Delimiter	,		1
48	Output 5 -1	11	(External output 1 to 12 code table)	2
49	Delimiter	,		1
50	Output 5 -2	62	(External output 1 to 12 code table)	2
51	Delimiter	,		1
52	Output 5 -3	62	(External output 1 to 12 code table)	2
53	Delimiter	,		1
54	Output 6 -1	20	(External output 1 to 12 code table)	2
55	Delimiter	,		1
56	Output 6 -2	62	(External output 1 to 12 code table)	2
57	Delimiter	,		1
58	Output 6 -3	62	(External output 1 to 12 code table)	2
59	Delimiter	,		1
60	Output 7 -1	18	(External output 1 to 12 code table)	2
61	Delimiter	,		1
62	Output 7 -2	62	(External output 1 to 12 code table)	2
63	Delimiter	,		1
64	Output 7 -3	62	(External output 1 to 12 code table)	2
65	Delimiter	,		1
66	Output 8 -1	23	(External output 1 to 12 code table)	2
67	Delimiter	,		1
68	Output 8 -2	62	(External output 1 to 12 code table)	2
69	Delimiter	,		1
70	Output 8 -3	62	(External output 1 to 12 code table)	2
71	Delimiter	,		1
72	Output 9 -1	24	(External output 1 to 12 code table)	2
73	Delimiter	,		1
74	Output 9 -2	62	(External output 1 to 12 code table)	2
75	Delimiter	,		1
76	Output 9 -3	62	(External output 1 to 12 code table)	2
77	Delimiter	,		1

	Item	Display	Range	Length
78	Output 10 -1	26	(External output 1 to 12 code table)	2
79	Delimiter	,		1
80	Output 10 -2	62	(External output 1 to 12 code table)	2
81	Delimiter	,		1
82	Output 10 -3	62	(External output 1 to 12 code table)	2
83	Delimiter	,		1
84	Output 11 -1	27	(External output 1 to 12 code table)	2
85	Delimiter	,		1
86	Output 11 -2	62	(External output 1 to 12 code table)	2
87	Delimiter	,		1
88	Output 11 -3	62	(External output 1 to 12 code table)	2
89	Delimiter	,		1
90	Output 12 -1	62	(External output 1 to 12 code table)	2
91	Delimiter	,		1
92	Output 12 -2	62	(External output 1 to 12 code table)	2
93	Delimiter	,		1
94	Output 12 -3	62	(External output 1 to 12 code table)	2
95	Delimiter	,		1
96	PARITY	0	0: OFF 1: ON	1
97	Delimiter	,		1
98	INPUT DELAY TIME	0	0: 1ms 1: 10ms	1
99	Delimiter	,		1
100	NG OUTPUT MODE	0	0: NORMALLY CLOSED 1: NORMALLY OPEN	1
101	Delimiter	,		1
102	OUTPUT TIME	0	0: 10ms 1: 100ms 2: HOLD	1
103	Delimiter	,		1
104	LEVEL OUTPUT	0	0: LEVEL 1: PULSE	1
105	Return code	[CR]	(0x0d)	1
106	Feed code	[LF]	(0x0a)	1

② Output data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1

	Item	Display	Range	Length
5	Item No.	18		2
6	Delimiter	:		1
7	Input 1	0	(External input 1 to 6 code table)	1
8	Delimiter	,		1
9	Input 2	1	(External input 1 to 6 code table)	1
10	Delimiter	,		1
11	Input 3	2	(External input 1 to 6 code table)	1
12	Delimiter	,		1
13	Input 4	3	(External input 1 to 6 code table)	1
14	Delimiter	,		1
15	Input 5	4	(External input 1 to 6 code table)	1
16	Delimiter	,		1
17	Input 6	8	(External input 1 to 6 code table)	1
18	Delimiter	,		1
19	Input 7	1	(External input 7 to 8 code table)	1
20	Delimiter	,		1
21	Input 8	3	(External input 7 to 8 code table)	1
22	Delimiter	,		1
23	Output 1 -1	00	(External output 1 to 12 code table)	2
24	Delimiter	,		1
25	Output 1 -2	62	(External output 1 to 12 code table)	2
26	Delimiter	,		1
27	Output 1 -3	62	(External output 1 to 12 code table)	2
28	Delimiter	,		1
29	Output 2 -1	01	(External output 1 to 12 code table)	2
30	Delimiter	,		1
31	Output 2 -2	62	(External output 1 to 12 code table)	2
32	Delimiter	,		1
33	Output 2 -3	62	(External output 1 to 12 code table)	2
34	Delimiter	,		1
35	Output 3 -1	02	(External output 1 to 12 code table)	2
36	Delimiter	,		1
37	Output 3 -2	62	(External output 1 to 12 code table)	2
38	Delimiter	,		1
39	Output 3 -3	62	(External output 1 to 12 code table)	2
40	Delimiter	,		1
41	Output 4 -1	13	(External output 1 to 12 code table)	2
42	Delimiter	,		1
43	Output 4 -2	62	(External output 1 to 12 code table)	2
44	Delimiter	,		1

	Item	Display	Range	Length
45	Output 4 -3	62	(External output 1 to 12 code table)	2
46	Delimiter	,		1
47	Output 5 -1	11	(External output 1 to 12 code table)	2
48	Delimiter	,		1
49	Output 5 -2	62	(External output 1 to 12 code table)	2
50	Delimiter	,		1
51	Output 5 -3	62	(External output 1 to 12 code table)	2
52	Delimiter	,		1
53	Output 6 -1	20	(External output 1 to 12 code table)	2
54	Delimiter	,		1
55	Output 6 -2	62	(External output 1 to 12 code table)	2
56	Delimiter	,		1
57	Output 6 -3	62	(External output 1 to 12 code table)	2
58	Delimiter	,		1
59	Output 7 -1	18	(External output 1 to 12 code table)	2
60	Delimiter	,		1
61	Output 7 -2	62	(External output 1 to 12 code table)	2
62	Delimiter	,		1
63	Output 7 -3	62	(External output 1 to 12 code table)	2
64	Delimiter	,		1
65	Output 8 -1	23	(External output 1 to 12 code table)	2
66	Delimiter	,		1
67	Output 8 -2	62	(External output 1 to 12 code table)	2
68	Delimiter	,		1
69	Output 8 -3	62	(External output 1 to 12 code table)	2
70	Delimiter	,		1
71	Output 9 -1	24	(External output 1 to 12 code table)	2
72	Delimiter	,		1
73	Output 9 -2	62	(External output 1 to 12 code table)	2
74	Delimiter	,		1
75	Output 9 -3	62	(External output 1 to 12 code table)	2
76	Delimiter	,		1
77	Output 10 -1	26	(External output 1 to 12 code table)	2
78	Delimiter	,		1
79	Output 10 -2	62	(External output 1 to 12 code table)	2
80	Delimiter	,		1
81	Output 10 -3	62	(External output 1 to 12 code table)	2
82	Delimiter	,		1
83	Output 11 -1	27	(External output 1 to 12 code table)	2
84	Delimiter	,		1

	Item	Display	Range	Length
85	Output 11 -2	62	(External output 1 to 12 code table)	2
86	Delimiter	,		1
87	Output 11 -3	62	(External output 1 to 12 code table)	2
88	Delimiter	,		1
89	Output 12 -1	62	(External output 1 to 12 code table)	2
90	Delimiter	,		1
91	Output 12 -2	62	(External output 1 to 12 code table)	2
92	Delimiter	,		1
93	Output 12 -3	62	(External output 1 to 12 code table)	2
94	Delimiter	,		1
95	PARITY	0	0: OFF 1: ON	1
96	Delimiter	,		1
97	INPUT DELAY TIME	0	0: 1ms 1: 10ms	1
98	Delimiter	,		1
99	NG OUTPUT MODE	0	0: NORMALLY CLOSED 1: NORMALLY OPEN	1
100	Delimiter	,		1
101	OUTPUT TIME	0	0: 10ms 1: 100ms 2: HOLD	1
102	Delimiter	,		1
103	LEVEL OUTPUT	0	0: LEVEL 1: PULSE	1
104	Return code	[CR]	(0x0d)	1
105	Feed code	[LF]	(0x0a)	1

8) PRINT [Item No. 21]

① Writing request data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	21		2
7	Delimiter	:		1
8	ITEM	0	0: OFF 1: MEASUREMENT 2: WAVEFORM 3: CURRENT ALL CYCLE 4: FORCE ALL CYCLE 5: HISTORY 6: HISTORY OUTOF LIM 7: SCHEDULE 8: SCREEN	1
9	Delimiter	,		1
10	INTERVAL	0001	0001 to 1000	4
11	Delimiter	,		1
12	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
13	Return code	[CR]	(0x0d)	1
14	Feed code	[LF]	(0x0a)	1

② Output data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	21		2
6	Delimiter	:		1
7	ITEM	0	0: OFF 1: MEASUREMENT 2: WAVEFORM 3: CURRENT ALL CYCLE 4: FORCE ALL CYCLE 5: HISTORY 6: HISTORY OUTOF LIM 7: SCHEDULE 8: SCREEN	1
8	Delimiter	,		1
9	INTERVAL	0001	0001 to 1000	4

	Item	Display	Range	Length
10	Delimiter	,		1
11	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
12	Return code	[CR]	(0x0d)	1
13	Feed code	[LF]	(0x0a)	1

9) COMMUNICATION [Item No. 22]

① Writing request data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	22		2
7	Delimiter	:		1
8	ITEM	0	0: OFF 1: MEASUREMENT 2: WAVEFORM 3: CURRENT ALL CYCLE 4: FORCE ALL CYCLE 5: HISTORY 6: HISTORY OUT OF LIM 7: SCHEDULE	1
9	Delimiter	,		1
10	INTERVAL	0001	0001 to 1000	4
11	Delimiter	,		1
12	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
13	Delimiter	,		1
14	WAVE DECIMATION	0	0: 20us 1: 50us 2: 100us 3: 200us 4: 500us 5: 1000us	1
15	Delimiter	,		1
16	UNIT	0	0: OFF 1: ON	1
17	Delimiter	,		1
18	DECIMAL POINT RANGE (Note)	0	0: . (period) 1: , (comma)	1
19	Delimiter	,		1
20	MODE (Note)	0	0: OFF 1: RS-232C 2: RS-485 3: ETHERNET	1
21	Delimiter	,		1
22	MODE (Note)	0	0: ONE WAY 1: TWO WAY	1
23	Delimiter	,		1
24	ID NO. (Note)	01	01 to 31	2

	Item	Display	Range	Length
25	Delimiter	,		1
26	SPEED (Note)	0	0: 9600 1: 19200 2: 38400	1
27	Delimiter	,		1
28	IP ADDRESS (Note)	000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
29	Delimiter	,		1
30	SUBNET MASK (Note)	000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
31	Delimiter	,		1
32	DEFAULT GATEWAY (Note)	000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
33	Delimiter	,		1
34	PORT NO. (Note)	1024	1024 to 5000	4
35	Return code	[CR]	(0x0d)	1
36	Feed code	[LF]	(0x0a)	1

(Note) Data cannot be changed. Do not make a change while writing data. Input the setting value as it is.

