RRDE/RDE-2/RCE

User Manual

Declaration of conformity

Name of commodity	Autolab RDE-2 Autolab RRDE	Metrohm Autolab B.V. Utrecht, The Netherlands autolab@metrohm.com www.metrohm.com
Description	Rotating Disk Electrode (RDE-2) and Rotating Ring Disk Electrode (RRDE) with a rotating liquid Hg contact, including a system for controlling rotational speed of a dedicated DC motor.	

This instrument is designed and tested according to the standards:

Electromagnetic compatibility: Requirements

EN 61326-1:2013

Electromagnetic compatibility: Emission

EN61000-3-2:2014 – fulfilled EN 61000-3-3:2013

Electromagnetic compatibility: Immunity

EN 61326-1:2013

Safety specifications

EN 61010-1 - Every instrument is routine-tested according to EN/IEC 61010-1 Appendix F in the production division.

CE

The instrument is in conformity with EU directives 2014/35/EU (Low Voltage Directive, LVD); 2014/30/EU (EMC Directive, EMC); 2011/65/EU (Directive for certain hazardous substances, RoHS) and fulfills the following specifications:

EN 61326	Electrical equipment for measurement, control and laboratory use – EMC requirements.
EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control and laboratory use.

Metrohm Autolab B.V. is holder of the TÜV-certificate of the quality system ISO 9001:2015 for quality assurance in development, production, sales and service of instruments and accessories for electrochemistry including technical support (registration number 7528).

Utrecht, November 30, 2017

J.J.M. Coenen
QC Manager

A. Idzerda
Head of Production

Metrohm Autolab B.V. at Utrecht will not accept any liability for damages caused directly or indirectly by connecting this instrument to devices, which do not meet relevant safety standards. The AUTOLAB RDE-2, RCE and RRDE were developed as a laboratory research instrument. Metrohm Autolab B.V. cannot under any circumstance be held responsible for the results of the use of the RDE-2, RCE or RRDE.
Please read this manual carefully before using the RDE-2, RCE or RRDE system

SAFETY PRACTICES

General

The following safety practices are intended to ensure safe operation of the equipment. Not following these instructions when using the Autolab Motor Controller in combination with the RDE-2 or the RRDE rotator, may cause unsafe operation.

Metrohm Autolab is not liable for any damage caused by not complying with the following instructions.

Electrical Hazards

- There are no user-serviceable parts inside. Servicing should only be done by qualified personnel.
- Removal of panels exposes to potentially dangerous voltages. Always disconnect the controller from all power sources before removing protective panels.
- Replace blown fuses only with size and rating stipulated on or near the fuse panel holder and in the manual.
- Replace or repair faulty or frayed insulation on power cords and motor cable.
- Replace motor cable only with the original spare part.
- When replacing power cord, use only approved type and conform local regulations.
- Be sure power cords are plugged into the correct voltage source and always use a wall outlet with protective earth.
- Check all connected equipment for proper grounding. Do not move the motor controller with power cords connected.

General Precautions

- Do not place the controller on an unstable surface.
- Do not expose the controller to damp or wet conditions.

Warning

The RDE-2 and RRDE rotators contain sealed mercury contacts. In case of damage to the unit please handle with care. Do not throw the unit with ordinary waste.

GENERAL SPECIFICATIONS

Table 1 – General specifications

Power Supply (V)	Autolab Motor controller
	100 – 240 V ± 10% selectable in 4 ranges
	100: 90 – 110 V
	120: 108 – 132 V
	220: 198 – 242 V
	240: 216 – 264 V
Power line frequency	50-60 Hz
Power consumption	50 VA (max)
Fuse (A-slow-slow)	100 V – 630 mAT
	120 V – 630 mAT
	220 V – 315 mAT
	240 V – 315 mAT
Operating environment	0 °C to 40 °C ambient temperature without derating
	80% relative humidity
Storage environment	-10 °C to 60 °C ambient temperature
Dimensions (W x H x D)	196 mm x 77mm x 245 mm (excl. connectors)
Weight	2.8 kg (controller only), 0.5 kg (rotator only)
Safety designed to	EN61010
EMC compliance	EN61326-1
Warm-up time	Not applicable
Motor speed range	100 ~ 10.000 Revolutions Per Minute (RPM)
Manual speed setting	100 ~ 10.000 RPM in 1 RPM steps
Remote speed setting	Speed set point: 0.1 ~ 10.0 V for 100 ~ 10.000 RPM respectively
Connection through insulated BNC connector	Core = HI-in, Shield = LO-in
	Differential input impedance: 1 MΩ ± 5%

	|Vin| max = 40 V
Settling time (Remote)	< 200 ms to within 2% of F.S. step
	(non linear operation: motor current limited)
	< 40 ms to within 2% of 1000 RPM step
Acceleration/Deceleration	Approx. 4000 RPM/s run/stop slope (MANUAL CONTROL)
Pollution degree	2
Installation category	II

Table of Contents

1 – Description

The Autolab RDE-2 (Rotating Disc Electrode), the Autolab RCE (Rotating Cylinder Electrode) and Autolab RRDE (Rotating Ring Disc Electrode) consist of the Autolab Motor Control Unit (MCUR) and a specific rotator (RDE-2 or RRDE). Figure 1 shows the RDE-2 setup.

