ULVAC

ULVAC, Inc.

SK00-3780-AI-102-05

SPUTTER ION PUMP CONTROL

MODEL GST-07L-B

INSTRUCTION MANUAL

Read this manual carefully before operation and keep it at hand for immediate reference.

ULVAC, Inc.

Before use

First of all, thank you very much for purchasing ULVAC's product.
Please read this book thoroughly for safe and proper use of this product.

Warning
● **This instruction manual describes important matters for safety handling of this product.** ● **Before operating this product, read this book thoroughly.** ● **Keep this instruction manual in a safe place at hand for persistent reference.** ● **Please contact sales or technical personnel of ULVAC if you damage or lose this instruction manual.** ● **Please contact sales or technical personnel of ULVAC if you have any questions or inquires about the matters not described in this instruction manual.**

About Safety Notation

In this manual and warning signs on the machine, signal words and symbol marks are displayed in order for you to understand the matters adhere. The meanings are shown below:

▸Meaning of signal words:

The terms that signify the warning level for safety are referred to as "signal words."

Warning	**This safety symbol indicates the possibility that improper handling will result in serious injury or loss of life.**
Caution	**This safety symbol indicates the possibility that improper handling may result in serious injury which has a risk of developing disability and property damage.**

▸Meaning of symbol marks:

	Signifies potential danger of electric shock.
	Signifies potential danger for injury on human body.
	Indicates that a ground connection is required.
	Signifies that the instruction manual must be referred to.

Safety precautions

Please be sure to read this instruction manual and safety precautions below for safe use of the ion pump control, GTS-07L (hereinafter called this unit).

Warning	**Power shutdown** **If this unit is damaged, shut down the power immediately.** **The continued use of damaged unit may cause a fire or an electrical shock.** **If you need repair service, contact the vendor, ULVAC, or service center listed in this instruction manual for safety.**
Warning	**Power shutdown** **If this unit generates abnormal heat, smoke or odor, shut down the power immediately.** **The continued use of this unit with any of the abnormal conditions above may cause a fire or an electrical shock. If you need repair service, contact the vendor, ULVAC, or service center listed in this instruction manual for safety.**
Warning	**Power shutdown** **Be sure to turn off the power supply of this unit before touching a high-voltage connector on the rear panel, before starting the work that touching the high-voltage connector may be required, and before opening the top panel to change the DIP switch setting inside the power supply.**
Warning	**Earth ground** **Be sure to ground the earth of the equipment installed to this unit.** **Be sure to ground the earth of the ion pump installed to this unit.**
Caution	**Disassembly** **Do not disassemble this unit.**
Caution	**Modification** **Do not modificate this unit. If you modificate this unit, performance is not guaranteed. Modification of this unit may cause a fire or an electrical shock.**
Caution	**Ambient operating conditions** **This unit uses high voltage. Do not disconnect the connector immediately after high-voltage operation power is turned OFF. High-voltage power may be charged. Disconnect the connector approx. one minute after the operation power is turned OFF.**
Caution	**Ambient operating conditions** **Keep liquids away from this unit. Liquids cause failure, earth leakage or fire.**
Caution	**Foreign object** **If foreign object such as metal or flammable item is admitted into the unit from the opening, be sure to remove it. Keep objects away from the connecting terminals on the front and rear panels of this unit. Using this unit with the object touched to the connecting terminal may damage the unit.**

Caution	**Apply voltage check** **Before starting up this unit, confirm that operation voltage of this unit is consistant with the supply voltage. Applying voltltage other than operation voltage to this unit causes trouble such as abnormal discharge or breakdown.**

Caution	**Ventilation** **Do not block the fan and air hole of this unit. Blocking the fan and air hole retains the heat inside the power supply, which may damage the unit.**

Caution	**Turning on AC input** **Before turning on the POWER ON breaker on the rear panel again after it is turned OFF, wait for approx. five sec to prevent CPU malfunction.**

Caution	**Wiring check** **Keep the connecting cables from coming in contact with the other conductor sections.**

Caution	**Operating conditions** **Use this unit under the conditions specified in the specification.**

Caution	**Transportation package** **When transporting this unit, reset the unit to the factory default.** **Transportation without resetting to the factory default may damage the unit.**

Caution	**Disposal** **When disposing this unit, follow the regulation of local governments.**

Types and display position on warning labels.

A warning labels is attached onto a warning location on the machine. Never fail to check these labels before operating machine.

Type and explanation on warning labels

	Before using the machine, carefully read through the instruction manual until understanding the details sufficiently.
	Parts with warning label have a risk of electrical shock. Turn off the primary power supply before starting wiring or maintenance.
	Attention display. Please check the warning mark on the display.
	Be sure to ground the earth of the equipment installed to this unit.

Warning Label display position

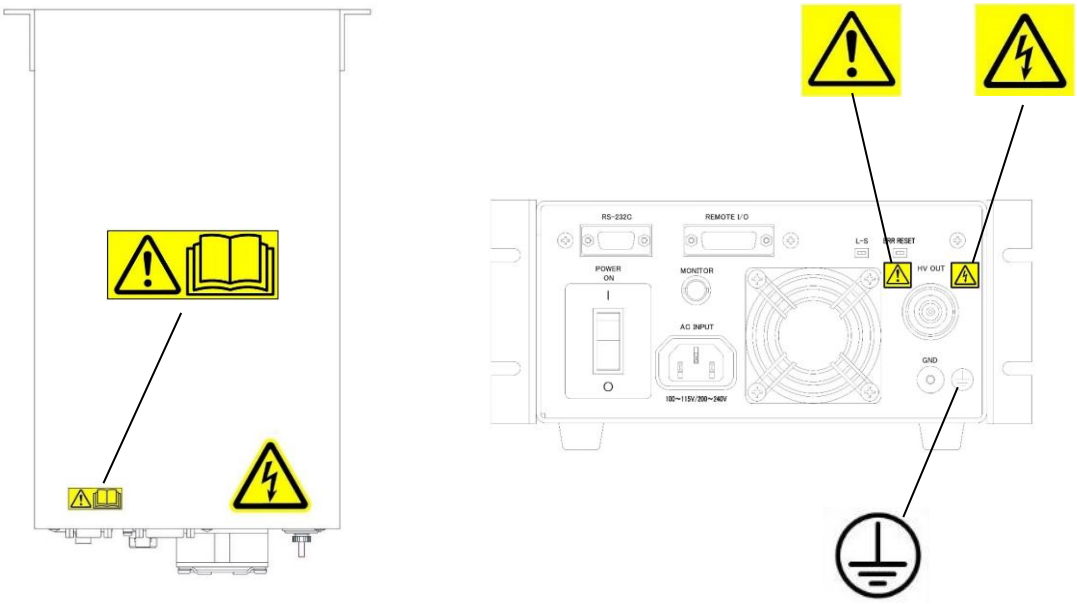

Fig.1 GST-07L-B Warning Label display position

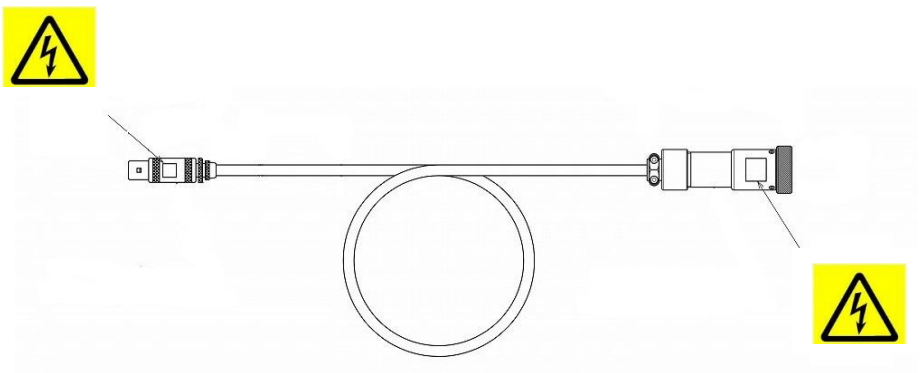

Fig.2 High voltage output cable Warning Label display position

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1. General Description

The sputter ion pump control, GST-07L is a DC high-voltage output power supply dedicated to the ULVAC sputter ion pumps, which can be operated in a high or ultra-high vacuum region of 10^{-2} to 10^{-4} Pa or lower.

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1.1 Features

(1) Light weight
The main unit weighs approx. 4 kg, approx. 60% reduction in weight as compared with the conventional GST series.
(Compared with our GST-03L)

(2) Multi-function enabled by CPU
This controller permits control of all sputter ion pumps (PST series).
Discharge current/pressure set value 0.01 to 99.99 A/Pa selectable at will
Startup timer can be set at will from 1 to 255 minutes

(3) Safety features
This controller comes with a function to prevent the erroneous operation of the operation panel switch.
As protective interlock function, error display on 7-segment LEDs is provided.
Holding function permits automatic restoration in case of power failure.

(4) Primary-side input voltage variable feature
Input voltage is selected from 90 to 126 VAC 50/60 Hz or 180 to 260 VAC 50/60 Hz.
(Input voltage is changed by the DIP switch inside the power supply.)

(5) Communicating function
Remote operation and automated operation are available by the external communication control function. (Remote control function and RS-232C communicating function are provided as standard.)
Also two pressure set points (discharge current converted Pa display) can be set.

(6) Compatible with XHV
Pump cell contamination can be reduced to the absolute minimum by the automatic start circuit and soft start functions. (Patent No. 1340297)

(7) Output cable with excellent electrical characteristics
Fluorocarbon resin (PFA resin) high-voltage cables with excellent resistance to the heat and cold and superb electrical characteristics are used.

1.2 Configuration

If you find any part damaged or missing part, contact your local ULVAC sales office or representative.