② Output data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1

	Item	Display	Range	Length
5	Item No.	22		2
6	Delimiter	:		1
7	ITEM	0	0: OFF 1: MEASUREMENT 2: WAVEFORM 3: CURRENT ALL CYCLE 4: FORCE ALL CYCLE 5: HISTORY 6: HISTORY OUT OF LIM 7: SCHEDULE 8: ENVELOPE	1
8	Delimiter	,		1
9	INTERVAL	0001	0001 to 1000	4
10	Delimiter	,		1
11	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
12	Delimiter	,		1
13	WAVE DECIMATION	0	0: 20us 1: 50us 2: 100us 3: 200us 4: 500us 5: 1000us	1
14	Delimiter	,		1
15	UNIT	0	0: OFF 1: ON	1
16	Delimiter	,		1
17	DECIMAL POINT RANGE	0	0: . (period) 1: , (comma)	1
18	Delimiter	,		1
19	MODE (Note)	0	0: OFF 1: RS-232C 2: RS-485 3: ETHERNET	1
20	Delimiter	,		1
21	MODE (Note)	0	0: ONE WAY 1: TWO WAY	1
22	Delimiter	,		1
23	ID NO.	01	01 to 31	2
24	Delimiter	,		1
25	SPEED (Note)	0	0: 9600 1: 19200 2: 38400	1
26	Delimiter	,		1

	Item	Display	Range	Length
27	IP ADDRESS (Note)	000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
28	Delimiter	,		1
29	SUBNET MASK (Note)	000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
30	Delimiter	,		1
31	DEFAULT GATEWAY (Note)	000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
			Space	1
		000	000 to 255	3
32	Delimiter	,		1
33	PORT NO.	0000	1024 to 5000	4
34	Return code	[CR]	(0x0d)	1
35	Feed code	[LF]	(0x0a)	1

10) USB [Item No. 23]

① Writing request data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	23		2
7	Delimiter	:		1
8	Item	0	0: OFF 1: MEASUREMENT 2: WAVEFORM 3: CURRENT ALL CYCLE 4: FORCE ALL CYCLE 5: HISTORY 6: HISTORY OUTOF LIM 7: SCHEDULE 8: SCREEN 9: ENVELOPE	1
9	Delimiter	,		1
10	INTERVAL	0001	0001 to 1000	4
11	Delimiter	,		1
12	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
13	Delimiter	,		1
14	WAVE DECIMATION	0	0: 20us 1: 50us 2: 100us 3: 200us 4: 500us 5: 1000us	1
15	Delimiter	,		1
16	UNIT	0	0: OFF 1: ON	1
17	Delimiter	,		1
18	DECIMAL POINT RANGE	0	0: . (period) 1: , (comma)	1
19	Return code	[CR]	(0x0d)	1
20	Feed code	[LF]	(0x0a)	1

② Output data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3

	Item	Display	Range	Length
4	Screen code	S		1
5	Item No.	23		2
6	Delimiter	:		1
7	ITEM	0	0: OFF 1: MEASUREMENT 2: WAVEFORM 3: CURRENT ALL CYCLE 4: FORCE ALL CYCLE 5: HISTORY 6: HISTORY OUTOF LIM 7: SCHEDULE 8: SCREEN	1
8	Delimiter	,		1
9	INTERVAL	0001	0001 to 1000	4
10	Delimiter	,		1
11	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
12	Delimiter	,		1
13	WAVE DECIMATION	0	0: 20us 1: 50us 2: 100us 3: 200us 4: 500us 5: 1000us	1
14	Delimiter	,		1
15	UNIT	0	0: OFF 1: ON	1
16	Delimiter	,		1
17	DECIMAL POINT RANGE	0	0: . (period) 1: , (comma)	1
18	Return code	[CR]	(0x0d)	1
19	Feed code	[LF]	(0x0a)	1

11) INTERNAL MEMORY [Item No. 24]

① Writing request data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	#		1
2	ID NO.	01	01 to 31	2
3	Write code	W		1
4	SCH.#	000	000	3
5	Screen code	S		1
6	Item No.	24		2
7	Delimiter	:		1
8	ITEM	0	0: OFF 1: WAVEFORM 2: CURRENT ALL CYCLE 3: FORCE ALL CYCLE	1
9	Delimiter	,		1
10	INTERVAL	0001	0001 to 1000	4
11	Delimiter	,		1
12	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
13	Delimiter	,		1
14	WAVE DECIMATION	0	0: 20us 1: 50us 2: 100us 3: 200us 4: 500us 5: 1000us	1
15	Return code	[CR]	(0x0d)	1
16	Feed code	[LF]	(0x0a)	1

② Output data (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	24		2
6	Delimiter	:		1
7	ITEM	0	0: OFF 1: WAVEFORM 2: CURRENT ALL CYCLE 3: FORCE ALL CYCLE	1
8	Delimiter	,		1
9	INTERVAL	0001	0001 to 1000	4
10	Delimiter	,		1

	Item	Display	Range	Length
11	OUT OF LIMIT OPERATION	0	0: OFF 1: ON	1
12	Delimiter	,		1
13	WAVE DECIMATION	0	0: 20us 1: 50us 2: 100us 3: 200us 4: 500us 5: 1000us	1
14	Return code	[CR]	(0x0d)	1
15	Feed code	[LF]	(0x0a)	1

12) ENVELOPE [Item No. 17]

① Output data for each schedule 001 to 020

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	001	001 to 020	3
4	Screen code	S		1
5	Item No.	17		2
6	Delimiter	:		1
7	OFFSET UPPER ENVE#1 SEGM#1	(Refer to the envelope upper/lower limit table.)		11
8	Delimiter	,		1
9	OFFSET UPPER ENVE#1 SEGM#2	(Refer to the envelope upper/lower limit table.)		11
10	Delimiter	,		1
11	OFFSET UPPER ENVE#1 SEGM#3	(Refer to the envelope upper/lower limit table.)		11
12	Delimiter	,		1
13	OFFSET UPPER ENVE#2 SEGM#1	(Refer to the envelope upper/lower limit table.)		11
14	Delimiter	,		1
15	OFFSET UPPER ENVE#2 SEGM#2	(Refer to the envelope upper/lower limit table.)		11
16	Delimiter	,		1
17	OFFSET UPPER ENVE#2 SEGM#3	(Refer to the envelope upper/lower limit table.)		11
18	Delimiter	,		1
19	OFFSET LOWER ENVE#1 SEGM#1	(Refer to the envelope upper/lower limit table.)		11
20	Delimiter	,		1
21	OFFSET LOWER ENVE#1 SEGM#2	(Refer to the envelope upper/lower limit table.)		11
22	Delimiter	,		1
23	OFFSET LOWER ENVE#1 SEGM#3	(Refer to the envelope upper/lower limit table.)		11
24	Delimiter	,		1
25	OFFSET LOWER ENVE#2 SEGM#1	(Refer to the envelope upper/lower limit table.)		11
26	Delimiter	,		1
27	OFFSET LOWER ENVE#2 SEGM#2	(Refer to the envelope upper/lower limit table.)		11
28	Delimiter	,		1
29	OFFSET LOWER ENVE#2 SEGM#3	(Refer to the envelope upper/lower limit table.)		11

	Item	Display	Range	Length
30	Delimiter	,		1
31	START TIME UPPER ENVE#1 SEGM#1	00000ms	00000 to 10000ms	7
32	Delimiter	,		1
33	START TIME UPPER ENVE#1 SEGM#2	00000ms	00000 to 10000ms	7
34	Delimiter	,		1
35	START TIME UPPER ENVE#1 SEGM#3	00000ms	00000 to 10000ms	7
36	Delimiter	,		1
37	START TIME UPPER ENVE#2 SEGM#1	00000ms	00000 to 10000ms	7
38	Delimiter	,		1
39	START TIME UPPER ENVE#2 SEGM#2	00000ms	00000 to 10000ms	7
40	Delimiter	,		1
41	START TIME UPPER ENVE#2 SEGM#3	00000ms	00000 to 10000ms	7
42	Delimiter	,		1
43	START TIME LOWER ENVE#1 SEGM#1	00000ms	00000 to 10000ms	7
44	Delimiter	,		1
45	START TIME LOWER ENVE#1 SEGM#2	00000ms	00000 to 10000ms	7
46	Delimiter	,		1
47	START TIME LOWER ENVE#1 SEGM#3	00000ms	00000 to 10000ms	7
48	Delimiter	,		1
49	START TIME LOWER ENVE#2 SEGM#1	00000ms	00000 to 10000ms	7
50	Delimiter	,		1
51	START TIME LOWER ENVE#2 SEGM#2	00000ms	00000 to 10000ms	7
52	Delimiter	,		1
53	START TIME LOWER ENVE#2 SEGM#3	00000ms	00000 to 10000ms	7
54	Delimiter	,		1
55	END TIME UPPER ENVE#1 SEGM#1	00000ms	00000 to 10000ms	7
56	Delimiter			1
57	END TIME UPPER ENVE#1 SEGM#2	00000ms	00000 to 10000ms	7
58	Delimiter	,		1

	Item	Display	Range	Length
59	END TIME UPPER ENVE#1 SEGM#3	00000ms	00000 to 10000ms	7
60	Delimiter	,		1
61	END TIME UPPER ENVE#2 SEGM#1	00000ms	00000 to 10000ms	7
62	Delimiter	,		1
63	END TIME UPPER ENVE#2 SEGM#2	00000ms	00000 to 10000ms	7
64	Delimiter	,		1
65	END TIME UPPER ENVE#2 SEGM#3	00000ms	00000 to 10000ms	7
66	Delimiter	,		1
67	END TIME LOWER ENVE#1 SEGM#1	00000ms	00000 to 10000ms	7
68	Delimiter	,		1
69	END TIME LOWER ENVE#1 SEGM#2	00000ms	00000 to 10000ms	7
70	Delimiter	,		1
71	END TIME LOWER ENVE#1 SEGM#3	00000ms	00000 to 10000ms	7
72	Delimiter	,		1
73	END TIME LOWER ENVE#2 SEGM#1	00000ms	00000 to 10000ms	7
74	Delimiter	,		1
75	END TIME LOWER ENVE#2 SEGM#2	00000ms	00000 to 10000ms	7
76	Delimiter	,		1
77	END TIME LOWER ENVE#2 SEGM#3	00000ms	00000 to 10000ms	7
78	Return code	[CR]	(0x0d)	1
79	Feed code	[LF]	(0x0a)	1

② Output data common to all schedules (SCH.# 000)

	Item	Display	Range	Length
1	Start code	!		1
2	ID NO.	01	01 to 31	2
3	SCH.#	000	000	3
4	Screen code	S		1
5	Item No.	17		2
6	Delimiter	:		1
7	COMPARATOR MODE	0	0: % SET 1: VALUE SET	1
8	Delimiter	,		1

	Item	Display	Range	Length
9	ENVELOPE INTERVAL	0	0: 20us 1: 50us 2: 100us 3: 200us 4: 500us 5: 1000us	1
10	Return code	[CR]	(0x0d)	1
11	Feed code	[LF]	(0x0a)	1

(5) Code Table of Communication and USB Data

Code tables of communication and USB data are shown below.

