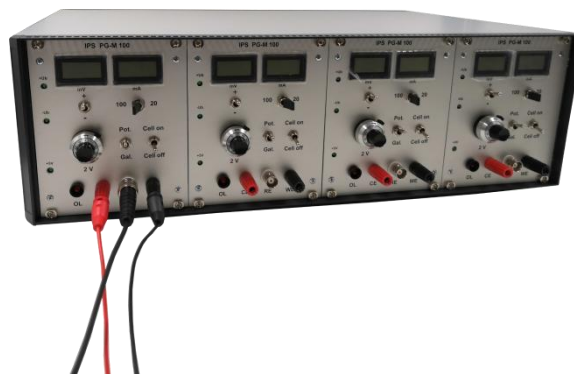


IPS PG-M 100 Manual



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1. Preface

1.1. Scope

This document describes in short sentences the operation of the potentiostat / galvanostat **PG-M 100**.

1.2. Intended audience

This paper is intended for the user or operator of the device.

1.3. Topic and delimitation

This introduction guide briefly explains how to use the **PG-M 100**, but does not explain the connections and detailed operation of the unit or the **EcmWin** software that can be used with the unit. Therefore an own document is available [1].

2. Introduction

The Potentiostat/Galvanostat is a fast and precise controller to analyze electrochemical processes. In the past, the devices became mainly used for Corrosion-research. However, always new applications arise in the areas of biochemistry and biotechnology.

The devices of the IPS/Jaisle company are basically built in analog design, which means that the appliances have practically no internal disturbing glitch and consequently no disturbing influences on the Electrochemical Process. Furthermore, the appliances are very fast, since the control rate only depends on the rise times of the used components. There are no runtime delays through digital calculated control- or filter-functions.

In principle, all IPS/Jaisle-Potentiostats can be used stand alone, i.e. they are equipped with all display- and operating elements for stationary operation. Especially the potentiostats of the PM-100 series are designed for easy experiments. Mainly they are used for Cathodic disbonding tests according to DIN 30 671 respectively ASTM G 8 respectively EN 10 285. But they can also be used for other hold-experiments or quasi-stationary experiments. Special features are the easy handling and the built-in instruments which show the applied potential and the current flow in the cell at every time and for every potentiostat. No external instruments or any switching from one to another device is necessary to see all relevant values.



The control circuits of the Potentiostat are neither damped nor restricted through any high-, low- or bandwidth-filters. The device works stable on the entire specified bandwidth. Therefore, sometimes it occurs that customers realize noise or unstable controllability at their measurements, which possibly doesn't appear with devices of other producers.

In practice, this behavior is to be assigned in all cases to environmental impacts. If the used electrolyte has a high electrical resistance, the connection for measurement becomes through an antenna to the high-ohmic input of the Reference electrode. The Potentiostat tries to regulate these disturbing signals and produces the named instabilities.

We are of the opinion that, at least in laboratory operation, the measuring arrangement should always be shielded first before any circuitry measures are taken. Ideally, the measuring cell should be placed in a Faraday cage. If it becomes apparent during laboratory operation that filters must be used in the field, there is nothing to prevent this. However, if filters are already used in laboratory operation, important information for evaluating the system may simply be missing.

Should such a case occur in your company, please contact us. We will be happy to support you with our experience.

2.1. Used symbols

	Danger – High voltage
	ATTENTION – refer to manual

2.2. Definition of important terms

Free Corrosion Potential: This is the word by word translation of the German specification. In English it's very often called as Open circuit potential (OCP) or open loop potential. It describes the potential which arises in the measuring cell between the measuring electrode and the reference electrode when the measuring or control circuit is open and no current can flow between the counter electrode and the measuring electrode.

2.3. Tasks of the potentiostat

- Measuring of the potential of a working electrode against a reference-electrode at open circuit (*Cell off*).
- Constant-hold of the potential of the working electrode against the reference-electrode in closed circuit mode (*Cell on*).
- Changes the potential of the working electrode in accordance with an internal set value through the variation of the cell current in the electrochemical cell. That Potential can be stationary, quasi-stationary.

2.4. Operation of a potentiostat

The Potentiostat is a controller which has the task to keep the working electrode of an electrochemical cell on a constant potential with the setting device adjustable potential against a reference-electrode. For this purpose, the potentiostat amplifies every small deviation of the potential of the measuring electrode from the set voltage

and thus regulates the current flowing through the cell, between the measuring electrode and the counter electrode.