Standard Equipment Configuration

GST-07L main unit		1 pc
Remote connector	D-sub 15-pin male connector 1-5 Interlock connected	1 pc
Instruction manual		1 pc

Power supply cords: Select accessories

Safety standard／countries	Allowable voltage／ Allowable current	Length	Socket type	Plug type
JIS／Japan (PSE)	AC250V／12A	3m	C13	For AC125V A type
UL／America ,CSA／Canada	AC125V／ 7A	3m	C13	A type
VDE／German ,FIMCO／Finland, CEBEC／Belgium ,SEMKO／Sweden, NEMCO／Norway ,NEMA／America	AC250V／10A	3m	C13	CEE7 Angle type
GB／China (CCC)	AC250V／10A	3m	C13	GB type
KS／Korea	AC250V／ 7A	3m	C13	K type

※Use the power supply cord which is certify in the usage country.
Please select the input cable that matched with the power rating of the system device.

Optional Parts

High voltage output cable	The cable length is prepared from 5m. Every plus 5m length can prepare, Max 65m

1.3 Specifications

Electrical specifications

Item		Specifications
Input specifications	Input rated voltage	AC100V～115V±10% AC200V～240V±10%
	Phase, frequency	Single phase 50/60Hz
	Input capacity	AC100V 3.0A or lower AC200V 1.5A or lower
	Leakage current	6mA or lower
	Input voltage reshuffling	Manual (Operation with the power supply inside DIP switch)
Output specifications	Rated voltage	DC7.5KV
	Rated current	DC30mA or lower
	Output polarity	Positive polarity
	Output properties	Constant voltage characteristic

Function specifications

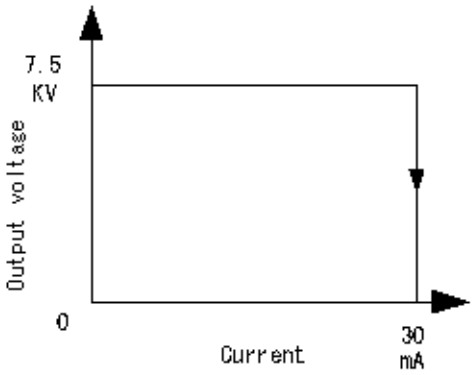
Item	Specifications	
Display system	Digital display (7-segment LEDs)	
Indication contents	Output current indication range	1μA to 30mA Automatic selection of two ranges: mA , μA
	Output voltage indication range	0.0 to 7.5 kV DC
	Pressure indication range	Pa 1E-2 to 1E-8 Pa mbar 1E-4 to 1E-10 mbar
Pressure set point	2 points	
Protective function	Error display/various protective functions are provided. High voltage (HV) output shuts down Err 0 to 8 light.	
Restoration after power failure	Automatic restoration after power failure is available when the HV-ON switch is ON.	
External control function	Equipped with various input/output functions. (REMOTE connector is provided) (Remote control and RS-232C communication control provided).	
Monitor terminal	Output of signals proportionate to 7-segment panel display. 0 to 10 V DC full scale for each range. Allowable load impedance 100 kΩ or more.	

Other specifications

Item	Specifications
Cooling method	Forced air cooling
Exterior dimensions	200mm wide x 99mm high x 370mm deep (excluding rack mounting fixtures)
Weight	4.0kg
Usage temperature	10～40℃
Humidity	Less than 85% (no dew condensation)
Operational altitude	Max 2000m
Overvoltage category	Category Ⅱ
Pollution degree	Pollution degree 2
Applicable standard	EN61326-1:2013 (EN 55011:2009 +A1:2010,Group 1,Class A, Industrial Electromagnetic Environment) IEC61010-1:2010(Third Edition)+AMD1:2016 EN61010-1:2010+A1:2019 UL61010-1:2012 R7.19 CAN/CSA-C22.2 No.61010-1-12

2. Principles of Operation

The GST-07L changes AC input power of 90 to 126 VAC and 180 to 260 VAC to AC input power of 90 to 126 VAC using an auto select switch and obtains DC power with a full-wave rectifying circuit/smoothing circuit.
Maximum 7.5 kV high voltage and maximum 30 mA output can be obtained through a resonance type switching converter circuit, a 4-stage high voltage multiplier rectification circuit and high-voltage filter circuit.
The control system is the PWM (pulse width modulation) circuit system.
The feedback voltage (FB-V) from the high-voltage divider and the feedback current detection signal (FB-I) of the current detecting resistance inserted on the common side are input to the PWM circuit, thereby the constant voltage characteristics and drooping characteristics of over current protection can be obtained (see the figure below).



In order to control external equipment, the GST-07L has two set point signal outputs independently from the remote operation control function (parallel/serial).

3. Installation

3.1 Installation Precautions

(1) The rack must be mounted on the front panel.
Do not install anything to the threaded portion of the rubber legs removed when mounting the rack.

*** Note: If any foreign object is admitted into the unit, the unit may be damaged.**

(2) Make sure to place the power cable plug in a place easy to disconnect for emergency.

(3) Installation environment
Use this unit in a room.

Operating conditions	Temperature range	10 to 40 °C
	Humidity range	85% or lower or no dew condensation

Do not install this unit in the following places.

(1) Place where temperature and/or humidity are high.

(2) Place when the unit may be splashed with water.

(3) Dusty place, place where corrosive gas is present.

(4) Harmful gas, explosive gas or combustible gas is present.

(5) Place subject to high electric field or high magnetic field.

(6) Place not well ventilated.

※This is a group 1, class A product according to EN 55011/CISPR 11.
This means that this product does not generate and/or use intentionally radio-frequency energy, in the form of electromagnetic radiation, inductive and/or capacitive coupling, for the treatment of material or inspection / analysis purpose and that it is suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

3.2 Connection

(1) Connect the supplied REMOTE-I/O connector.

(2) Connect the AC input cable.

(3) Connect the grounding wire.

(4) Connect the high-voltage cable.

(5) Check the grounding wire at the pump side.

*** Note: The GST-07L is not equipped with an emergency off function (EMO circuit). Use the EMO circuit of the equipment incorporated into the GST-07L.**

<Important>
For this power supply, manual setting for input voltage is necessary.
Factory default setting: 200V
Setting procedure: Open the top panel and operate the DIP switch on the MCU board.

3.2.1 Procedure to change input voltage

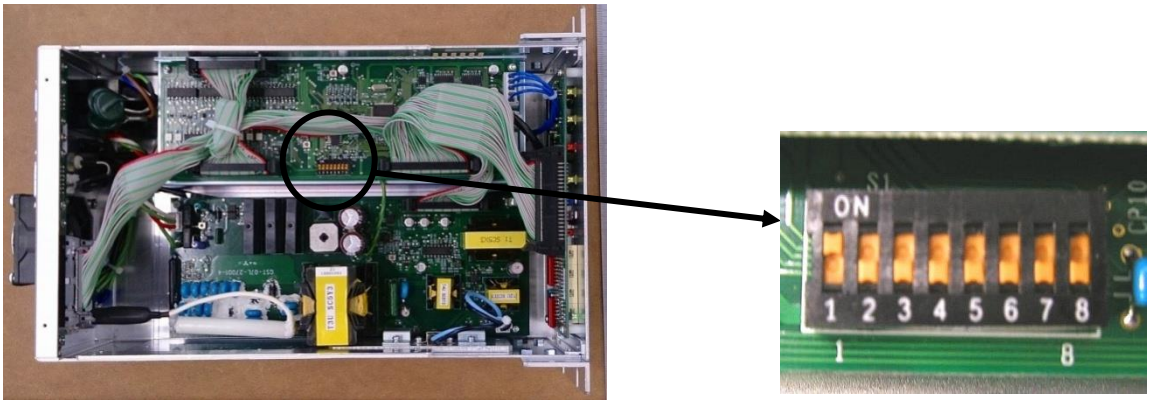
(1) Remove the AC input cable and high-voltage output cable from the power supply.

(2) Remove eight countersunk screws and open the top panel.

The disassembly of the top panel, please remove the bolt of the arrow point.

(3) Input voltage can be changed by the DIP switch No.7 shown in the photo below.
DIP switch No.7 ON : Input voltage 100V
OFF : Input voltage 200V

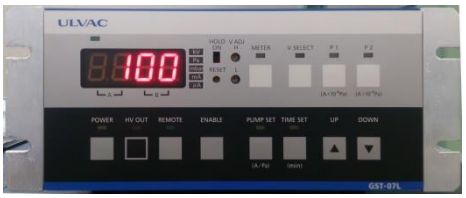
<View form the top after the top panel is removed>



3.2.2 How to check input voltage

Connect the AC input cable and turn ON the POWER ON breaker on the front panel.
The set input voltage is displayed on the front panel.

<Front panel display when 100V is set>



< Front panel display when 200V is set >

If input voltage is different from the input voltage setting of this power supply, Err.5 is displayed after the POWER ON breaker on the rear panel is turned ON, and operation is not available.

3.3 Combining with Sputter Ion Pump

(1) Characteristics
The startable pressure characteristics change depending on the ULVAC sputter ion pumps to be combined. Reference data with the combination of the ULVAC ion pumps are given below.