1) Item number data table

Item No.	Screen	Item No.	Screen
01	MEASUREMENT	14	SYSTEM SETUP
02	WAVEFORM	15	SEAM SETUP
03	CURRENT ALL CYCLE	16	COMPARATOR
04	FORCE ALL CYCLE	17	ENVELOPE
06	HISTORY	18	EXT INPUT/OUTPUT
07	HISTORY OUT OF LIM	21	PRINT
11	VIEW	22	COMMUNICATION
12	BASIC SETUP	23	USB
13	EXTEND SETUP	24	INTERNAL MEMORY

2) Measurement code table

Item code	Item name	Measured value			Unit	
		Display	Range	Length	Display	Length
00	CURR PEAK	0.000 00.00 000.0	0.000 to 9.999 00.00 to 99.99 000.0 to 999.9	5	kA	2
01	CURR RMS					
02	CURR AVG RMS					
03	VOLT PEAK	0.00 00.0	0.00 to 9.99 00.0 to 99.9	4	V	1
04	VOLT RMS					
05	VOLT AVG RMS					
06	COND ANGLE	000	000 to 180	3	deg	3
07	POWER AVE	000.00	000.00 to 300.00	6	kW	2
08	RESISTANCE AVE	000.00	000.00 to 300.00	6	mOhm	4
09	WELD TIME	0000.0 0000 000.00	0000.0 to 3000.0 (in 0.5 CYC steps) 0000 to 3000 000.00 to 300.00	6 4 6	CYC ms	3 2
10	WELD TIME TP	000.00	000.00 to 300.00	6	ms	2
11	WELD TIME TH					
12	FLOW TIME	0000 000.00	0000 to 3000 000.00 to 300.00	4 6	ms	2
13	DIST INITIAL	+00.000 +000.00 +0.0000 +00.000	-30.000 to +30.000 -300.00 to +300.00 -3.0000 to +3.0000 -30.000 to +30.000	7	mm inch	2 4
14	DIST PULSE1					
15	DIST PULSE2					
16	DIST FINAL					
17	DIST REAL TIME	+00.000 +000.00 +0.0000 +00.000	+00.000 +000.00 +0.0000 +00.000	7	mm inch	2 4

Item code	Item name	Measured value			Unit	
		Display	Range	Length	Display	Length
18	FORCE PEAK	00.00 000.0 0000	00.00 to 99.99 000.0 to 999.9 0000 to 9999	5 5 4	N kgf lbf	1 3 3
19	FORCE AVG1					
20	FORCE AVG2					
21	FORCE INITIAL					
22	FORCE FINAL					
23	FORCE REAL TIME	00.00 000.0 0000	00.00 to 99.99 000.0 to 999.9 0000 to 9999	5 5 4		
24	FORCE TIME	00000	00000 to 30000	5	ms	2
25	EXT PEAK	+0.000 +00.00 +000.0 +0000	-9.999 to +9.999 -99.99 to +99.99 -999.9 to +999.9 -9999 to +9999	6 6 6 5	 V N kgf lbf degC degF Mpa bar psi	0 1 1 3 3 4 4 3 3 3
26	EXT AVE1					
27	EXT AVE2					
28	EXT INITIAL					
29	EXT FINAL					
30	EXT REAL TIME	+0.000 +00.00 +000.0 +0000	-9.999 to +9.999 -99.99 to +99.99 -999.9 to +999.9 -9999 to +9999	6 6 6 5		
31	EXT TIME	00000	00000 to 30000	5	ms	2
32	WELD COUNT	000000	L	6		0
33	GOOD COUNT	000000	000000 to 999999	6		0
34	No setting	-	No measured value	1		0
35	ENVELOPE	-	No measured value	1		0

3) Judgment code table

Code	Judgment	Display	Length
0	No judgment	-	1
1	GOOD	G	
2	NG LOWER	L	
3	NG UPPER	U	
4	OVER	O	
5	NO CURR	C	
6	IMPULS	I	
7	PARITY	P	
8	COUNT UP	-	
9	No judgment	-	

4) Upper/lower limit code table

Item code	Item name	Measured value (*)			Unit (*)
		Display	Range	Length	
00	CURR PEAK	000.000kA__ 0000.00kA__ 00000.0kA__	000.000 to 009.999kA__ 0000.00 to 0099.99kA__ 00000.0 to 00999.9KA__	11	kA__
01	CURR RMS				
02	CURR AVG RMS				
03	VOLT PEAK	0000.00V___ 00000.0V___	0000.00 to 0009.99V___ 00000.0 to 00099.9V___	11	V___
04	VOLT RMS				
05	VOLT AVG RMS				
06	COND ANGLE	-------deg_	-------deg_	11	deg_
07	POWER AVE	0000.00kW__	0000.00 to 0300.00kW__	11	kW
08	RESISTANCE AVE	0000.00mOhm	0000.00 to 0300.00mOhm	11	mOhm
09	WELD TIME	00000.0CYC	00000.0 to 03000.0CYC_ (in 0.5 CYC steps)	11	CYC_
		0000000ms__	0000000 to 0030000ms__		ms__
		0000.00ms__	0000.00 to 0300.00ms__		
10	WELD TIME TP	00000.0ms__	0000.00 to 0300.00ms__	11	ms__
11	WELD TIME TH				
12	FLOW TIME	0000000ms__	0000000 to 0030000ms__	11	ms__
13	DIST INITIAL	+00.000mm__ +000.00mm__ +0.0000inch +00.000inch	-30.000 to +30.000mm__ -300.00 to +300.00mm__ -3.0000 to +3.0000inch -30.000 to +30.000inch	11	mm__
14	DIST PULSE1				
15	DIST PULSE2				
16	DIST FINAL				
17	DIST REAL TIME	-------mm__ -------inch	-------mm__ -------inch		
18	FORCE PEAK	0000.00N___ 00000.0N___ 0000000N___	0000.00 to 0099.99N___ 00000.0 to 00999.9N___ 0000000 to 0009999N___	11	N___ kgf_ lbf_
19	FORCE AVG1				
20	FORCE AVG2				
21	FORCE INITIAL				
22	FORCE FINAL				
23	FORCE REAL TIME	-------N___	-------N___		
24	FORCE TIME	-------ms__	-------ms__	11	ms__
25	EXT PEAK	+00.000degC +000.00degC +0000.0degC +000000degC	-09.999 to +09.999degC -099.99 to +099.99degC -0999.9 to +0999.9degC -009999 to +009999degC	11	____ V___ N___ kgf_ lbf_ degC degF Mpa_ bar_ psi_
26	EXT AVE1				
27	EXT AVE2				
28	EXT INITIAL				
29	EXT FINAL				
30	EXT REAL TIME	----------	----------	11	
31	EXT TIME	-------ms__	-------ms__	11	ms__
32	WELD COUNT	----------	----------	11	

Item code	Item name	Measured value (*)			Unit (*)
		Display	Range	Length	
33	GOOD COUNT	----------	----------	11	
34	No setting	----------	----------	11	
35	ENVELOPE	----------	----------	11	

* A space falls into “_” for digit matching.

5) Envelope upper/lower limit code table

① % SET

Item code	Item name	Measured value (*)			Unit (*)
		Display	Range	Length	
	CURRENT VOLTAGE POWER RESISTANCE DISPLACEMENT FORCE EXTERNAL No setting	+000000%___	-000050 to +000050%___	11	%___

* A space falls into "_" for digit matching.

② VALUE SET

Item code	Item name	Measured value (*)			Unit (*)
		Display	Range	Length	
0	CURRENT	+00.000kA__ +000.00kA__ +0000.0kA__	-09.999 to +09.999kA__ -099.99 to +099.99kA__ -0999.9 to +0999.9kA__	11	kA__
1	VOLTAGE	+000.00V___ +0000.0V___	-009.99 to +009.99V___ -0099.9 to +0099.9V___	11	V___
2	POWER	+000.00kW__	-300.00 to +300.00kW__	11	kW__
3	RESISTANCE	+000.00mOhm	-300.00 to +300.00mOhm	11	mOhm
4	DISPLACEMENT	+00.000mm__ +000.00mm__ +0.0000inch +00.000inch	-30.000 to +30.000mm__ -300.00 to +300.00mm__ -3.0000 to +3.0000inch -30.000 to +30.000inch	11	mm__ inch
5	FORCE	+000.00N___ +0000.0N___ +000000N___	-099.99 to +099.99N___ -0999.9 to +0999.9N___ -009999 to +009999N___	11	N___ kgf_ lbf_
6	EXTERNAL	+00.000degC +000.00degC +0000.0degC +000000degC	-09.999 to +09.999degC -099.99 to +099.99degC -0999.9 to +0999.9degC -009999 to +009999degC	11	____ V___ N___ kgf_ lbf_ degC degF Mpa_ bar_ psi_

* A space falls into "_" for digit matching.

6) External input/output code table

External input 1 to 6 code table

Item code	Item name
0	PARITY
1	PROGRAM PROTECT
2	MEASUREMENT STOP
3	COUNT RESET
4	ERROR RESET
5	MEAS BEFORE WELD
6	DIST 0 RESET
7	FORCE 0 RESET
8	No setting

External input 7 to 8 code table

Item code	Item name
0	DIST TRIGGER
1	FORCE TRIGGER
2	EXTERNAL TRIGGER
3	No setting

External output 1 to 12 code table

Item code	Item name	Item code	Item name	Item code	Item name
0	CURR NG	21	POWER ON	42	FL TIME-U
1	VOLT NG	22	READY	43	FL TIME-L
2	TIME NG	23	DIST LEV1	44	POWER-U
3	TIME TP NG *1 / BK CURR NG *2	24	DIST LEV2	45	POWER-L
4	TIME TH NG *1 / BK VOLT NG *2	25	DIST LEV3	46	RESIST-U
5	FL TIME NG	26	FORCE LEV1	47	RESIST-L
6	POWER NG	27	FORCE LEV2	48	DIST-U
7	RESIST NG	28	FORCE LEV3	49	DIST-L
8	DIST NG	29	EXT LEV1	50	FORCE-U
9	FORCE NG	30	EXT LEV2	51	FORCE-L
10	EXT NG	31	EXT LEV3	52	EXT-U
11	NO CURR	32	CURR-U	53	EXT-L
12	NG	33	CURR-L	54	NG-U
13	GOOD	34	VOLT-U	55	NG-L
14	PREDIST NG	35	VOLT-L	56	PREDIST U
15	PREFORCE NG	36	TIME-U	57	PREDIST L
16	PRE EXT NG	37	TIME-L	58	PREFORCE U
17	PRE GOOD	38	TIME TP-U *1 / BK CURR-U *2	59	PREFORCE L
18	TROUBLE	39	TIME TP-L *1 / BK CURR-L *2	60	PRE EXT U
19	SCH NG	40	TIME TH-U *1 / BK VOLT-U *2	61	PRE EXT L
20	COUNT UP	41	TIME TH-L *1 / BK VOLT-L *2	62	No setting

*1 Item names when NORMAL, NORMAL TRACE or SINGLE TRACE is set for MODE in the SYSTEM SETUP (1) screen. (Refer to Chapter 8, “n-1 SYSTEM SETUP (1) Screen.”)

*2 Item names when SEAM is set for MODE in the SYSTEM SETUP (1) screen. (Refer to Chapter 8, “n-1 SYSTEM SETUP (1) Screen.”)

7) Waveform code table

Item code	Item name	Measured value			Unit	
		Display	Range	Length	Display	Length
0	CURRENT	+0.000 +00.00 +000.0	-9.999 to +9.999 -99.99 to +99.99 -999.9 to +999.9	6	kA	2
1	VOLTAGE	+0.00 +00.0	-9.99 to +9.99 -99.9 to +99.9	5	V	1
2	POWER	000.00	000.00 to 300.00	6	kW	2
3	RESISTANCE	000.00	000.00 to 300.00	6	mOhm	4
4	DISPLACEMENT	+00.000 +000.00 +0.0000 +00.000	-30.000 to +30.000 -300.00 to +300.00 -3.0000 to +3.0000 -30.000 to +30.000	7	mm inch	2 4
5	FORCE	00.00 000.0 00000	00.00 to 99.99 000.0 to 999.9 00000 to 09999	5	N kgf lbf	1 3 3
6	EXTERNAL	+0.000 +00.00 +000.0 +00000	-9.999 to +9.999 -99.99 to +99.99 -999.9 to +999.9 -09999 to +09999	6	 V N kgf lbf degC degF Mpa bar psi	0 1 1 3 3 4 4 3 3 3
7	No setting	-	-	-	-	-

13. Error List and Maintenance

(1) Troubleshooting

The **MM-400A** informs of an error occurrence by showing the error number.

Error code	Description	Cause	Remedy
E01	SYSTEM ERROR	Problem detected in **MM-400A**'s control system	Turn off the power and on again. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E02	FREQUENCY ERROR	A problem was detected in the frequency detection circuit.	Turn off the power and on again. Check if the input power supply in use has disturbance in frequency.
E03	TRIGGER LEVEL ERROR	A problem was detected in the current detection circuit.	Turn off the power and on again. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E04	BATTERY VOLTAGE LOW	The backup battery voltage is 2.2 V or less.	Replace the batteries. Refer to "(2) Replacing the Battery."
E05	SCHEDULE ERROR	Schedule data in memory is damaged.	Check all the settings. If the data in memory is damaged, the following are possible causes: • Generation of powerful power supply or electrostatic noise • Abnormal supply voltage resulting, for example, from lightening or induced lightening • Flash memory's rewrite limit exceeded It would be useful to record the settings in preparation for data damage. To print the settings, use the print function (refer to "n. PRINT Screen" in Chapter 8, "Operation Screens") or Chapter 17 "Schedule Data Table." Also, you can save data in a USB (refer to "i. USB Screen" in Chapter 8, "Operation Screens"). When you touch the INITIAL key and select YES (refer to "n-1. SYSTEM SETUP (1) Screen" in Chapter 8, "Operation Screens"), the memory is initialized, resetting all settings back to factory settings. Set the data you recorded again. The memory will be initialized in approximately 10 seconds. Do not turn OFF the power during the initialization. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.