2.5. Tasks of the galvanostat

The general function of the galvanostat is applying a current instead of a potential at a sample. The special in this case, why we extend this device was a customer request, who want to create hydrogen in a defined mode, here in a current related method. So the application of this device is mainly creating hydrogen, in one case in a potentiostatic mode by applying a negative potential at a coated and defined damaged sample to investigate the cathodic despondent, in the other case by creating a defined (current related) volume of hydrogen to investigate the hydrogen uptake of a steel sample (or also other samples like plastic or rubber; which are used for sealing).

2.6. Operation of a galvanostat

The operation is similar to the potentiostatic mode. A sample will connected to the device that is switch from potentiostatic to galvanostatic mode and then with selecting the polarity and turning the potentiometer, a current will drive through the sample. Beside the hydrogen embrittlement case, the device also can used for charge and discharge of batteries for example.

3. General Operation

Immediately after unpacking, the instrument should be checked for mechanical damage and loose parts in the interior. If there is any (obvious) transport damage the supplier must be informed immediately. The instrument must not be put into operation.

3.1. Safety

This device has been designed and tested in accordance with IEC Publication 1010-1 (overvoltage category II, pollution degree 2), safety requirements for electrical equipment for measurement, control and laboratory use. The CENELEC regulations EN 61010-1 correspond to this standard. It has left the factory in a safe condition. This instruction manual contains important information and warnings which have to be followed by the user to ensure safe operation and to retain the function generator in a safe condition.

The case, chassis and all measuring terminals are connected to the protective earth contact of the appliance inlet. The instrument operates according to Safety Class I (three-conductor power cord with protective earth conductor and a plug with earth contact).

The mains/line plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor.

The mains/line plug should be inserted before connection is made to measuring circuits.

Whenever it is likely that protection has been impaired, the instrument shall be made inoperative and be secured against any unintended operation. The protection is likely to be impaired if, for example, the instrument

- shows visible damage,
- fails to perform the intended measurements,
- has been subjected to prolonged storage under unfavorable conditions (e.g. in the open or in moist environments),
- has been subject to severe transport stress (e.g. in poor packing)

When opening or closing of the casing, the device must be disconnected of all voltage sources.

If a measurement or an adjustment is inevitable at the opened device under tension, so this only may happen through the manufacturer or through a specialist authorized from the manufacturer, that is trusted with the dangers interconnected with it.

In the device, there are touch-dangerous parts, which are covered by the casing in the normal operating mode.

3.2. Operation conditions

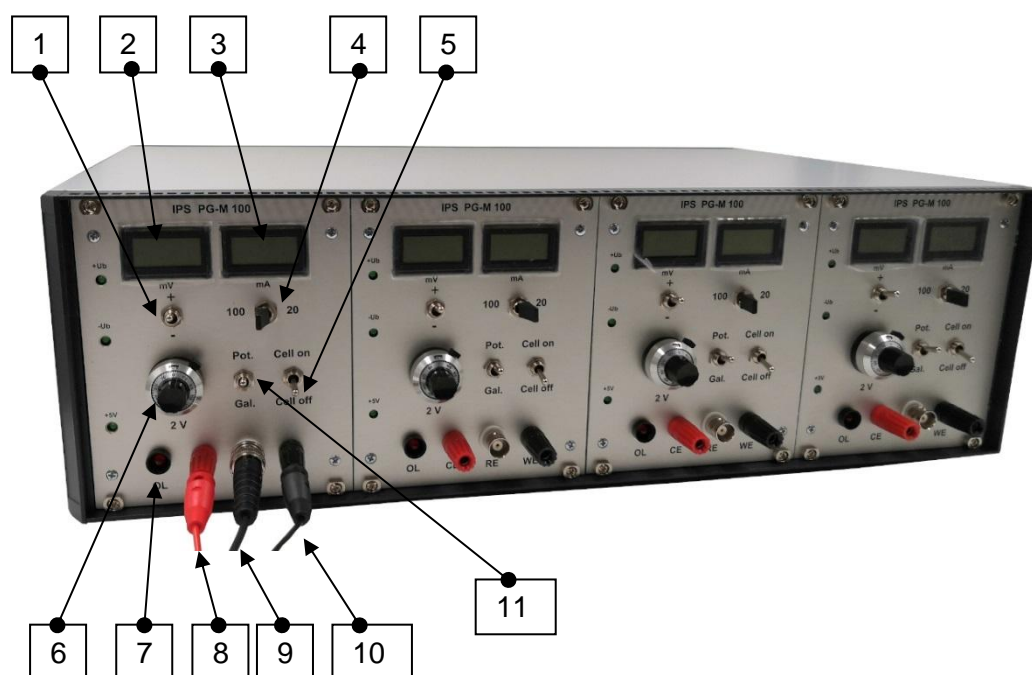
The instrument has been designed for indoor use. The permissible ambient temperature range during operation is +10°C (+50°F) ... +40°C (+104°F). It may occasionally be subjected to temperatures between +10°C (+50°F) and -10°C (+14°F) without degrading its safety. The permissible ambient temperature range for storage or transportation is -10°C ... +70°C. The maximum operating altitude is up to 2200m. The maximum relative humidity is up to 80%.