Type of pump	Pumping speed (N_2)	Discharge intensity	*Startable pressure
PST-030 AU/CU	30 l/sec	I/P = 3 A/Pa	$<10^{-2}$ Pa
PST-050 AU/CU	45 l/sec	I/P = 3 A/Pa	$<10^{-2}$ Pa
PST-100 AX/CX	100 l/sec	I/P = 6 A/Pa	$<5.0 \times 10^{-3}$ Pa
PST-200 AXII/CXII	200 l/sec	I/P = 8 A/Pa	$<3.8 \times 10^{-3}$ Pa
PST-400 AXII/CXII	360 l/sec	I/P = 10 A/Pa	$<3.0 \times 10^{-3}$ Pa
PST-110 AU	100 l/sec	I/P = 6.6A/Pa	$<5.0 \times 10^{-3}$ Pa

* The startable pressure can be calculated by using the following equation.

$$\frac{0.03A}{\text{I/P value (A/Pa)}}$$

(2) Discharge current (output current) and pressure
The discharge current of the sputter ion pump is approximately proportional to pressure.
Each sputter ion pump has inherent discharge intensity values (I/P).
Discharge current value is determined by multiplying coefficient by pressure.
Therefore, the approximate pressure in the pump can be known by measuring the current flowing from the high-voltage power supply to the sputter ion pump.

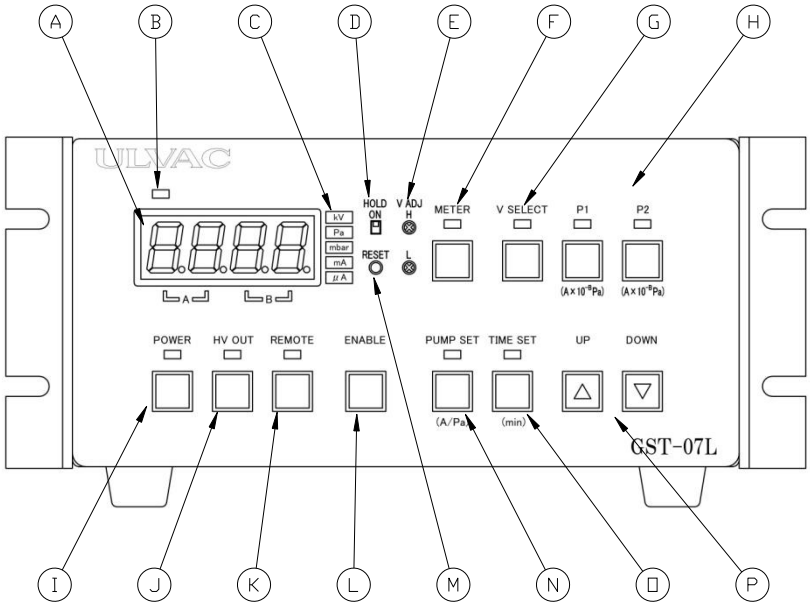
*** Note: The pressure in the ion pump differs slightly from the pressure indication on the vacuum gauge installed to the chamber.**

4. Operation

4.1 Functions of Components

4.1.1 Front Panel

This section describes functions of operation buttons on the front panel.



A) Indicator
7-segment LED digital display
(The A section and B section are used for pressure display.)
Example) 1.009 → 1.0×10^{-9}

B) AC input lamp
Indicates that the control system DC power supply of the GST-07L is turned ON and the CPU is running.
The LED lamp always blinks when the CPU is running.

C) METER range
Has 5 ranges of KV, Pa, mbr, mA and μA.
The LED (red) at the left of each character lights on to indicate the range mode.

[KV]
The KV range indicates DC output voltage
(Voltage applied between the anode and cathode of the sputter ion pump).
Example) H 7.5 → H setting 7.5 KV, L 4.5 → L setting 4.5 KV

[Pa, mbr]
The Pa and mbr ranges indicate a rough pressure in the sputter ion pump by converting discharge current based on the discharge intensity characteristic value (I/P) set by the “PUMP” key.
However, measurement limit is pressure calibration value when 1 μA.

[mA,μA]
The mA and μA ranges indicate the discharge current in the sputter ion pump.
The mA and μA ranges are changed over by automatic discrimination (mA and μA are changed over at 1 mA).

D) HOLD

This switch (sliding system) is used to determine if the automatic restoration is performed when power has failed during continuous operation.

In order to activate this HOLD switch, turn ON the HOLD switch (slide the switch up) before starting operation.

Before turning ON the HOLD switch, set the “ENABLE” + “POWER” keys.

The HOLD switch function depends on the operating status before power failure.

Before power failure, if “POWER” + “HV-OUT” keys are ON and high voltage outputs, high voltage will output again after the power is restored.

If power was shut down when only the “POWER” key is ON, only power is turned ON when power is restored.

E) V ADJ (H), (L)

V ADJ (H, L) is a voltage adjustment potentiometer for determining the higher limit of the high-voltage output set value.

Another item G) The output voltage can be selected at two points (H, L) by setting V SELECT.

H mode: V ADJ (H) varies output voltage.
Adjstable range of output voltage 7.5~5.0KV

L mode: V ADJ (L) varies output voltage.
Adjstable range of output voltage 5.0~1.0KV

The output voltage can be set by turning the V ADJ (H) or (L) potentiometer using a precision screwdriver.

F) METER

The [METER] key is used to enter the METER range setting mode when changing over the mode to the METER range.

Turning ON the [METER] key lights the LED (yellow) and enters the METER range setting mode.

The range can be changed over in conjunction with the “UP/DOWN" keys when the LED (yellow) lights on.

The range can be changed over regardless of whether HV OUT is ON or OFF.

Turning ON the [METER] key again lights off the LED and exits from the METER range setting mode.

Note: mA and µA are automatically discriminated.

G) V SELECT

The [V SELECT] key is used to enter the V SELECT setting mode when changing between the two set output voltages (H, L).

Turning ON the [V SELECT] key lights the LED (red) and enters the V SELECT setting mode.

The two output voltages set by V ADJ (H), (L) can be changed over in conjunction with the [UP/DOWN] keys.

They can be changed over whether HV OUT is ON or OFF.

Turning ON the [V SELECT] key again lights off the LED and exits from the V SELECT setting mode.

H) SET POINT P1, P2

The [SET-POINT, P1, P2] keys are used to enter the SET-POINT setting mode. The SET-POINT setting of REMOTE I/O P1 and P2 can be changed over. This setting is available when HV OUT is OFF.

Press the “P1” (or “P2”) key once to enter the [SET-POINT, P1, P2] mode. (Setting is available only when HV is OFF.)

A section (upper double digits) of the Meter display (7-segment LEDs) blinks and setting is available in conjunction with the [UP/DOWN] keys.

B section (lower double digits) of the Meter display (7-segment LEDs) blinks by pressing the “P1” (or “P2”) key again and setting is available in conjunction with the [UP/DOWN] keys.

Setting range A : 1.0 to 9.0 (step 1.0)
B : 02 to 11 (step 01) (B: 04 to13 when unit is mbr)

When HV OUT is ON, pressing either "P1" or "P2" key displays the set value for one second, then, the display automatically returns to the original indication.

If the pressure in the pump drops below the SET-POINT P1 or P2 set value, the set point turns ON and the LED of the "SET-POINT P1, P2" key lights on.

P1 and P2 output independently with two circuits.

I) POWER

The “POWER” key is used to start up the power supply.

Turning ON/OFF the “ENABLE” + “POWER” keys turns ON /OFF the low-voltage power supply of the HV power circuit. At the same time, LED of the [POWER] switch turns ON/OFF.

The “POWER" key is also used to reset error display (ERR-1 to 8).

However, if the error is not cleared by pressing this key, the error cannot be reset.

J) HV OUT

The “HVOUT" key is used to output high voltage. When the METER range is KV, simultaneously turning ON the “ENABLE" + “HVOUT" keys blinks the LED of the “HVOUT" key.
If the pressure in the pump is higher than 30mA, which leads to soft start and the LED blinks (one sec: ON/two-sec: OFF).
After the soft started and runs, the LED lights on and set voltage continuously outputs.
Simultaneously turning ON the “ENABLE" + “HVOUT" keys again lights off the LED of the “HVOUT" key and turns OFF HVOUT.

K) REMOTE

The “REMOTE" key is used to change over external remote control and front panel control.
Simultaneously turning ON the “ENABLE" + “REMOTE" keys lights the LED (green) of the “REMOTE" key and sets up the REMOTE mode (external remote control mode).
The key operation on the front panel is disabled. (Only the “POWER" key can be operable.)
If power failure occurs and the “HOLD” switch is OFF, [POWER] and [REMOTE] return to OFF after the power is restored.
If continuous external remote control is necessary, keep the [HOLD] switch ON.

L) ENABLE

The “ENABLE" key is used simultaneously with the “POWER", “HVOUT" or “REMOTE" key to prevent erroneous operation of these three keys.

M) RESET

Not used.

N) PUMP SET

The “PUMP-SET” key is used to enter the PUMP-SET setting mode, which sets the discharge intensity characteristic value (discharge current/pressure and characteristic value) (I/P: in A/Pa) that varies by the pump.
For the discharge intensity characteristic value of each pump, refer to 3-3. COMBINING WITH PUMP.

Example) Discharge intensity characteristic value 3A/Pa → Insert 03.00.

Turning ON the “PUMP-SET" key when HV OUT is OFF lights the LED (yellow) of the “PUMP-SET" key and enters the PUMP SET setting mode (setting is available only when HVOUT is OFF).
Setting is available in conjunction with the [UP/DOWN] keys.
The display speed changes depending on how the "UP/DOWN" keys are pressed.

1 pulse	: One step changes.
When pressing for more than 1 sec (but less than 4 sec)	: Low speed changes continuously.
When pressing for 4 sec or more	: High speed changes continuously.

Turning ON the “PUMP-SET" key again turns off the LED and exits from the PUMP-SET setting mode. If the “PUMP-SET" key is turned ON when HV is OUT, the set value will be displayed for one second (LED in the “PUMP-SET" key lights on during display), then, the display automatically returns to the original indication.