Error code	Description	Cause	Remedy
E06	ENVELOPE ERROR	Envelope setting data exceeds the settable range.	Check the following when an error occurs in the envelope setting. Check if each envelope setting falls under any of the following four items and make a setting again. • The set time (end - start) exceeds 5000 in each SEGMENT. Ex.) When SAMPLING INTERVAL is 100 µs with start 0 and end 400 ms, the number of data is 400 ÷ 0.1 = 4000, which is normal, but when SAMPLING INTERVAL is 50 µs, the number of data is 400 ÷ 0.05 = 8000 and it exceeds 5000, and therefore the envelope error occurs. • ENVELOPE INTERVAL is shorter than SAMPLING INTERVAL. Ex.) When setting SAMPLING INTERVAL to 100 µs and ENVELOPE INTERVAL to 20 µs or 50 µs, the envelope error occurs. • ENVELOPE INTERVAL cannot be evenly divided by SAMPLING INTERVAL. Ex.) When setting SAMPLING INTERVAL to 20 µs and ENVELOPE INTERVAL to 100 µs, it is normal, but when ENVELOPE INTERVAL is 50 µs, it cannot be divided evenly, and therefore the envelope error occurs. • Settings of START TIME and END TIME are the same. Ex.) When setting START TIME to 5 ms, and END TIME to 5 ms, the setting range becomes 0 ms, and therefore the envelope error occurs.
		Envelope setting data in memory is damaged.	Check the following when an error occurs at power on. Check all the settings. If the data in memory is damaged, the following are possible causes: • Generation of powerful power supply or electrostatic noise • Abnormal supply voltage resulting, for example, from lightening or induced lightening It is advisable to back-up envelope data in the USB often, as a precaution against possible data corruption. When you touch the INITIAL key and select YES (refer to “n-1. SYSTEM SETUP (1) Screen” in Chapter 8, “Operation Screens”), the memory is initialized, resetting all settings back to factory settings. Read the data you saved. The memory will be initialized in approximately 60 seconds. Do not turn OFF the power during the initialization. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.

Error code	Description	Cause	Remedy
E07	MONITOR MEMORY ERROR	Measured value data in internal memory is damaged.	If the data in internal memory is corrupt, the following are possible causes: • Generation of powerful power supply or electrostatic noise • Abnormal supply voltage resulting, for example, from lightening or induced lightening • Low memory battery voltage It is advisable to back-up measured value data onto other media often, as a precaution against possible data corruption. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E08	CLOCK ERROR	Loss of the hour due to low voltage of the backup current	After replacing the batteries, set the clock again. Refer to “(2) Replacing the Battery.”
E09	INTERNAL COMMUNICATION ERROR	Unable to make communication between internal units.	Turn off the power and on again. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E10	EXTERNAL 24V POWER OVER LOAD	The built-in 24 V DC power, output from the rear terminal, was overloaded.	Turn off the power, and check the I/O connections on the rear. • Check if the 24 V DC power supply is not shorted. • Check if nothing with the large current capacity is connected. Do not use the internal power supply other than for external input/output signals.
E11	FORCE SENSOR ERROR	Unable to set the force offset to 0.	Check the following when an error occurs when performing a zero rest of displacement, changing to the measurement mode, or changing the schedule. • If no force sensor is connected, connect a force sensor or select a setting other than AUTO, FORCE and EXT for TRIGGER in the BASIC SETUP (1) screen (for all 127 schedules). For the force sensor built in a head, the force continues to be applied. • When a zero reset of force sensor is not performed, perform the zero reset of force sensor, referring to “n-2. SYSTEM SETUP (2) Screen” in Chapter 8, “Operation Screens.” For the load cell built in a head, a force is applied in some cases. Perform it without a force applied. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.

Error code	Description	Cause	Remedy
E11	FORCE SENSOR ERROR (continued from previous page)	Setting data of force rest stored in memory is damaged.	Check the following when an error occurs at power on. If the data in memory is damaged, the following are possible causes: • Generation of powerful power supply or electrostatic noise • Abnormal supply voltage resulting, for example, from lightening or induced lightening Perform the zero reset of force sensor, referring to "n-2. SYSTEM SETUP (2) Screen" in Chapter 8, "Operation Screens." For the load cell built in a head, a force is applied in some cases. Perform it without a force applied. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E13	PRINTER ERROR	A problem was detected in the printer.	Check the printer for paper. If the printer is out of paper, load new paper. If the printer paper cover is open, close the cover.
E14	USB ERROR	The USB writing cannot keep up with the measurement.	When MEASUREMENT is selected for ITEM: • USB writing for measurement is not in time. When the USB write buffer (4000) is exceeded, an error occurs. Check the measurement interval. When the USB write delay occurs, replace the USB.
		Data to be read from the USB is abnormal.	When SCHEDULE is selected for ITEM: • The setting value of schedule data to be read exceeds the setting range. • Among CSV files of schedule data to be read, any one of these are lacking (refer to "i. USB screen (9) FILE NO" in Chapter 8, "Operation Screens"). • The decimal point of schedule data to be read is different from the setting. When ENVELOPE is selected for ITEM: • The specified folder or the CSV file does not exist in the USB. • The envelope data to be read is not as specified. • The decimal point of envelope data to be read is different from the setting.
		Unable to read from or write in the USB.	The following are possible causes: • Reading or writing without inserting a USB • Use of unsupported USB (refer to "i. USB Screen in Chapter 8, "Operation Screens" About the USB memory). Confirm the USB.

Error code	Description	Cause	Remedy
E15	INTERNAL MEMORY ERROR	Measured value data in memory is damaged.	If the data in memory is corrupt, the following are possible causes: • Generation of powerful power supply or electrostatic noise • Abnormal supply voltage resulting, for example, from lightening or induced lightening It is advisable to back-up measured value data onto other media often, as a precaution against possible data corruption. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
		The limit of the writing data quantity in the flash memory (120 waveforms or all cycles in total) has exceeded.	Save the loaded data of “q. INTERNAL MEMORY Screen in Chapter 8, “Operation Screens” in the USB and perform the ALL DEL function.
E17	CURRENT TRIGGER ERROR	The current signal continues to be detected.	If, after measurement, the current trigger continues to be applied, bring the current trigger down below the trigger level after measurement. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E18	VOLTAGE TRIGGER ERROR	The voltage signal continues to be detected.	If, after measurement, the voltage trigger continues to be applied, bring the voltage trigger down below the trigger level after measurement. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E19	FORCE TRIGGER ERROR	After measurement, the force input signal remains above the trigger levels.	If, after measurement, force continues to be applied, bring the force down below the trigger level after measurement. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E20	EXTERNAL TRIGGER ERROR	After measurement, the external input (±10 V voltage or 4 to 20 mA current) signal remains above the trigger levels.	If, after measurement, external input continues to be supplied, bring the external input down below the trigger level after measurement. However, for 4 to 20 mA current input, an error occurs even with 0 mA or 4 mA or less. Therefore, it is required to input at least 4 mA. Adjust the current level to keep 4 mA to trigger level or less. If the error is not eliminated, the **MM-400A** needs repair. Please contact us.
E22	COMMUNICATION ERROR	The communication output cannot keep up with the measurement.	When MEASUREMENT is selected for ITEM: • Communication for measurement is not in time. When the communication output buffer (4000) is exceeded, an error occurs. Check the measurement interval and the communication speed.

Judgment display		Description
MEASUREMENT screen	**HISTORY screen**	
GOOD	G	Measured value is between the upper and lower limits set in the COMPARATOR screen.
NG UPPER	U	Measured value is greater than the upper limit set in the COMPARATOR screen.
NG LOWER	L	Measured value is smaller than the lower limit set in the COMPARATOR screen.
NO CURR	C	Input must be fed to the NO CURR signal if you wish to use the lack of current judgment feature in the event of lack of welding current (if lack of current flow is detected). (Refer to Chapter 10, “(2) Description of the External I/O Signals.”)
OVER	O	Measured value is outside the measurable range. Check the range for each item. Check also whether the welding power supply is operating properly.
PULSE NG	I	Current flow stopped before the set number of stages was reached during impulse measurement. Check the impulse settings. Check also whether the welding power supply is operating properly.
PARITYNG	P	The total number of schedule selection and parity signals closed is not odd. Select the parity signal and close the schedule selection and parity signals so that the total number of closed signals is odd. This error occurs if you have selected ON for the parity terminal in the EXT INPUT/OUTPUT (4) screen.
COUNT UP	None	Count exceeds the preset value. Check the preset counter or reset the count.

(2) Replacing the Battery

The **MM-400A** incorporates a lithium battery for memory backup.

The life expectancy of the lithium battery is five years. Five years after you purchase this product or if BATTERY VOLTAGE falls down to “2.2V” in “n-2. SETUP SYSTEM (2) Screen”, replace the battery according to the following procedure.

WARNING

- When replacing the lithium battery, be sure to turn off the main power in order to prevent electric shock.
- When the battery is replaced, the stored data is lost. Accordingly, record the data before replacing the battery.

a. Necessary items

- Non-conductive tool having dull tip like a plastic screwdriver (to lift up the battery)
- Non-conductive gloves (made of latex, etc.)

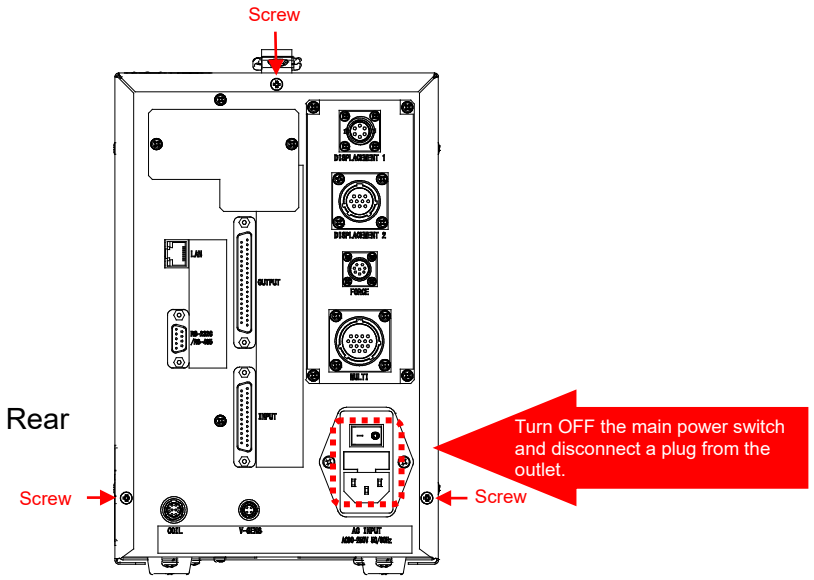
b. Maintenance parts

Item	Model No.
Manganese dioxide lithium battery	CR 2450

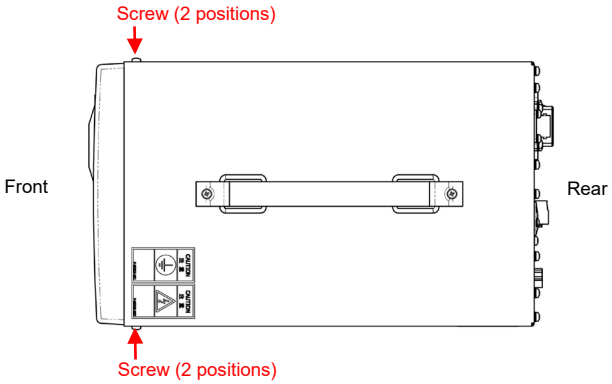
c. Replacement procedure

1) Wear non-conductive gloves on both hands.