If condensed water exists in the instrument it should be acclimatized before switching on. In some cases (e.g. extremely cold device) two hours should be allowed before the instrument is put into operation. The instrument should be kept in a clean and dry room and must not be operated in explosive, corrosive, dusty, or moist environment. The Potentiostat can be operated in any position, but the convection cooling must not be impaired. The ventilation holes may not be covered. For operation the instrument should be used in the horizontal position, preferably tilted upwards, resting on the tilt handle.

The specifications stating tolerances are only valid if the instrument has warmed up for 30 minutes at an ambient temperatures between +15°C (+59°F) and +30°C (+86°F). Values without tolerances are typical for an average instrument.

4. Display and Controls

4.1. Front Side



1. Polarity-switch +/-
2. Digital display of potential of the working-electrode against the reference electrode
3. Digital display of cell current. The maximum value depends on the position of the Current range switch
4. Current range switch 20 mA, 100 mA
5. Switch between the mode open circuit potential (*Cell off*) and Closed circuit (*Cell on*)
6. Potentiometer for the polarization potential $\pm 2V$
7. Indicator for the open circuit potential (OCP) or as overload control in "Cell on" mode
8. Banana socket for counter electrode connection
9. Banana socket for reference electrode connection
10. Banana socket for working electrode connection
11. Switch between the operation mode "*Potentiostat*" and "*Galvanostat*"

4.2. Back Side



On the back side of the Potentiostat you find the main power plug and the on/off switch. With this multifunction connector you can select the main power between 230V/50Hz and 110V/50-60Hz. You have to open the cover where you see the red voltage value. Then you can remove these part and turn around to change the main power. In this part there are also the two fuses to protect the device respectively the main power circuit if there is an error in the device.

5. Starting up

If you are working the first time with a potentiostat, you should first use the device manually (**the P-M 100 only work in manual mode**) to become familiar with the conditions of an electrochemical cell.

The manual operating mode is also meaningful, if you want to examine new materials and know not exactly, which current values you can expect.

Before you switch on the Potentiostaten, please check following points:

With the power switch on the backside the Potentiostat is switched on. Switch the toggle switch [5] to *Cell off*. If no measurement cell is connected, the Potentiostat possibly shows utopian values. If a cell is connected, you see the open circuit potential working electrode against the reference electrode.

5.1. Potentiostatic Measurement

The toggle switch [5] must be in position *Cell off*.

Now, the electrodes can be connected without danger to the Potentiostat. No current can flow through the cell.

If the electrodes are connected, the display [2] shows the open circuit potential between the working electrode and the reference-electrode in mV.

The open circuit potential should stand still on a value or slowly drifting toward a constant value. If the potential jumps, so a mistake may be in parts of the cell.

Possibly, an air-bubble is in the intermediate vessel or in the reference-electrode.

- Are all electric connections o.k.?
- Are the working electrode and the intermediate vessel dipped sufficiently in the electrolyte?

Test these points and confiscate that the displayed potential is stable. Only then, it is meaningful to continue the process at all.

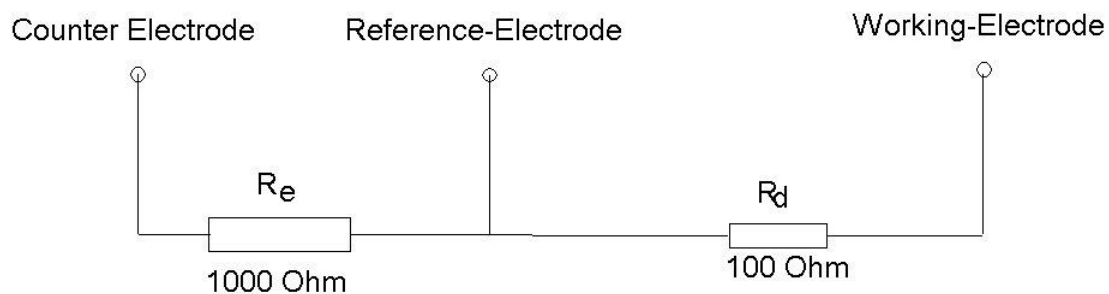
If stable potential appeared, you can switch with the toggle switch [1] to the same polarity that the OCP has. In most cases you will see a potential between +/- 1000 mV. It depends on the material you use. Now, you turn the potentiometer [6] to the right. Observe the indicator [7]. At the beginning the indicator light is burning. If the LED light is going down the internal set potential is close to the open circuit potential. Now, you can switch to *Cell on* without the risk to damage your working electrode. The internal potential is the same as the OCP and now current (or a very low value) will flow between counter electrode and working electrode.