O) TIME_SET

The [TIME_SET] key is used to enter the operation time setting mode at soft start.
The displayed value indicates the maximum operation time of soft start.
When the maximum time elapses after HV is OUT, “Err-2” is displayed.
Setting is available when HV OUT is OFF.
Turning ON [TIME_SET] when HVOUT is OFF lights the LED (yellow) of the [TIME_SET] key and enters the TIME_SET setting mode (setting is available only when HVOUT is OFF).
TIME_SET setting is available in conjunction with the [UP/DOWN] keys.
The display speed changes depending on how the “UP/DOWN" keys are pressed.

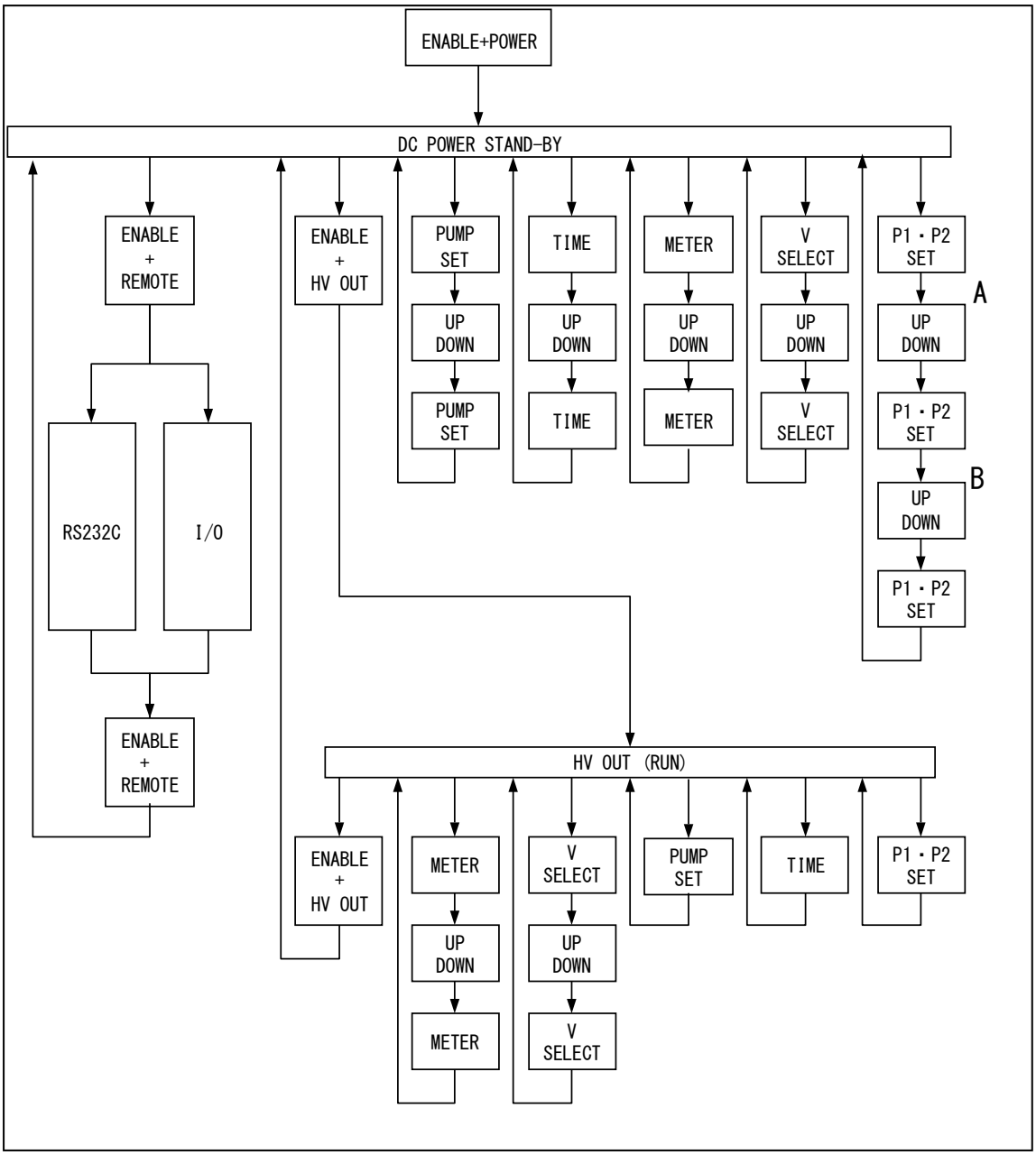
1 pulse	:	One step changes.
When pressing for 1 sec or more	:	Continuously changes. (The variable speed is the low speed level at PUMP_SET.)

Turning ON the “TIME_SET" key again turns off the LED and exits from the TIME_SET setting mode.
If the “TIME_SET" key is turned ON when HVOUT is ON, the set value will be displayed for one second (LED of the “TIME_SET" key lights on during display), then, the display automatically returns to the original indication.

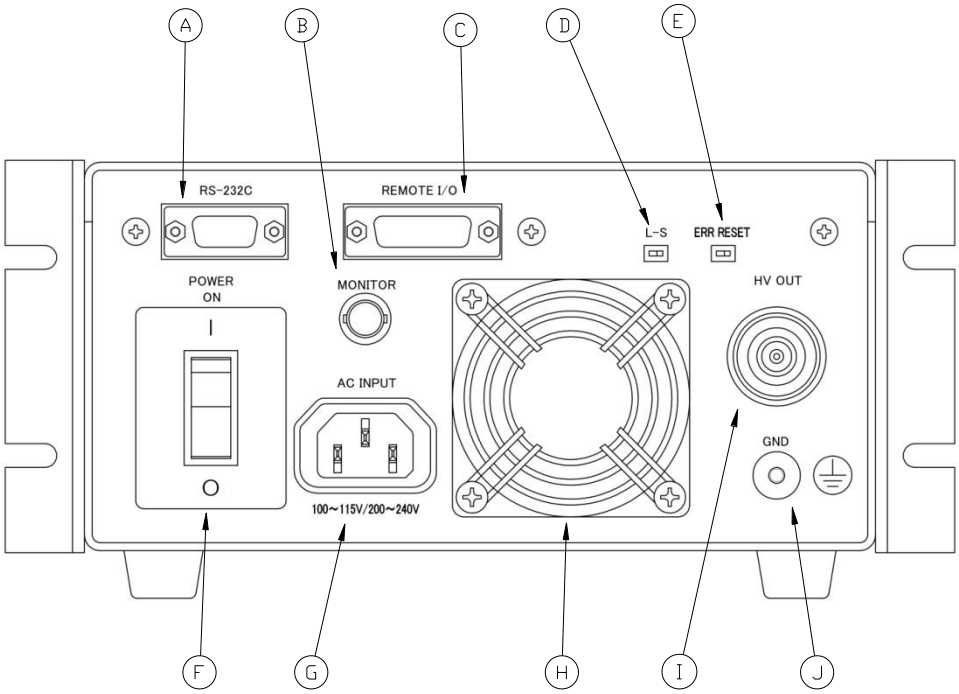
P) UP/DOWN

The “UP/DOWN” keys are used to change the setting after entering the setting modes shown below.
METER, V-SELECT, SET-POINT (P1, P2), PUMP-SET, TIME-SET

4.1.2 Front Panel･Key Setting Mode Flow



4.1.3 Rear Panel



A) RS-232C communication connector
For details, refer to Item 4.7 RS-232C communication.
Connector specification: D-sub9pin, Female

B) MONITOR connector
Analog output BNC connector corresponding to the indicator of each range on the front panel.
0V to10V DC linear for each value is output.

KV range	0 to 7.5 KV → 0 to + 7.5 V
Pa, mbr range	"A" part (mantissa value 1.0 to 9.9) → + 1.0 V to + 9.9 V
Current range (mA, µA)	0 to 0.1 mA → 0 to 9.9 V
	0.1 to 10 mA → 0.1 to 9.9 V
	10 to 30 mA → 1.0 to 3.0 V

C) REMOTE-I/O connector
This is an external control connector to input/output various signals.
Connector specification: D-sub15pin, Female

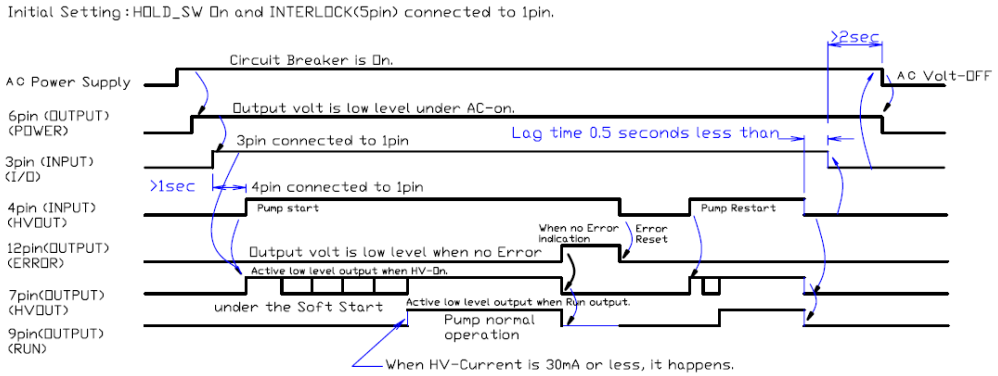
Pin No.	Signal identification	Contents	Type
1	+ 12 V	+ 12 V DC, maximum load current not more than 100 mA Power to be applied to REMOTE-3 to 5 pins	OUTPUT
2	GND	GND for control	COMMON
3	REMOTE I/O & RS-232C	Connected to REMOTE pin-1: HV-OUT (pin 4) is enabled. When open: RS-232C communication is enabled	INPUT
4	HV OUT	When pins 3 to1 are connected: connected to pin 1 → HV-ON Open: HV is OFF. When changed from connection to open: Reset ERROR (pin 12)	INPUT
5	INTERLOCK	When open: Turns OFF the HV power supply and displays ERRO. Whenever using this, connect this to pin 1.	INPUT
6	POWER	POWER-ON state: L (2 to 6 pins switch-on)	OUTPUT
7	HV OUT	HVOUT state: L (2 to 7 pins switch-on)	OUTPUT
8	REMOTE/LOCAL	In local mode: L (2 to 8 pins switch-on)	OUTPUT
9	RUN	When RUN state: L (2 to 9 pins switch-on)	OUTPUT
10	P1 OK	When Pa indicated value is smaller than the SET-POINT-P1 set value: L (2 to10 pins switch-on)	OUTPUT
11	P2 OK	When the Pa indicated value is smaller than the SET-POINT-P2 set value: L (2 to11 pins switch-on)	OUTPUT
12	ERROR	Normally: L (2 to12 pins switch-on) When an error occurs: OFF	OUTPUT
13			
14	Analog output	1) L-S switch is at [L]: 0 to 10 V when output current is 0 to 30 mA 2) L-S switch is at [S]: LOG (Pa) output. Pressure equivalent to 1 μA is 0 V and pressure equivalent to 30 mA is 10 V.	ANALOG OUTPUT
15	ANALOG GND	Analog GND	ANALOG OUTPUT