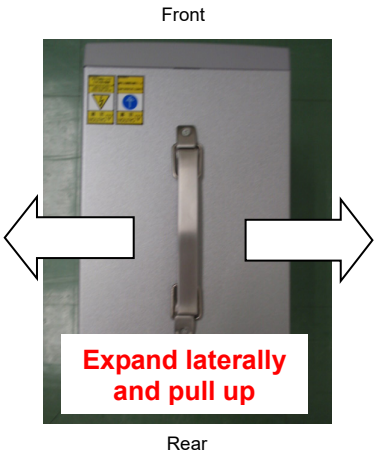
2) Turn OFF the main power switch and be sure to disconnect a plug from the outlet.

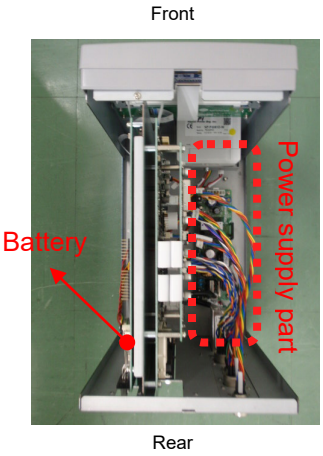


3) After one minute from turning OFF the power switch and disconnecting a plug from the outlet, remove seven screws on the rear and sides of the **MM-400A** with a Phillips screwdriver.

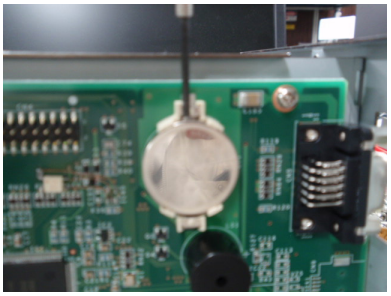


4) Expand the sheet metal cover laterally and pull it upward to remove it.





5) Lift up an old battery with a non-conductive tool having dull tip like a plastic screwdriver to replace it with a new one not to touch the power supply part.



6) When inserting a new battery, insert it in the battery holder with its positive (+) side facing up.

7) Expand and insert the cover and mount it on the body.

8) Tighten seven screws with 0.63 N·m of general torque.

9) Turn the power on.

10) Start the equipment. When “E04: BATTERY VOLTAGE LOW” appears, press the [RESET] button. Confirm that the battery error disappears and set a schedule again to return to a normal use.

ATTENTION

Lithium batteries contain hazardous substances. At the time of disposal, observe the local laws and regulations.

(3) Replacing the Fuse

A fuse will be broken in case of the occurrence of the exceeding the rated voltage (applying overvoltage). If a fuse is broken, replace it according to the following procedure.

WARNING

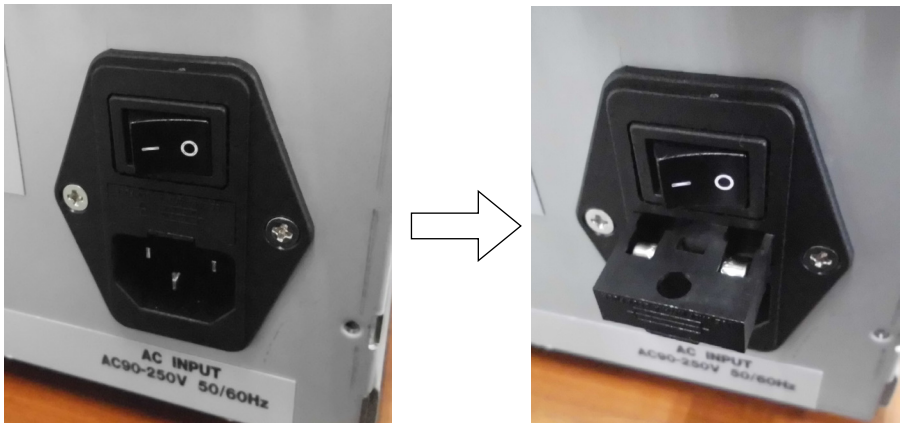
When replacing the fuse, be sure to disconnect the power cable.

a. Maintenance parts

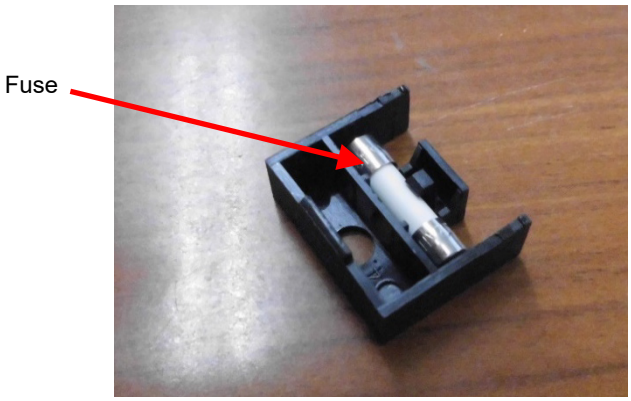
Item	Model No.
Time lag fuse (2 A)	0215002.MXP

b. Replacement procedure

1) Pull out the red fuse box from the AC inlet.



2) Remove the broken fuse.
Install a new fuse at the position where the old fuse has been removed.



14. Specifications

(1) Measurement Specification

Target	Specification	
Current	Measurement range	1x sensitivity coil 2.000 kA range: 0.100 to 2.000 kA 6.00 kA range: 0.30 to 6.00 kA 20.00 kA range: 1.00 to 20.00 kA 60.0 kA range: 3.0 to 60.0 kA 200.0 kA range: 10.0 to 200.0 kA 10x sensitivity coil 0.200 kA range: 0.010 to 0.200 kA 0.600 kA range: 0.030 to 0.600 kA 2.000 kA range: 0.100 to 2.000 kA 6.00 kA range: 0.30 to 6.00 kA 20.00 kA range: 01.00 to 20.00 kA
	Measurement time	ms-AC: 1 to 5000 ms CYC-AC: 0.5 to 250.0 CYC (50 Hz), 0.5 to 300.0 CYC (60 Hz) CYC-***Hz-AC: 0.5 to 200.0 CYC (M050: 50 Hz), 0.5 to 300.0 CYC (M063: 63 Hz), 0.5 to 2000.0 CYC (M500: 500 Hz) LONG CYC-AC: 0.5 to 500.0 CYC (50 Hz), 0.5 to 600.0 CYC (60 Hz) CYC-DC: 0.5 to 100.0 CYC (50 Hz), 0.5 to 120.0 CYC (60 Hz) ms-DC: 1 to 2000 ms SHORT ms-DC: 0.50 to 300.00 ms (0.05-ms increment)
	Measurement item	Maximum value (peak value) within the current flow time or RMS in the interval from the start to end of the measurement RMS depending on the measurement mode CYC mode: Arithmetic mean RMS every half-cycle (original mode) RMS of all measurement range (ISO mode) ms mode: Arithmetic mean RMS every 1 ms (original mode) RMS of all measurement range (ISO mode) ms-SHORT mode: RMS in the interval from the start to end of the measurement

Target	Specification		
Current	Measurement accuracy	MM-400A: ± 1% of full scale (excluding sensor error) Conduction angle: ± 9 degrees MB-400M/800M: ± 1% of full scale (for measurement up to 20 kA of the RMS current)	
	Detection method	Toroidal coil MB-800K, MB-400K (Conventional 1x sensitivity coil) MB-45F (10x sensitivity coil) MB-800M, MB-400M (Recommended: ISO17657-compliant)	
Voltage	Measurement range	6.00 V range: 0.30 to 6.00 V 20.0 V range: 1.0 to 20.0 V	
	Measurement item	Maximum value (peak value) within the current flow time or RMS in the interval from the start to end of the measurement RMS depending on the measurement mode CYC mode: Arithmetic mean RMS every half-cycle (original mode) RMS of all measurement range (ISO mode) ms mode: Arithmetic mean RMS every 1 ms (original mode) RMS of all measurement range (ISO mode) ms-SHORT mode: RMS in the interval from the start to end of the measurement	
	Measurement accuracy	± 1% of full scale (excluding sensor error)	
Force[*1]	Measurement range	MA-520B	4.90 to 98.06 N, 0.50 to 10.00 kgf, 1.10 to 22.04 lbf
		MA-521B	49.0 to 980.6 N, 5.0 to 100.0 kgf, 11.0 to 220.4 lbf
		MA-770A	245 to 4903 N, 25 to 500 kgf, 55 to 1102 lbf
		MA-522B MA-771A	490 to 9806 N, 50 to 1000 kgf, 110 to 2204 lbf
	Measurement time	1 to 10000 ms	
	Measurement item	Mean value/maximum (peak)	
	Measurement accuracy	± 3% of full scale (excluding sensor error)	
	Detection method	Force sensor: MA-520B/521B/522B Current/force sensor: MA-770A/771A	

Target	Specification	
External current / voltage input *1	Input voltage / current range	-10 to +10 V or 4 to 20 mA
	Measurement range	5% to 100% of rated setting
	Measurement time	1 to 1000 ms
	Measurement item	Mean value/maximum (peak)
	Measurement accuracy	± 3% of full scale (excluding sensor error)
Displacement *1	Measurement range	The measurement range changes depending on the SENSOR STEP setting. The measurement range of displacement is ± (SENSOR STEP setting x 30000) μm. (Ex.) When the SENSOR STEP setting is 1 μm: ±30.000 mm When the SENSOR STEP setting is 10 μm: ±300.00 mm
	Measurement item	Starts measurement at the start of current flow and measures the displacement at the end of delay time.
	Measurement accuracy	±30.000 mm range: ±15 μm (sensor with 1 μm or less resolution) ±300.00 mm range: ±150 μm (sensor with 1.1 μm or more resolution)
Conduction angle	Measurement range	0 to 180 degrees
	Measured values	Max. conduction angle over measurement interval
	Measurement accuracy	± 9 degrees
Seam measurement	Measurement time*2	5 minutes
	Measurement item*2	CYC-AC, ms-AC: Current, voltage CYC-DC, ms-DC, SHORT ms-DC: Voltage

Target	Specification
Measured value display	Select ten measured values from the following to display: Peak current RMS current Average RMS current Peak voltage RMS voltage Average RMS voltage Conduction angle Average power Average resistance Weld time Weld time TP Weld time TH Flow time Initial displacement*1 Pulse 1 displacement*1 Pulse 2 displacement*1 Final displacement*1 Peak force*1 Average force 1*1 Average force 2*1 Initial force*1 Final force*1 Real time force*1 Force time*1 Peak external peak*1 Average external 1*1 Average external 2*1 Initial external*1 Final external*1 Real time external*1 External time*1 Weld count Good count

Target	Specification
Waveform display	Select four waveforms from the following to display (The waveform is displayed coarsely since the measurement result is skipped.): Current waveform Voltage waveform Power waveform Resistance waveform Displacement waveform*1 Force waveform*1 External voltage/current input waveform*1
All cycle display	Current, voltage, conduction angle (Conduction angle appears only when CYC-AC, CYC-***Hz-AC or LONG CYC-AC is selected for TIME in the BASIC SETUP (1) screen.) Displays data every half-cycle or 1 ms Force*1 Displays data every 10 ms.
Trigger method	Current trigger Auto trigger*1 Force trigger*1 External voltage/current input trigger*1 Constant trigger Displacement (external) trigger*1 Force (external) trigger*1 External (external) trigger*1
Impulse	Select an option from the following to use (When “00” is selected for PULSE No., a normal measurement is made for SET PULSE and ALL PULSE (SET).): SET PULSE: Measures only specified pulse. ALL PULSE (SET): Measures all specified number of pulses (20 pulses maximum). ALL PULSE (NO SET): Measures when the current flow interval is 500 ms or less. NO COOL (2nd step measurement): Measurement is possible only if the current at the second step is larger than that at the first step.
Judgment function	Upper/lower limit judgment of five measurements selected for measured value display No-current judgment by a current detection when the no-current signal is received from the external input Envelope judgment by the upper/lower limit threshold based on the reference waveform

*1: Force/displacement-equipped specification function

*2: The measurement method is different from that of the normal measurement. Refer to Chapter 8, “r. SEAM WAVEFORM Screen” and “s. SEAM SETUP Screen.”