Comment:

About the high amplification of the internal difference-amplifier it doesn't become always through succeeds to balance the light off. This is not necessary however. Already one short going out or going darker means, that the open circuit potential was set exactly on fractions of one mV. Now, you can switch to *Cell on* [5] and polarize cathodic or anodic with the potentiometer [6]. The polarity of the polarization refers to the working electrode. Keep an eye on the instrument [3] (Current) and switch the current range position [4] if necessary, that the indicator is in the upper area of the scale. The maximum current is specified with 100mA. But the instrument also can show bigger values and the potentiostat deliver normally more than 100mA. The maximum value can be 150mA or up to 200mA. May be, this values cannot hold very long, because the internal power supplies were fused with electronic fuses. They can hold a higher current for a time but not continues. So don't be shocked if you see an higher values than 100mA.

The working electrode is virtual on earth, it may not become real earthed. In this case the Potentiostat does not work.

A simply test of the Potentiostat can execute with an ohmic dummy-cell. Connect two resistances like subsequently portrayed at the Potentiostat.



After switching on the Potentiostat, the DVM [2] shows 0 mV, if the toggle switch [5] is switched in position *Cell on*. Put the I-Range [4] on an value of 20 mA and the potentiometer [6] on an value of 1000 mV (control at the DVM [2]). The μ A meter [3] shows 10mA. That means that at an potential of 1000 mV is at the 100 ohm Resistance of the dummy-cell, the current is:

$$\frac{1000 \text{ mV}}{100 \text{ Ohm}} = 10 \text{ mA}$$

the compliance voltage is then:

$$U = 1100 \text{ Ohm} \times 10 \text{ mA} = 11\text{V}$$

or

$$V = 1 + \frac{R_1}{R_2} = 1 + \frac{1000}{100} = 11 \text{ V}$$

Hint

11V is the maximum output voltage of the Potentiostat.

5.2. Galvanostatic Measurement

In the galvanostat mode, the potentiometer with 2V control voltage can be used to set 10mA and 100mA, which is depending on the selected range

In the 20mA range you can set +-20mA with the full modulation of 2V and in the 100mA range actually +- 200mA, although the device is specified with 100mA only.

The 200mA is not intended for continuous operation, but if you need it for a short time, it is feasible.

6. Warranty

IPS Elektroniklabor GmbH & Co. KG warrants to its customers that the product it manufactures and sells will be free from defects in materials and workmanship for a period of 2 years. This warranty shall not apply to any defect, failure or damage caused by improper use or inadequate maintenance and care. **IPS** shall not be obliged to provide service under this warranty to repair damage resulting from attempts by persons other than **IPS** representatives to install, repair, service or modify these products. In order to obtain service under this warranty, Customers must contact and notify the distributor who has sold the product.

Each instrument is subjected to a quality test with 24 hour burn-in before leaving the production. Practically all early failures are detected by this method. In the case of shipment by post, rail or carrier it is recommended that the original packing is carefully preserved. Transport damages and damage due to gross negligence are not covered by the guarantee. In the case of compliance, a label should be attached to the housing of the instrument which describes briefly the faults observed. If at the same time the name and telephone number (dialing code and telephone or direct number or department designation) is stated for possible queries, this helps towards speeding up the processing of guarantee claims.

7. Technical Data

Polarisation Range	$\pm 2V$
Compliance Potential	$\pm 11V$
Maximum current	$\pm 100mA$
Rise time	100 $\mu s/V$
Current range	$\pm 20mA$ and $\pm 100mA$

8. List of documents

Referenced sources of information are listed here:

[1]	<i>IPS Elektronlabor GmbH & Co KG: Manual „EcmWin - Software for Electrochemical Measurement“</i>
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