“OUTPUT” is open collector output, and indicates Tr-ON with L.
For Pin 2 and Pin 15, internal housing GND and internal DC power GND are connected at one point.

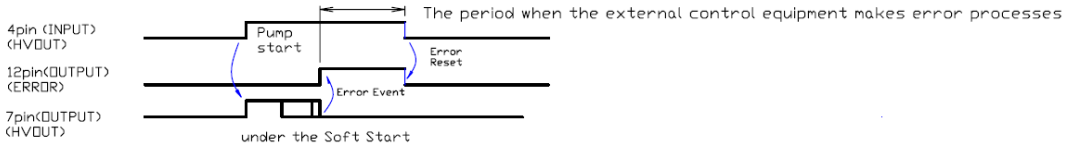
Reference 1: External control timing chart at REMOTE I/O
Reference: Item 8. Attached drawings, external remote (parallel I/O) reference flow diagram

(1) When the controller runs normally up to RUN state, and then errors (ERR-2, ERR-3 and ERR-4) occurred
First operation: AC input supply with HOLD_SW-ON. Turn CB-ON, POWER-ON (simultaneously turn ON ENBLE and POWER-P/B), and then shut down AC input supply.
Operation with INTERLOCK (1 to 15 pins connected) and without ERROR

(1) The timing chart of the Remote I/O Signals includes Error(ERR-2,ERR-3,ERR-4) handling .



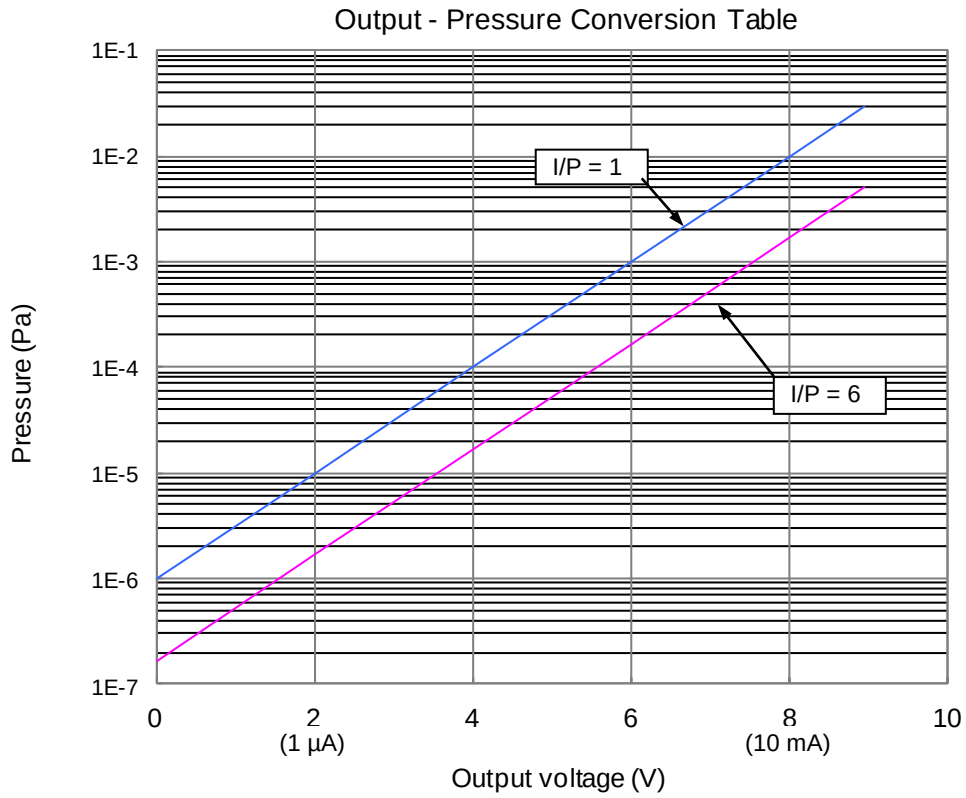
(2) The Error (ERR-2,ERR-3,ERR-4) handling which is in the midst of software starting.



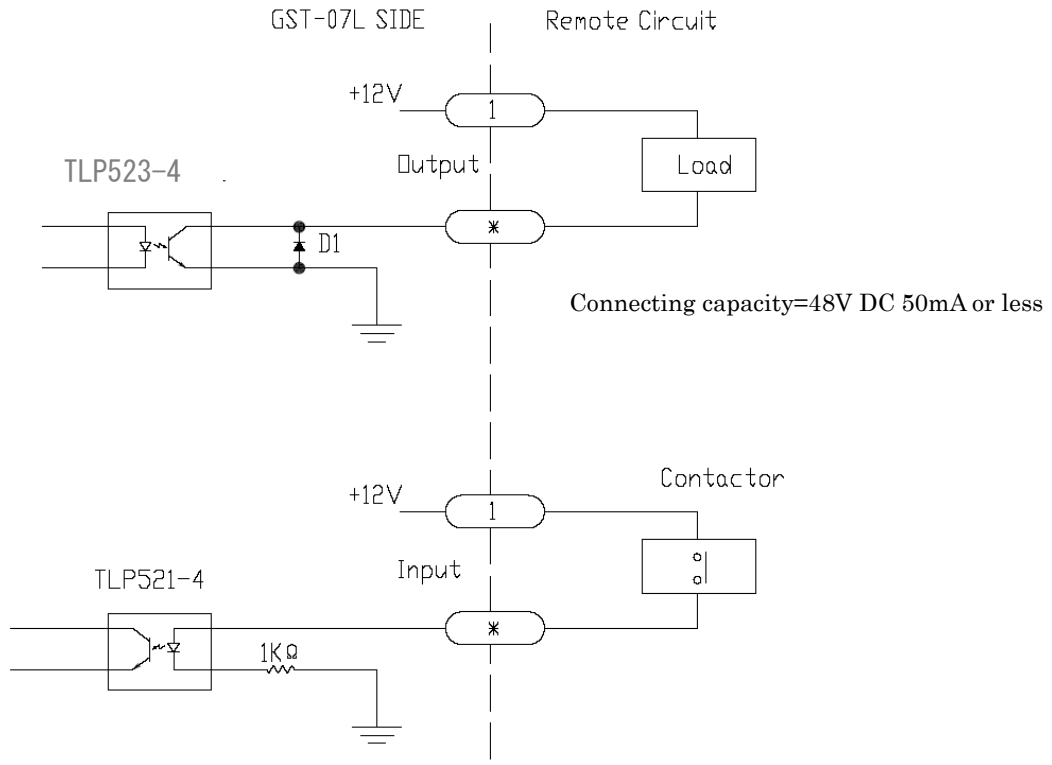
Reference 2: LOG output conversion equation for analog output (pin 14) of REMOTE-I/O
Converts pressure equivalent to 1 μA and 10 mA to LOG and adjusts the scale to 0 to 8 V.
When the output current is I x , LOG output is calculated as follows:

$$Vx = 2 \times (LOG_{10} (Pa) - LOG_{10} (Pa(0)))$$

Pa(0) is the pressure when the current is 1 μA

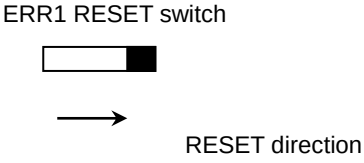


Reference 3: Overview of input/output circuit for external control



D) L-S switch
This is used to determine the type of analog signal (L: Linear, S: Logarithm) of pin 14 of the REMOTE-I/O connector.

E) ERR1-RESET
"Err.1" is a switch to stop earth error function.
When GST-07L judge that grounding is in condition not to be considered to be it for AC input, GST-07L display "ERR1" and do control for a stop.
To forcibly use this power supply, turn ON this switch and ignore the error, ERR1.
To turn ON this switch, slide the switch to the right toward the rear panel.



*** Note: When performing this operation, "Safety precautions" described above must be followed. Fully understand the operation before taking actions.**

F) Power on breaker
The protective circuit is activated at the rating of 5 A with the main AC input switch.
Turning ON this switch supplies DC power to the control circuit such as CPU.
As a result, the LED on the front panel blinks at all times.

*** Note: Before turning ON the POWER ON breaker switch again after it is turned OFF, wait for approx. five sec. for safety.**

G) AC input connector
3-pin inlet for applying the primary input power through the power supply cord.
The input voltage is as follows.
Single phase 100 to 115 V AC ±10%, 50/60 Hz
Single phase 200 to 240 V AC ±10%, 50/60 Hz
Never apply a voltage other than allowed.