(2) Specification of the MM-400A

Item		Specifications
Display items		MEASUREMENT screen WAVEFORM screen VIEW screen COMPARATOR screen ENVELOPE screen HISTORY screen PRINT screen USB screen ALL CYCLE screen FORCE TIMING screen BASIC SETUP screen EXTEND SETUP screen SYSTEM SETUP screen EXT INPUT/OUTPUT screen COMMUNICATION screen INTERNAL MEMORY screen
Printer output		Printer is built in.
External data output		RS-232C/RS-485/Ethernet
Number of schedules		127
Rated input voltage		100 to 240 V AC (50/60 Hz) or 24 V DC
Input voltage tolerance		90 to 250 V AC (47 to 63 Hz) or 21.6 to 26.4 V DC
Power consumption		40 W (50 W with printer running)
Input current		0.32 A (0.40 A max. with printer running)
Operating environment*1	Operating ambient temperature	0°C to 45°C
	Operating ambient humidity	10°C to 90%RH (with printer not running) (no condensation) 35°C to 85%RH (with printer running) (no condensation)
	Temperature during transport or storage	-10°C to 55°C
	Humidity during transport or storage	10°C to 90% (no condensation)
	Altitude	1000 m max.
Outer dimensions		266 mm (H) x 172 mm (W) x 288 mm (D) (excluding protrusions)
Mass		Approx. 5 kg (excluding options)
Overvoltage category		II
Case protection		IP20

*1: Use this product in the environment without conductive dust. If conductive dust enters in the product, this may result in a failure, electric shock, or fire. When using this product in this environment, make contact with us.

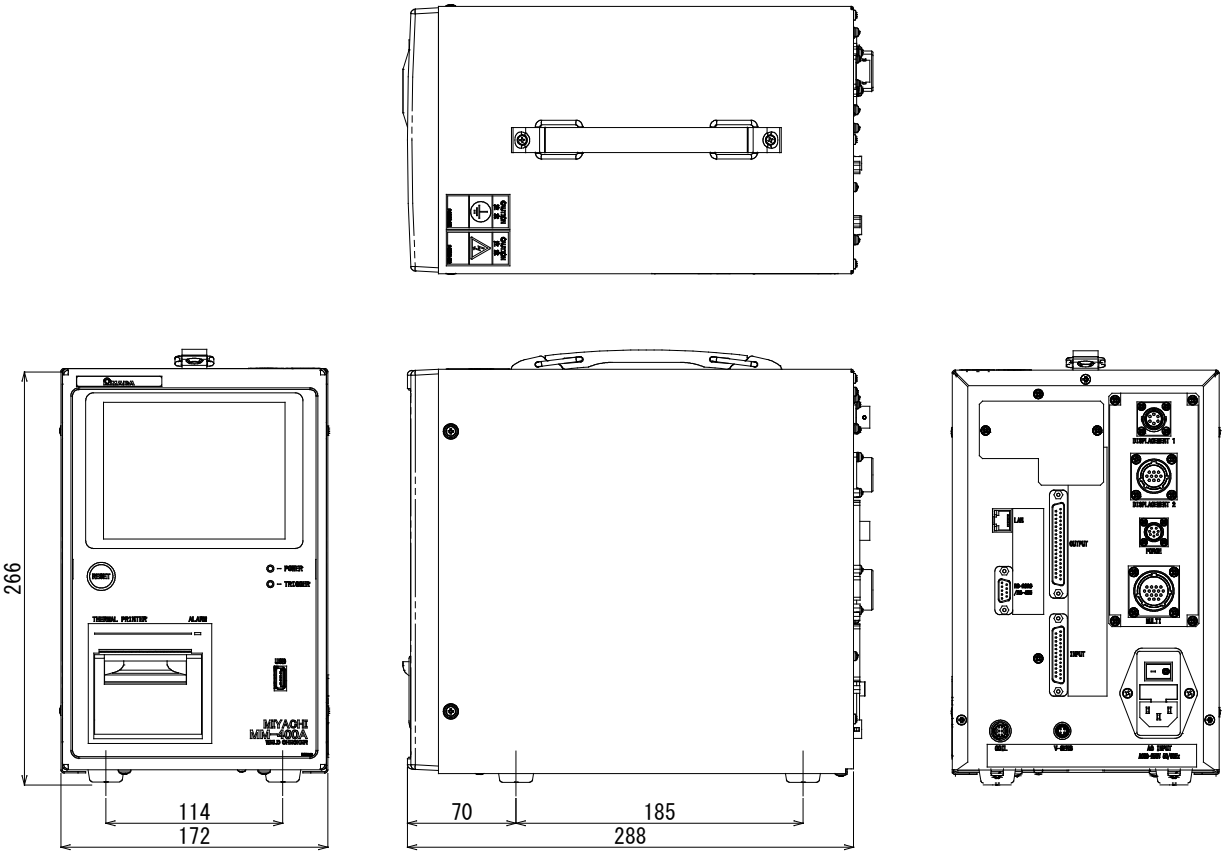
15. Calibration

Regular calibration is required to maintain the **MM-400A** performance.
Calibration is conducted at our facility.
For calibration, please send your toroidal coil, force sensor and displacement sensor together with the **MM-400A**. Depending on the operating environment, the extent of deterioration varies from one **MM-400A** to another. Therefore, the **MM-400A** must be calibrated together with the toroidal coil, the force sensor and the displacement sensor as a set.
For more information about calibration, contact us.

16. Outline Drawing

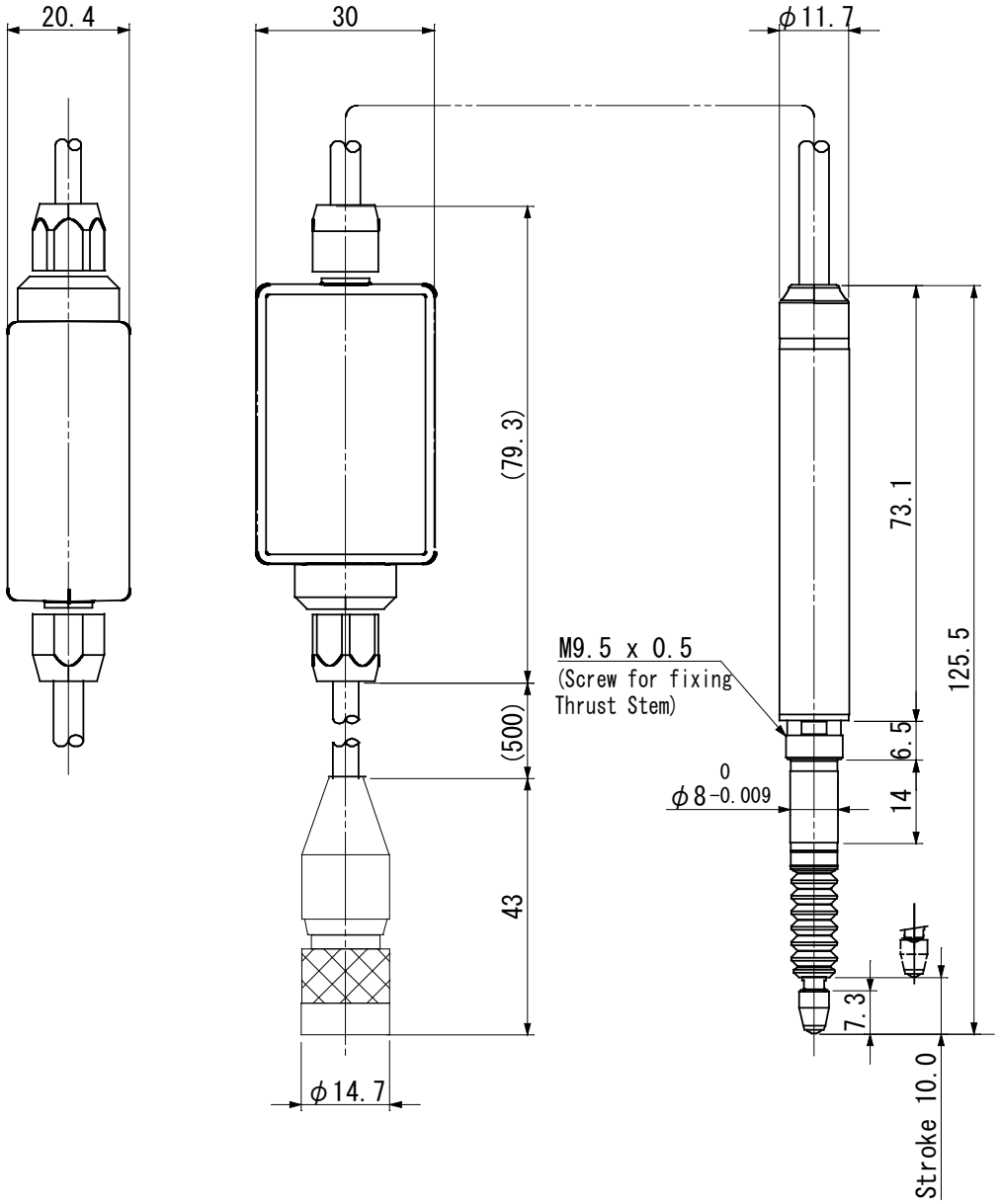
(1) MM-400A

(Dimensions in mm)

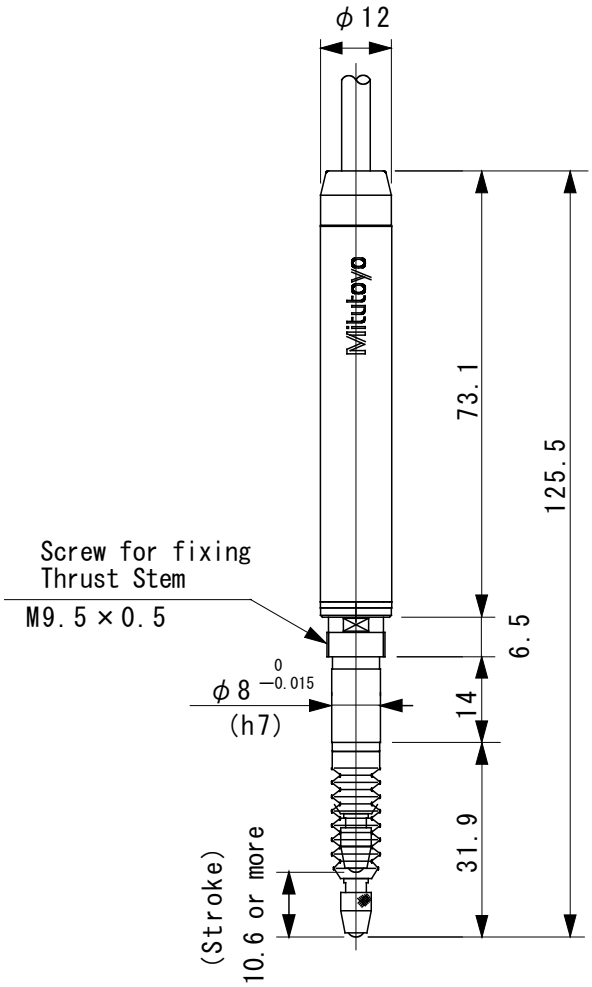


(2) Displacement Sensor

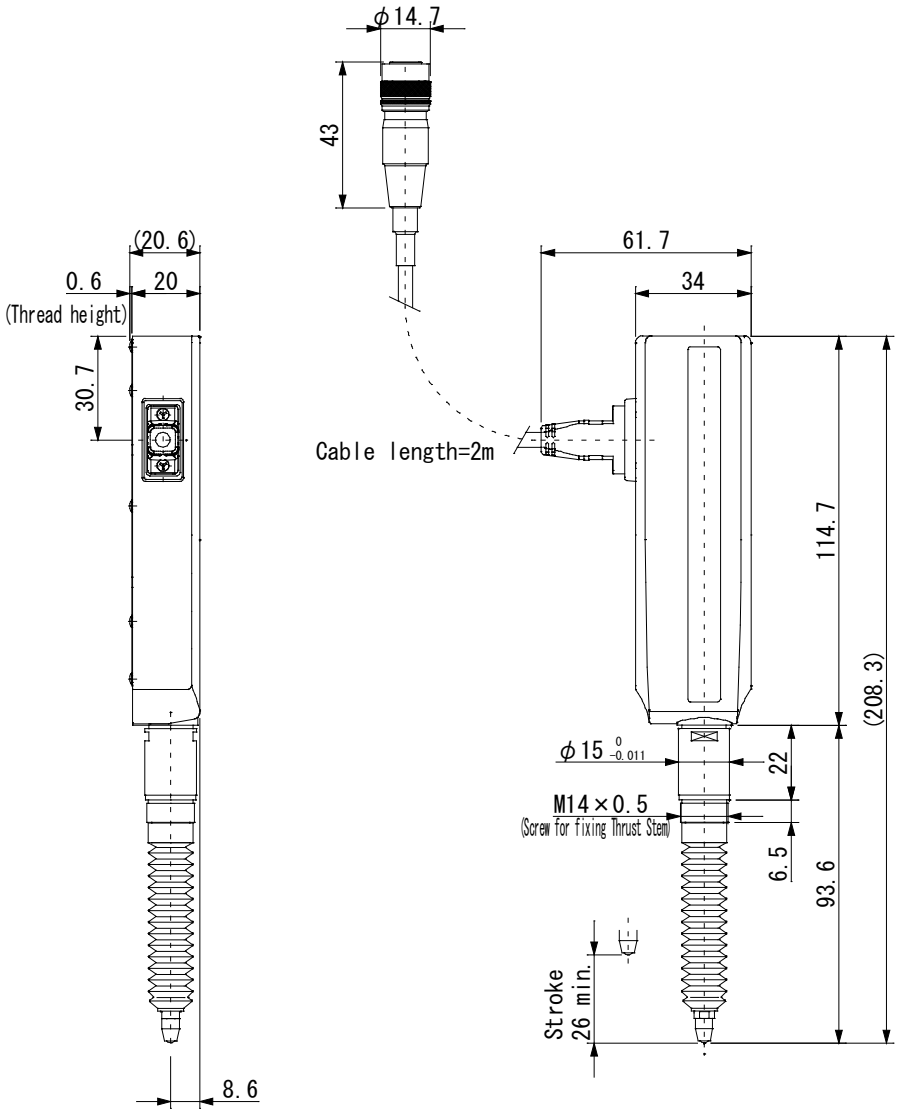
a. **LG200-110** Type, Mitutoyo



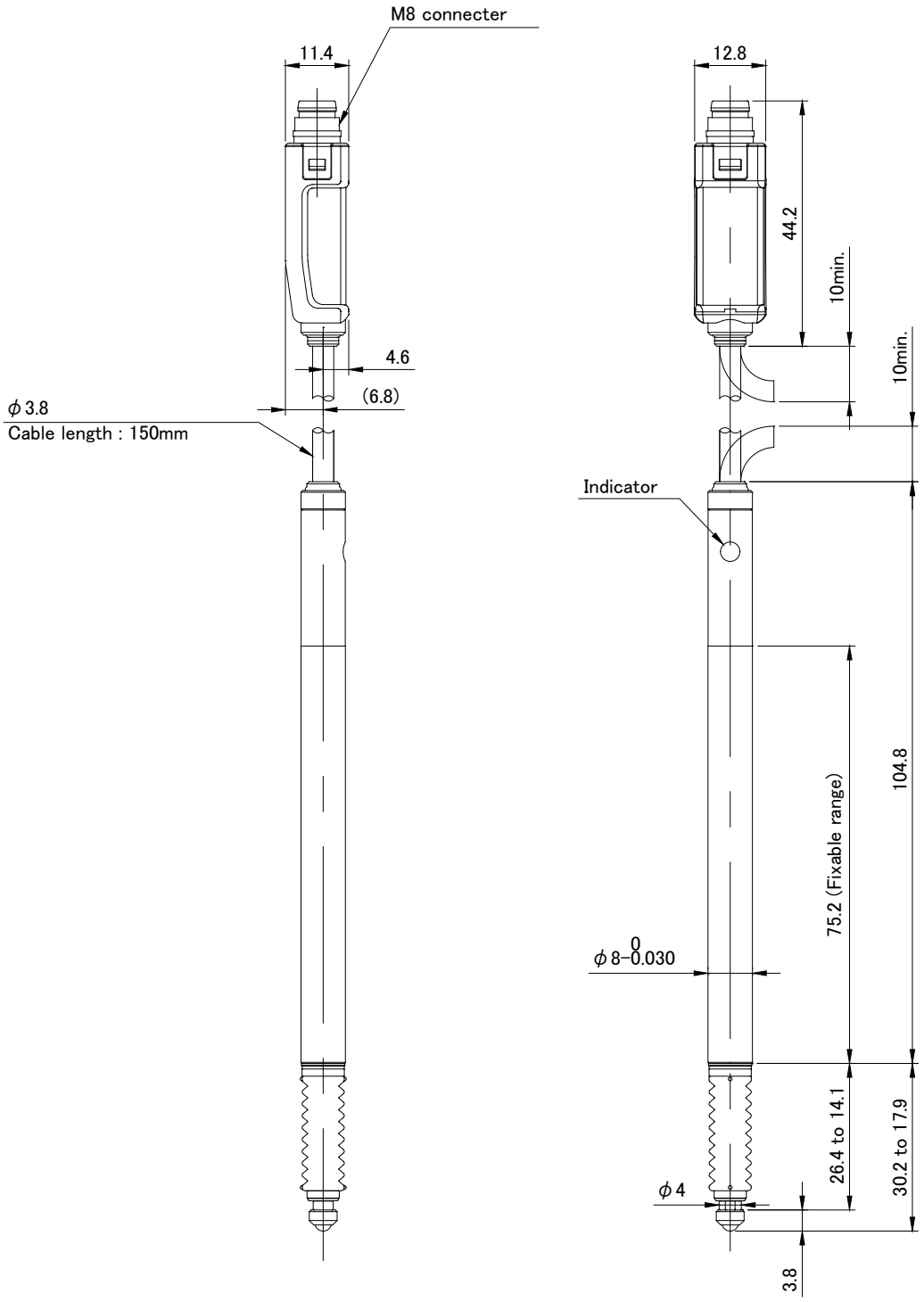
b. **LGK-110** Type, Mitutoyo (Discontinued)



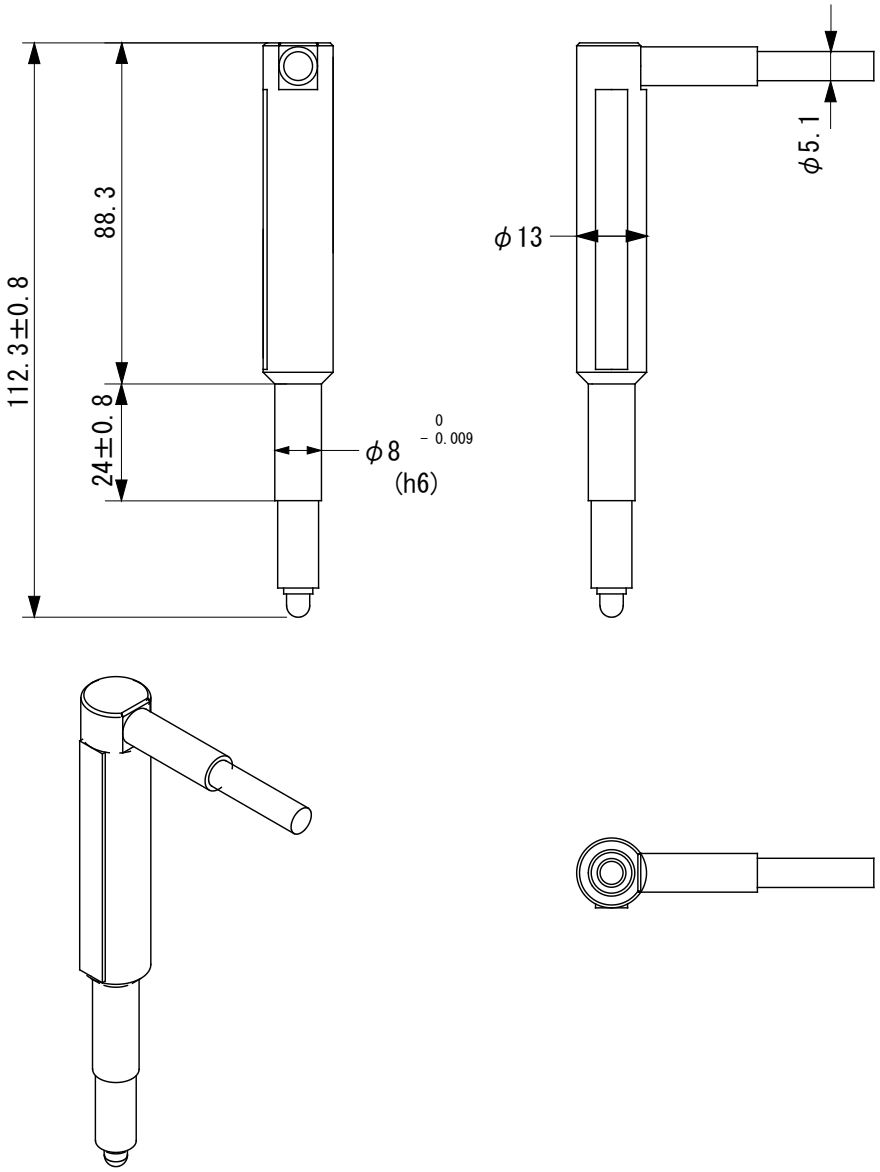
c. **LG100-125** Type, Mitutoyo



d. **GT2-P12** Type, KEYENCE



e. **ST1278** Type, HEIDENHAIN



17. Schedule Data Table

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
BASIC SETUP (1)	SCHEDULE NAME					
	TRIGGER	CURRENT				
	TIME	CYC-AC				
	FREQUENCY (*)	050Hz				
	CURRENT RANGE	20.00kA				
	VOLTAGE RANGE	20.0V				
	START TIME	0000.0CYC				
	END TIME	0300.0CYC				
BASIC SETUP (2)	PULSE MODE	SET PULSE				
	PULSE No.	00				
	COOL TIME	000.5CYC				
	FALL LEVEL (*)	80%				
	MEASUREMENT MIN TIME	01.0CYC				
	MEAS INHIBIT TIME	00.0S				
	END LEVEL	05.0%				
	PULSE 2 TRIG LEVEL (*)	00.00kA				
BASIC SETUP (3)	CURRENT TRIGGER LEVEL	90				
	TOROIDAL COIL	TIMES 1				
	CALCULATION	ORIGINAL				
	CURRENT SENSOR	TOROIDAL COIL				
	SHUNT RESISTOR	50mV/0.5kA				

(Note) (*) is not displayed by default.