H) Air-cooling fan
Discharge direction: Blowout
Rated voltage: DC12V

I) HV OUT
High-voltage output connector.
Connect the high-voltage connector of the high-voltage output cable.
The high-voltage connector of the high-voltage output cable is easily connected with quick lock mechanism.
Securely connect the high-voltage connector.
Note that if it is not securely connected, unexpected trouble such as discharge or short circuit may occur.
Locknut mechanism is provided to the high-voltage connector of the high-voltage output cable to prevent desorption during conduction.

J) GND
Grounding terminal. For safety reasons, always ground this terminal.
If power is turned ON without grounding this terminal, error (ERR1) displays.

4.2 Initial Settings

4.2.1 Initial Settings

(1) Front panel
- REMOTE OFF
- HOLD OFF
- V-ADJ-H 7.5 kV
- V-ADJ-L 5.2 kV
- METER KV range
- V-SELECT H
- SET-POINT-P1 1.0×10^{-2} Pa
- SET-POINT-P2 1.0×10^{-2} Pa
- PUMP-SET 18.00 A/Pa
- TIME-SET 255 min.

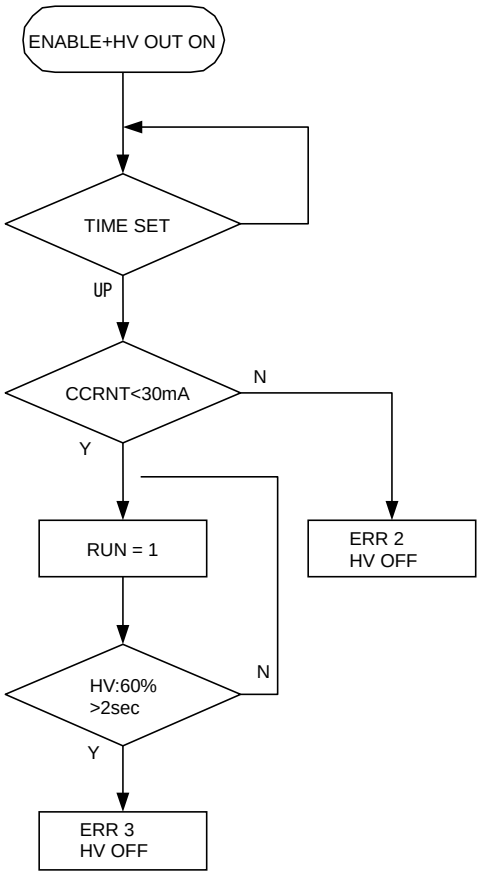
(2) Rear panel
- REMOTE I/O Pins 1 to 5 are connected. (INTERLOCK)
- REMOTE I/O Open between pins 1 to 3. (RS-232C)
- L-S switch L
- ERR1-RESET OFF (Left side)

(3) DIP switch (Inside power supply)
- NO.1 ON
- NO.2 to 6 OFF

4.2.2 Changing The Initial Setting Values

The initial setting can be changed with the “UP/DOWN" keys.
Refer to 4.1. FUNCTIONS OF COMPONENTS.
Changeable items
- REMOTE/LOCAL
- V-SELECT
- SET-POINT P1, P2
- PUMP-SET
- TIME-SET
- METER range

4.3 Startup And Starting Operation



If the output current is 30 mA or more when HV is ON, power is ON for one second and OFF for two second cyclically. (Soft start function is included as standard.)

If the output current does not lower to below 30 mA (pressure does not drop) within the time set in TIME SET, “ERR 2" appears and operation stops.

If the output current comes down to below 30 mA within the time set in TIME SET, “HV OUT" lights on and high voltage outputs continuously.
At the same time, RUN signal outputs to the REMOTE I/O connector on the rear panel

As the output current increases and exceeds 30 mA due to abnormal load, the output voltage drops due to constant current drooping characteristic.
If the output voltage lowers to below 60% of the value set in V ADJ. for approx. two seconds or more, “ERR 3" appears and operation stops.

Actions to be taken in case of “ERR2” and “ERR3” differ between the local state and remote state.

In the local state, press the “POWER” switch and reset the error, and turn ON “HV OUT” again.

In the remote state, reset the error at the falling end of the “HV OUT” level input signal of the REMOTE I/O connector on the rear panel and turn ON the signal again.

4.4 Measurement Limit Pressure

Measurement limit current to the vacuum pressure display of this unit is 1.0×10^{-6} (A).
The measurement limit pressure is calculated from the discharge intensity value of the combined sputter ion pump by using the following equation.
Measurement limit pressure (Pa) = measurement limit current/discharge intensity value.
In this unit, mantissa of the pressure display value is displayed “0.0” when measurement limit pressure is below measurement limit current.

Pump model	Pumping speed (N_2)	Discharge intensity	Measurement limit pressure
PST-030 AU/CU	30 l/sec	I/P = 3 A/Pa	$<5.5 \times 10^{-7}$ Pa
PST-050 AU/CU	45 l/sec	I/P = 3 A/Pa	$<3.3 \times 10^{-7}$ Pa
PST-100 AX/CX	100 l/sec	I/P = 6 A/Pa	$<1.6 \times 10^{-7}$ Pa
PST-200 AX II/CX II	200 l/sec	I/P = 8 A/Pa	$<1.2 \times 10^{-7}$ Pa
PST-400 AX II/CX II	360 l/sec	I/P = 10 A/Pa	$<1.0 \times 10^{-7}$ Pa
PST-110 AU	100 l/sec	I/P = 6.6 A/Pa	$<1.5 \times 10^{-7}$ Pa

*** Note: The pressure in the ion pump slightly differs from the pressure indication on the vacuum gauge installed to the chamber.**

4.5 Error Display and Err Contents

(1) Err 0 : INTERLOCK error
Pins 1 to 5 of the REMOTE-I/O connector on the rear panel are open.

(2) Err 1 : EARTH error
Power was turned ON when the GST-07L main unit is not grounded due to disconnection of the earth wire, or the GST-07L is not grounded due to disconnection of the earth wire after power is turned ON.

(3) Err 2 : TIME-OUT error
Current does not lower to below 30 mA within the time set in TIME-SET after soft start by turning ON HVOUT.

(4) Err 3 : RUN error
When the output voltage has lowered to below 60% in the RUN state for 2 sec or more (the soft start becomes 30 mA or less within the set time).

(5) Err 4 : HVOUT error
Neither voltage nor current is delivered (output failure) when HVOUT is ON.

(6) Err 5 : INPUT VOLTAGE error
Setting voltage of the power supply is different from the primary supply voltage.

(7) Err 6 : Temperature error
Temperature of the heat sink of the power MOS of the switching power supply is 60°C or more.

(8) Err 7 : RS-232C communication error
Check sum error

(9) Err 8 : Serial EEPROM error
Check sum error of backup memory.

4.6 RS-232C Communication

4.6.1 Specifications of Communication Control

Communication system	Half duplex communication
Synchronizing system	Asynchronous system
Baud rate	9600 (factory default), 4800, 2400 bps
Data bit length	8 bits (ASCII)
Stop bit length	1 bit
Parity check	Invalid
Send line feed code	CR + LF
Receive line feed code	CR

4.6.2 RS-232C cable

When connecting the GST-07L and computer, use a straight cable.
[Connection]
GST07L : D-SUB9 (female)

Pin No.	Signal	Signal code
2	Send data	TXD
3	Receive data	RXD
5	Signal ground	SG
7	Clear to send	CTS
8	Request to send	RTS

4.6.3 Description of Commands

Inside of [ ] can be omitted. Either one can be selected from the two separated with the separator, "|" in [ ] for each command.
Use half-sized characters for all commands.
In actual operation, add "CR" to each command before sending it.

A command

Function	Confirms the SET POINT (set point) state. The target set point is P1.
Format	A
Example of use	A
Explanation	Returns the result of comparison of SET POINT P1 set pressure and the current pressure with a numeric value. The unit is Pa in both cases. 0: Pressure is higher than SET POINT P1 set pressure 1: Pressure is lower than SET POINT P1 set pressure
Reference	Q, B command

B command

Function	Confirms the SET POINT (set point) state. The target set point is P2.
Format	B
Example of use	B
Explanation	Returns the result of comparison between the SET POINT P2 set pressure and the current pressure in numerical value. The unit is Pa in both cases. 0: Pressure is higher than the SET POINT P2 set pressure 1: Pressure is lower than the SET POINT P2 set pressure
Reference	R, A command

C command

Function	Clears error when the operation stops by error. E2 to E4 are applicable.
Format	C
Example of use	C
Explanation	Stops by error and HVOUT is turned OFF. Error is reset with C command. HVOUT remains OFF.
Reference	Error code

D command

Function	Calls up data in the meter setting range
Format	D
Example of use	D
Explanation	Calls up the data set with M command.
Reference	M command

H command

Function	Confirms or changes the HVOUT (high-voltage output) state.
Format	H [0 | 1]
Example of use	H Confirms the current state. H0 Turns OFF HVOUT. H1 Turns ON HVOUT.
Explanation	Acquires the high-voltage output state with H command, stops the high-voltage output with the H0 command, and applies it with H1.

M command

Function	Confirms or changes the meter setting condition.
Format	M [0 |1 | 2 | 3 | 4 |5]
Example of use	M Enters the meter setting mode and returns the numeric value of the current set state. M0 Exits from the meter setting mode. M1 Sets the meter range at KV. M2 Sets the meter range at pressure Pa. M3 Sets the meter range at pressure mbr. M4 Sets the meter range at current mA or μA.
Explanation	The numerical values returned with M command are 1 Meter range is KV 2 Meter range is Pa 3 Meter range is mbr 4 Meter range is current (mA, μA) Meter range mA or μA is automatically operated by the GST-07L.
Reference	D command

N command

Function	Confirms the RUN state.
Format	N
Example of use	N
Explanation	RUN state is a state in which the output current becomes 30 mA or less within the TIME-SET time and startup is completed. This state is returned with a numeric value 0 Not in RUN state 1 In RUN state
Reference	T command

P command

Function	Confirms the POWER (GST-07L control power) state or turns it OFF.
Format	P [0]
Example of use	P Returns the current POWER ON state with numeric value. P0 Turns OFF POWER.
Explanation	1 POWER is ON. Executing P0 turns OFF HVOUT simultaneously.

Q command

Function	Confirms or sets the SET-POINT (set point) set value. The target set point is P1.
Format	1 [0 | set value]
Example of use	Q Returns the current setting. Q0 Exits from this setting mode. Q3E-07 Sets pressure value 3×10^{-7} Pa to set point P1.
Explanation	The numeric value returned by Q command is 3E-07. The unit of pressure is Pa only. The set

value of format is not recognized unless the number of digit and shape are as follows.
Half-size 5 digits of “nE-nn”, where n is a numeric value of 0 to 9 and E- is fixed.

Reference R command

R command

Function Confirms or sets the SET-POINT (set point) set value.
The target set point is P2.

Format 1 [0 | set value]

Example of use
R Returns the current setting.
R0 Exits from this setting mode.
R3E-07 Sets pressure value 3×10^{-7} Pa to set point P1.

Explanation The numeric value returned by R command is 3E-07. The unit of pressure is Pa only. The set value of format is not recognized unless the number of digit and shape are as follows.
Half-size, 5 digits of “nE-nn”, where n is a numeric value of 0 to 9 and E- is fixed.

Reference Q command

T command

Function Confirms or changes the set value of TIME-SET set value (time-out/error time setting at startup).

Format T [0 | set value]

Example of use
T Returns the current set value.
T0 Exits from this mode.
T50 Changes the TIME-SET set value to 50 minutes.

Explanation In the case of 30 minutes, the set value returned by T command is 30.
The format set value is 1 to 255 (half-size numeral).

Reference N command

U command

Function Confirms or changes the PUMP-SET set value of discharge intensity.

Format U [0 | set value]

Example of use
U Returns the current set value.
U0 Exits from this mode.
U2000 Sets the setting value to 20A/Pa.

Explanation The numeric value returned by U command is “2000” with fixed point when it is 20.00 A/Pa.
The set value of format is 1 to 9999 (half-size numeral). The unit is A/Pa.

V command

Function Confirms or changes the H/L mode state of high-voltage output.

Format V [0 |1 | 2]

Example of use
V Returns the current set value.
V0 Exits from this mode.
V1 Sets the high voltage output to Low.
V2 Sets the high voltage output to High.

Explanation Characters returned by V command are as follows.
L High-voltage output is Low.
H High-voltage output is High.

Z command

Function Returns the GST-07L version.

Format Z

Explanation Returns “GST-07L CONTROLLER VERSION X.XX”. X is a numeral.

5. Inspection · Repair

(1) Critical Trouble

[Symptom]

The AC input lamp (LED) on the front panel does not blink although the POWER ON breaker on the rear panel is turned ON.
Or 7-segment LEDs or/and all LEDs remain ON with disabled state.

[Corrective Action]

Turn OFF the POWER ON breaker on the rear panel.
Wait for approx. five sec. and turn it ON again.
If symptom is not cleared by corrective action, substrate defect is suspected.
Contact your local ULVAC service network for repair.

[Symptom]

Err 4, 6, 7 or 8 occurs.

[Corrective Action]

Contact your local ULVAC service network for repair.

(2) Corrective actions by user when external cause is suspected

- Err0: Check the INTERLOCK signal.
- Err1: Check grounding.
- Err2: Check the vacuum pumping system (pumping speed, pressure rise characteristics, etc.)
- Err3: Check abrupt pressure rise.
- Err5: Check the input voltage setting.

(3) Inspection precaution

The GST-07L has a function that abrupt high voltage from the primary-side input can be bypassed to the varistor to protect circuits as the surge prevention measure.
Therefore, resistance could appear in the Insulation resistance measurement between the line and earth.
Please understand that this is not caused by the unit failure.

6. Warranty Clauses

This product was shipped after rigid company inspection. However, in case any failure occurs under ULVAC's responsibility, such as defect in manufacturing and damage during transportation, Buyer shall inform ULVAC, Inc. or the local ULVAC representatives. ULVAC will repair or exchange it at free of charge.

6.1 Warrantable Items

(1) Sputter ion pump control GST-07L-B

6.2 Duration of guarantee

(1) Domestic business in Japan: one year after shipping date from ULVAC.
(2) Direct export transaction: one year after date of B/L

6.3 Warrantee scope

(1) Domestic business in Japan:
・Product, which has damage, caused by a failure on delivery.
・Products not satisfying the standard specifications although the product is used under the service conditions described in this document such as temperature range and power etc.
(2) Direct export transaction:
・Product, which has damage, caused by a failure on delivery.
The warrantee scope shall confirm to INCOTERMS.
・Products not satisfying the standard specifications although the product is used under the service conditions described in this document such as temperature range and power etc.

6.4 Response procedure

(1) Domestic business in Japan:
ULVAC send a replacement or Buyer return the defective items to ULVAC, Inc. or to the local ULVAC representatives for repair. If field service is required, Buyer shall ask ULVAC, Inc. or the local ULVAC representatives.
(2) Direct export transaction:
ULVAC send a replacement or Buyer return the defective items to ULVAC, Inc. or to the local ULVAC representatives for repair. Return charge shall be paid by Buyer.

6.5 Disclaimer

(1) Failure occurred after expiration of warranty period
(2) Failure caused by force majeure, such as fire, storm and flood damage, earthquake, lightning strike, war etc.
(3) Failure occurred due to carelessness handling or faulty usage.
(4) Products remodeled, disassembled or repaired without ULVAC's acceptance
(5) Failure occurred under abnormal environment, such as intense electromagnetic field, radiation, high-temperature, high-humidity, flammable gases, corrosive gases, dust etc.
(6) Failure occurred by noise.
(7) Product deficiency or secondary indemnification occurred to Buyer.
(8) Product deficiency or secondary indemnification occurred to Buyer, from law suit to ULVAC by third party for patent infringement.
(9) The reason of the failure deemed below the specified usage condition by ULVAC technical staff.
(10) Consumable parts.

6.6 Others

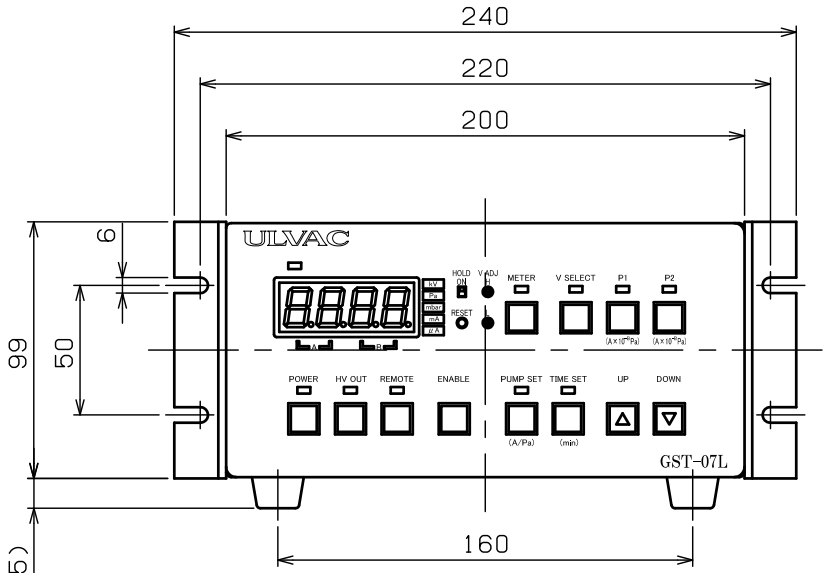
(1) In case, special agreement or memorandum for specifications is made individually.
(2) Buyer shall inform ULVAC when this product is exported out of Japan. In the meantime, Buyer shall take necessary procedures according to Foreign Exchange and Foreign Trade Law.
(3) As for the question and consultation, Buyer shall check the model and serial number and ask the local representative or ULVAC, Inc.
https://www.ulvac.co.jp/en/support/
(4) The contents of this document is subject to change without notice in future.