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
EXTEND SETUP (1)	OUTPUT LEVEL 1	+00.000mm				
	OUTPUT LEVEL 2	+00.000mm				
	OUTPUT LEVEL 3	+00.000mm				
	FINAL DELAY TIME	00000ms				
	PULSE DELAY TIME 1	0000ms				
	PULSE DELAY TIME 2	0000ms				
	RESET DELAY TIME	0000ms				
EXTEND SETUP (2)	INITIAL MEASUREMENT	CURRENT START				
	MEAS AFTER PULSE	CURRENT START				
	FINAL MEASUREMENT	DELAY TIME				
	PULSE 2 RESET	OFF				
EXTEND SETUP (3)	MEASUREMENT MODE	REFERENCE				
	SENSOR	Mitutoyo				
	SENSOR STEP	01.0um				
	POLARITY	FORWARD				
	UNITS	mm				
	OUTPUT RANGE	32.767				

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
EXTEND SETUP (4)	OUTPUT LEVEL 1	0000N				
	OUTPUT LEVEL 2	0000N				
	OUTPUT LEVEL 3	0000N				
	DELAY TIME	0000ms				
	START TIME 1	00000ms				
	END TIME 1	10000ms				
	START TIME 2	00000ms				
	END TIME 2	10000ms				
	RISE LEVEL	80%				
	FALL LEVEL	80%				
EXTEND SETUP (5)	SENSOR	MA-771				
	SPAN	1000				
	RATED OUTPUT (*)	1.000mV/V				
	RATE (*)	9806N				
	OFFSET	+0000				
	DECIMAL RANGE (*)	****				
	UNITS	N				
	TRIGGER LEVEL	10.0%				
	INITIAL MEASUREMENT	CURRENT START				
EXTEND SETUP (6)	OUTPUT LEVEL 1	0000N				
	OUTPUT LEVEL 2	0000N				
	OUTPUT LEVEL 3	0000N				
	DELAY TIME	0000ms				
	START TIME 1	00000ms				
	END TIME 1	10000ms				
	START TIME 2	00000ms				
	END TIME 2	10000ms				
EXTEND SETUP (7)	INPUT	VOLTAGE				
	RATE	9999				
	DECIMAL RANGE	****				
	UNITS					
	TRIGGER LEVEL	10.0%				
	INITIAL MEASUREMENT	CURRENT START				
SYSTEM SETUP (1)	MODE	NORMAL				
	LANGUAGE	ENGLISH				
	WELD COUNTER PRESET	000000				
	GOOD COUNTER PRESET	000000				
	DATE AND TIME	-				
		-				
	BRIGHTNESS	07				
		OFF				

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
SYSTEM SETUP (2)	CURRENT SAMPLING INTERVAL	200μs				
	CURRENT CONVERSION COEFFICIENT	227.0mV/kA				
	FORCE / EXTERNAL SAMPLING INTERVAL	500μs				

(Note) (*) is not displayed by default.

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
COMPA-RATOR	CURRENT AVERAGE RMS LOWER	00.00kA				
	CURRENT AVERAGE RMS UPPER	99.99kA				
	CURRENT PEAK LOWER	00.00kA				
	CURRENT PEAK UPPER	99.99kA				
	VOLTAGE AVERAGE RMS LOWER	00.0V				
	VOLTAGE AVERAGE RMS UPPER	99.9V				
	VOLTAGE PEAK LOWER	00.0V				
	VOLTAGE PEAK UPPER	99.9V				
	WELD TIME LOWER	0000.0CYC				
	WELD TIME UPPER	3000.0CYC				

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
ENVELOPE (2) ENVELOPE #1	SEGMENT#1					
	ON/OFF	OFF				
	OFFSET UPPER	00.00kA				
	OFFSET LOWER	00.00kA				
	START TIME UPPER	00000ms				
	START TIME LOWER	00000ms				
	END TIME UPPER	00000ms				
	END TIME LOWER	00000ms				
	SEGMENT#2					
	ON/OFF	OFF				
	OFFSET UPPER	00.00kA				
	OFFSET LOWER	00.00kA				
	START TIME UPPER	00000ms				
	START TIME LOWER	00000ms				
	END TIME UPPER	00000ms				
	END TIME LOWER	00000ms				
	SEGMENT#3					
	ON/OFF	OFF				
	OFFSET UPPER	00.00kA				
	OFFSET LOWER	00.00kA				
	START TIME UPPER	00000ms				
	START TIME LOWER	00000ms				
	END TIME UPPER	00000ms				
	END TIME LOWER	00000ms				

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
ENVELOPE (2) ENVELOPE #2	SEGMENT#1					
	ON/OFF	OFF				
	OFFSET UPPER	00.0V				
	OFFSET LOWER	00.0V				
	START TIME UPPER	00000ms				
	START TIME LOWER	00000ms				
	END TIME UPPER	00000ms				
	END TIME LOWER	00000ms				
	SEGMENT#2					
	ON/OFF	OFF				
	OFFSET UPPER	00.0V				
	OFFSET LOWER	00.0V				
	START TIME UPPER	00000ms				
	START TIME LOWER	00000ms				
	END TIME UPPER	00000ms				
	END TIME LOWER	00000ms				
	SEGMENT#3					
	ON/OFF	OFF				
	OFFSET UPPER	00.0V				
	OFFSET LOWER	00.0V				
	START TIME UPPER	00000ms				
	START TIME LOWER	00000ms				
	END TIME UPPER	00000ms				
	END TIME LOWER	00000ms				
ENVE-LOPE (3)	COMPARATOR MODE	VALUE SET				
	ENVELOPE INTERVAL	1000µs				

Setting screen	Setting item	Initial value	Setting value
VIEW	MEASUREMENT 1	CURR AVE RMS	
	MEASUREMENT 2	CURR PEAK	
	MEASUREMENT 3	CURR AVE RMS	
	MEASUREMENT 4	CURR PEAK	
	MEASUREMENT 5	WELD TIME	
	MEASUREMENT 6	-	
	MEASUREMENT 7	-	
	MEASUREMENT 8	-	
	MEASUREMENT 9	-	
	MEASUREMENT 10	-	
	WAVEFORM 1	CURRENT ON	
	WAVEFORM 2	VOLTAGE ON	
	WAVEFORM 3	POWER ON	
	WAVEFORM 4	RESISTANCE ON	

Setting screen	Setting item	Initial value	Setting value
PRINT	ITEM	OFF	
	INTERVAL	0001	
	OUT OF LIMIT OPERATION	OFF	
	HISTORY AREA start (*)	2016.01.01	
	HISTORY AREA end (*)	2077.12.31	
	SCHEDULE AREA start (*)	001	
	SCHEDULE AREA end (*)	127	

Setting screen	Setting item	Initial value	Setting value
USB	ITEM	OFF	
	INTERVAL	0001	
	OUT OF LIMIT OPERATION	OFF	
	WAVE DECIMATION	200us	
	UNITS	OFF	
	DECIMAL POINT RANGE	.	
	HISTORY AREA start (*)	2016.01.01	
	HISTORY AREA end (*)	2077.12.31	
	SCHEDULE AREA start (*)	001	
	SCHEDULE AREA end (*)	127	
	FILE NO (*)	01	

Setting screen	Setting item	Initial value	Setting value
COMMU-NICATION (1)	ITEM	OFF	
	INTERVAL	0001	
	OUT OF LIMIT OPERATION	OFF	
	WAVE DECIMATION	200us	
	UNITS	OFF	
	DECIMAL POINT RANGE	.	
	HISTORY AREA start (*)	2016.01.01	
	HISTORY AREA end (*)	2077.12.31	
	SCHEDULE AREA start (*)	001	
	SCHEDULE AREA end (*)	127	
COMMU-NICATION (2)	MODE	OFF	
		ONE WAY	
	ID NUMBER	01	
	IP ADDRESS (*)	198.168.001.010	
	SUBNET MASK (*)	255.255.255.000	
	DEFAULT GATEWAY (*)	198.168.001.100	
	PORT NUMBER (*)	1024	

(Note) (*) is not displayed by default.

Setting screen	Setting item	Initial value	Setting value
EXT INPUT/ OUTPUT (1)	INPUT 1	PARITY	
	INPUT 2	PROGRAM PROTECT	
	INPUT 3	MEASUREMENT STOP	
	INPUT 4	COUNT RESET	
	INPUT 5	ERROR RESET	
	INPUT 6		
	INPUT 7	DIST TRIGGER	
	INPUT 8	FORCE TRIGGER	
EXT INPUT/ OUTPUT (2)	OUTPUT 1	CURR NG	
	OUTPUT 2	VOLT NG	
	OUTPUT 3	TIME NG	
	OUTPUT 4	GOOD	
	OUTPUT 5	NO CURR	
	OUTPUT 6	COUNT UP	
	OUTPUT 7	TROUBLE	
	OUTPUT 8	DIST LEV1	
	OUTPUT 9	DIST LEV2	
	OUTPUT 10	FORCE LEV1	
	OUTPUT 11	FORCE LEV2	
	OUTPUT 12		
EXT INPUT/ OUTPUT (3)	PARITY	OFF	
	INPUT DEBOUNCE TIME	10ms	
	NG OUTPUT MODE	NORMALLY CLOSED	
	OUTPUT TIME	10ms	
	OUTPUT LEVEL	OUTPUT LEVEL	

Setting screen	Setting item	Initial value	Setting value
INTERNAL MEMORY	ITEM	OFF	
	INTERVAL	0001	
	OUT OF LIMIT OPERATION	OFF	
	WAVE DECIMATION	200us	

Setting screen	Setting item	Initial value	SCH	SCH	SCH	SCH
SEAM SETUP (1)	SCHEDULE NAME					
	START MEASUREMENT	000.0CYC				
	MEASUREMENT RANGE	0.5CYC				
	MEASUREMENT INTERVAL	00.5CYC				
	START TIME 1	00000.0CYC				
	END TIME 1	15000.0CYC				
	START TIME 2	00000.0CYC				
	END TIME 2	15000.0CYC				
	START TIME 3	00000.0CYC				
	END TIME 3	15000.0CYC				
SEAM SETUP (2)	CURRENT 1 LOWER	00.00kA				
	CURRENT 1 UPPER	99.99kA				
	CURRENT 2 LOWER	00.00kA				
	CURRENT 2 UPPER	99.99kA				
	CURRENT 3 LOWER	00.00kA				
	CURRENT 3 UPPER	99.99kA				
	VOLTAGE 1 LOWER	00.0V				
	VOLTAGE 1 UPPER	99.9V				
	VOLTAGE 2 LOWER	00.0V				
	VOLTAGE 2 UPPER	99.9V				
	VOLTAGE 3 LOWER	00.0V				
	VOLTAGE 3 UPPER	99.9V				
SEAM SETUP (3)	TRIGGER	CURRENT				
	TIME	CYC-AC				
	CALCULATION	ORIGINAL				
	CURRENT RANGE	20.00kA				
	VOLTAGE RANGE	20.0V				
	CURRENT TRIGGER LEVEL	90				
	TOROIDAL COIL	TIMES 1				
	END LEVEL	05.0%				

Index

CE

AMADA WELD TECH CO., LTD.

EU Declaration of Conformity

The company/manufacturer: **AMADA WELD TECH CO., LTD.**
95-3, Futatsuka, Noda-City, 278-0016 JAPAN

Herewith declares in his own sole responsibility conformity of the product

Designation: **Weld Checker**
Types/Serial Number, etc.: **MM-400A-00-00 / MM-400A-00-01**

With applicable regulations below

EC Directive:

Low Voltage Directive 2014/35/EU
EMC Directive 2014/30/EU
RoHS Directive 2011/65/EU , (EU)2015 / 863

Harmonized European/International Standards applied:
ISO 12100 : 2010 , ISO 13849-1 : 2015 , ISO 61010-1 : 2010+A1 : 2016
IEC 61326-1 : 2020
ISO 17651-1 : 2005 , ISO 17651-2 : 2005 , ISO 17651-3 : 2005 , ISO 17651-4 : 2005 ,
ISO 17651-4 : 2005 , ISO 17651-5 : 2005
ISO17651 for only in combination with MB-400A/800M

Importer Distributor in EU:
(please place distributor/importer stamp here)

AMADA WELD TECH GmbH
Lindberghstrasse 1, D-82178 Puchheim, GERMANY
Tel: + 49 8983 9403 - 0

Division:

2021. 5. 18

Noda-City/Japan 2021-05-18
Place and Date

AMADA WELD TECH CO., LTD.

T. Jingu

Toshiaki Jingu / Quality guarantee general manager
Name/Signature/Position

Note: This Declaration certifies conformity with the above mentioned Directive(s), but gives no assurances of properties within the meaning of the Law concerning product liability and ProdSGSG. It becomes invalid if any technical or other modification are carried out without manufacturers consent.

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