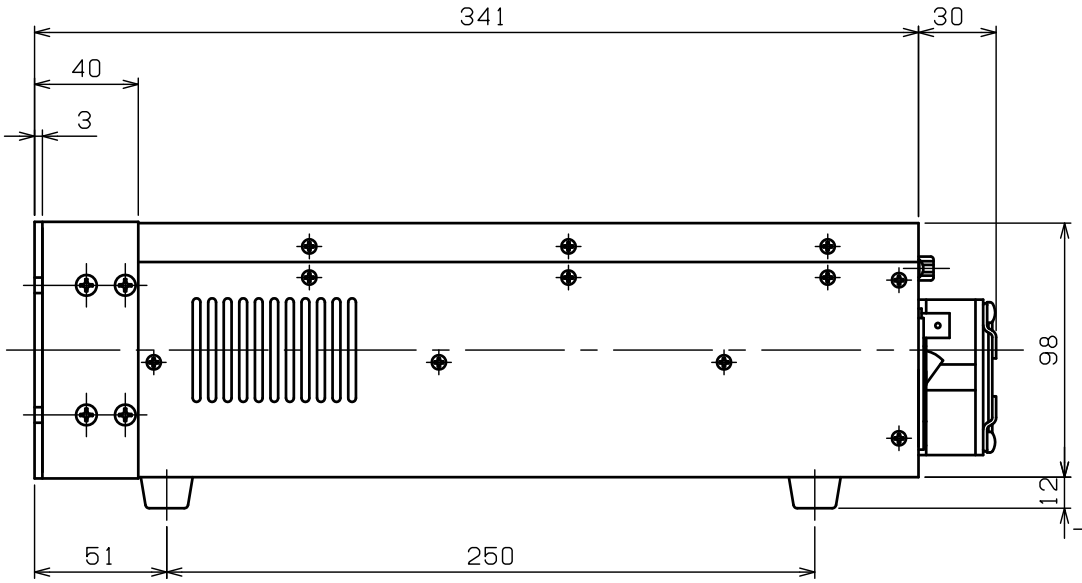
7. Attached Drawings

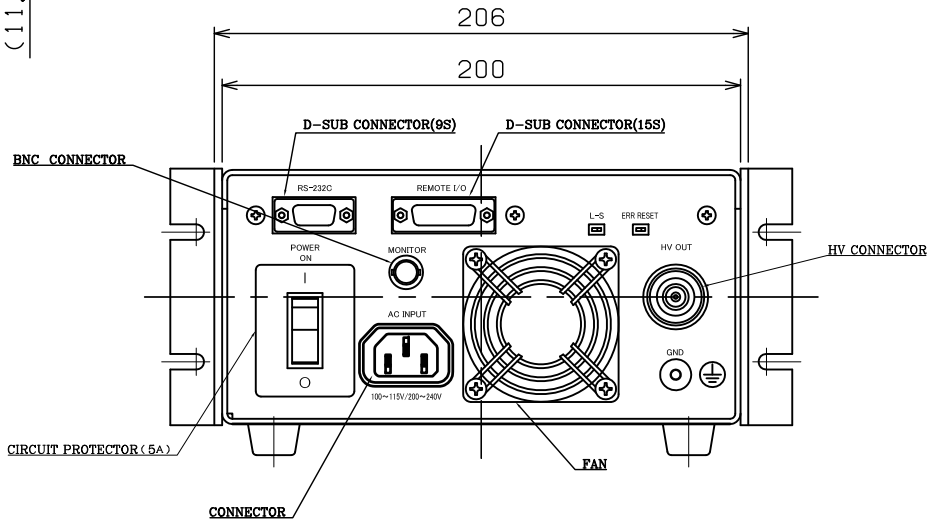
(1) Appearance diagram: BS0808-173A

(2) Input-output connection diagram: BS0808-170-00 E

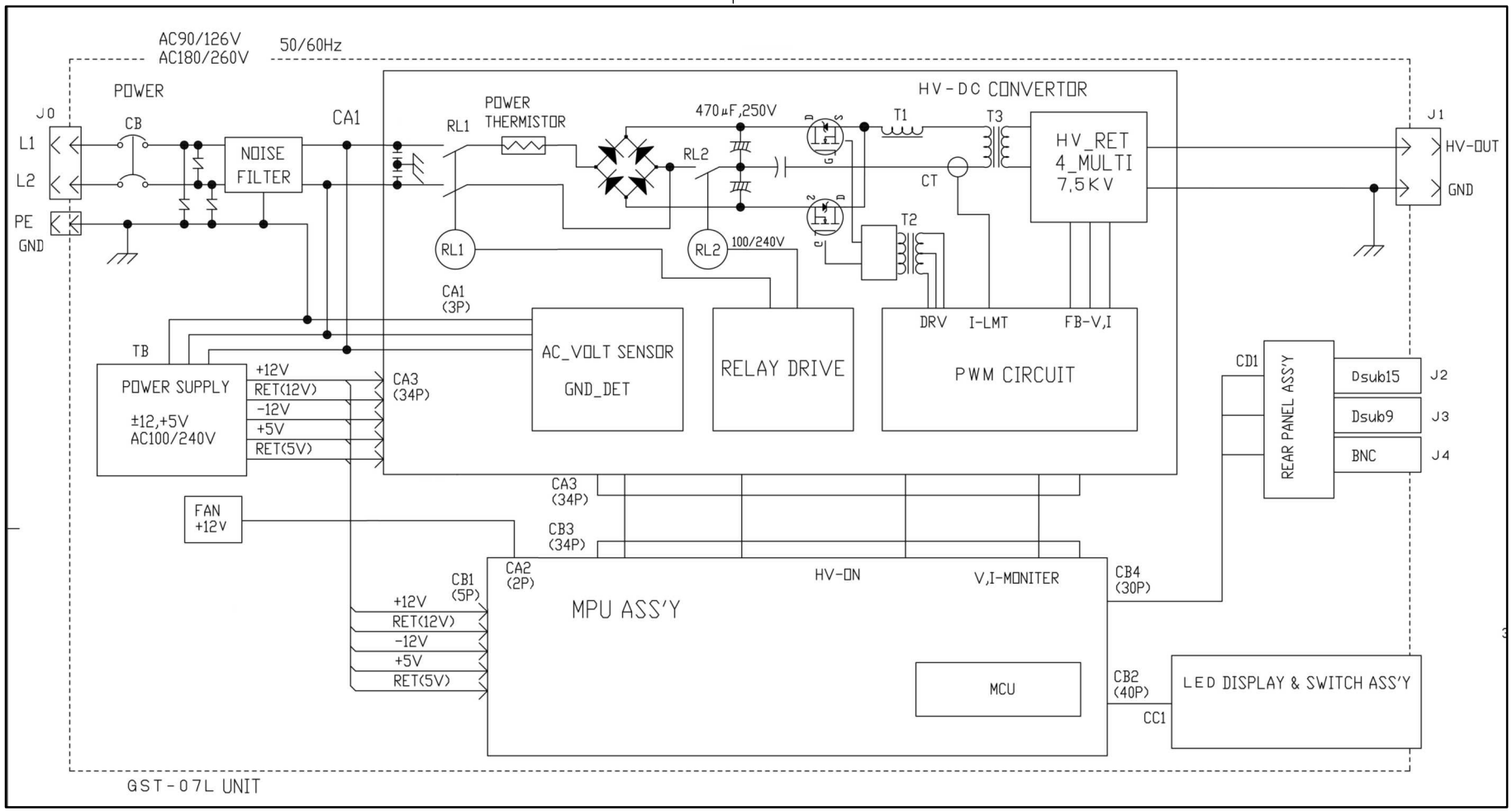
(3) EU DECLATION OF CONFORMITY







貼	DWG. No	DATE	NAME	△-			
				△-			
流用元図番			計算重量	△-			
TOLERANCES UNLESS NOTED	JIS B 0419-mH級 JIS B 0408-B 級		A3	MARK	DATE	REMARKS	
				REVISION			
APPRV 承認	CHECK 検図	DESIG 設計	DRAW 製図	ULVAC	TITLE	Out side view	
				SCALE	1:2	GST-07L-B	
				DATE	2016/04/06		
MFG No.				DWG No.	BS0808-173A		



貼	DWG. No	DATE	NAME	△-			
				△-			
流用元図番			計算重量	△-			
TOLERANCES UNLESS NOTED	JIS B 0419-mH級 JIS B 0408-B 級		A3	MARK	DATE	REMARKS	
				REVISION			
APPRV 承認	CHECK 検図	DESIG 設計	DRAW 製図	ULVAC	TITLE	GST-07L-B	
				SCALE	1:1	BLOCK DIAGRAM	
				DATE	2016/07/11		
MFG No.				DWG No.	BS0808-170-00E		

ULVAC

CE EU DECLARATION OF CONFORMITY CE

The object of the declaration is in conformity with the relevant Union harmonization legislation.
This declaration is issued under the sole responsibility of the manufacturer.

Product	SPUTTER ION PUMP CONTROL	
Model	GST-07L-B	
Manufacturer	ULVAC, Inc. 2500 HAGISONO, CHIGASAKI-SHI, KANAGAWA-KEN, 253-8543 JAPAN	
Test standard	Low Voltage Directive 2014/35/EU	EN61010-1:2010+A1:2019
	EMC Directive 2014/30/EU	[Emission Test] EN61326-1:2013 CISPR11:2009+A1:2010 Group1 Class A Industrial Electromagnetic Environment
	Restriction of the use of Certain hazardous substances (RoHS) 2011/65/EU	EN 50581:2012
Test lab.	TUV Rheinland japan Ltd.	

Note: This declaration becomes invalid if technical or operational modifications are introduced without the manufacture's consent.

Signature : Jiro Endo

Date : 27/August/2021

Name : JIROU ENDO

Title : General Manager of Components Division

This mark is applied to the electronic information product sold in the People's Republic of China. The figure at the center of the mark is the validity date of environmental protection. This product does not influence the environment, the human body and the property during the period reckoning the manufacturing date as long as the caution for safe use regarding the products are observed.
*The environmental protection validity date is not the product warranty period.

Table1. Making format for names and contents of hazardous substances or elements

Name of parts	Hazardous substances or elements					
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
Body	O	O	O	O	O	O
Panel	O	O	O	O	O	O
Base	O	O	O	O	O	O
Electrical Parts	O	O	O	O	O	O

O: indicating that content of the hazardous substance or element in all homogeneous materials of the part does not exceed the requirements for concentration limits specified by SJ/T11363-2006.
×: indicating that content of the hazardous substance or element in, at least one kind of, homogeneous materials of the part exceeds the requirements for concentration limits specified by SJ/T11363-2006. Producer may further explain the technical excuse to the items marked with "X" perspecific conditions here.

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