Figure 1 – The Autolab motor controller (MCUR, left) and the rotator (RDE-2) mounted on the electrochemical cell (right)

1.1 – RDE-2 scope of delivery

The Autolab Rotating Disc Electrode (RDE-2) is supplied with the following items:

1. Autolab Motor Controller Unit (MCUR)
2. Autolab RDE-2 Rotator
3. Two-way connection cable
4. 1 m BNC cable
5. Power cable
6. 3 mm platinum RDE tip

1.2 – RCE scope of delivery

The Autolab Rotating Cylinder Electrode (RCE) is supplied with the following items:

1. Autolab Motor Controller Unit (MCUR)
2. Autolab RDE-2 Rotator
3. Two-way connection cable
4. 1 m BNC cable
5. Power cable
6. RCE electrode tip with one Stainless steel and one Carbon steel cylinders

1.3 – RRDE scope of delivery

The Autolab Rotating Ring Disc Electrode (RRDE) is supplied with the following items:

1. Autolab Motor Controller Unit (MCUR)
2. Autolab RRDE Rotator
3. Three-way connection cable
4. 1 m BNC cable
5. Power cable
6. 5 mm platinum/platinum RRDE tip

2 – Electrode tips

Metrohm Autolab offers electrode tips for the two types of rotators:

- RDE tips, compatible with the RDE-2 rotator only
- RDE tips, compatible with the RDE-2 and the RRDE rotators
- RRDE tips, compatible with the RRDE rotators only
- RCE tips, compatible with the RDE-2 rotator only

Warning

The 3 mm (6093950xx and 612043xx) and 5 mm (350000xxxx) type of disk electrodes are compatible with the Autolab RRDE rotator with the disk contact taken from the WE2 cable of the RRDE rotator.

Do not attempt to any other disk or cylinder electrodes on the RRDE shaft as this will damage the shaft.

Warning

The Maximum rotation rate of the Rotating Cylinder Electrodes (RCE) in combination with the RDE-2 rotator is **5000 rpm**.

Warning

Never apply excessive force when mounting the electrodes on the rotator.

2.1 – RDE electrode tips

The RDE electrodes are available in two different form factors (3 mm and 5 mm), as shown in Figure 2.

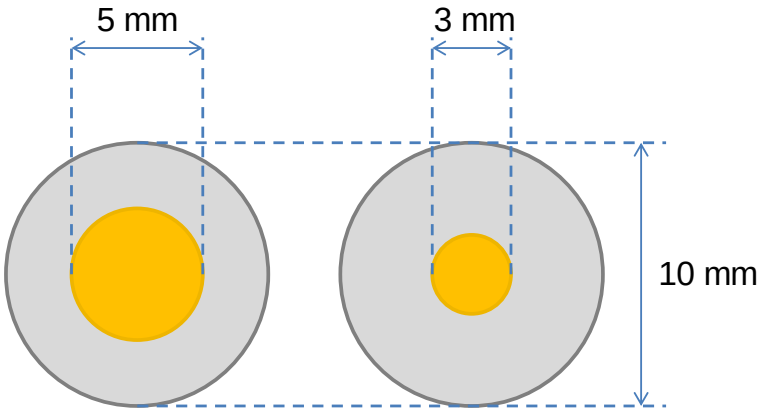

Figure 2 – The two different RDE form factors

These electrode tips are fitted in a 10 mm PEEK shaft.

Warning

The 3 mm (6093950xx and 612043xx) and 5 mm (350000xxxx) type of disk electrodes are compatible with the Autolab RRDE rotator with the disk contact taken from the WE2 cable of the RRDE rotator.

Do not attempt to any other disk or cylinder electrodes on the RRDE shaft as this will damage the shaft.

Warning

All electrode tips can be used in a temperature range of 10 °C to 40 °C.

Table 2 summarizes the available RDE tips available for the Autolab RDE-2.

Table 2 – Overview of the RDE tips

Item code	Material and diameter	Shaft material	Thread
609395014 61204300 (old)	Glassy carbon, 3 mm	PEEK	M4
609395024 61204310 (old)	Platinum, 3 mm	PEEK	M4
609395034 61204320 (old)	Gold, 3 mm	PEEK	M4
609395044 61204330 (old)	Silver, 3 mm	PEEK	M4
3500003900 RDE.GC50.S (old)	Glassy carbon, 5 mm	PEEK	M4
3500003910 RDE.Pt50.S (old)	Platinum, 5 mm	PEEK	M4
RDE.Au50.S	Gold, 5 mm	PEEK	M4
RDE.Ag50.S	Silver, 5 mm	PEEK	M4
3500003870 RDE.BLANK.S (old)	Empty tip, 5 mm	PEEK	M4
3500003880 RDE.Cu50.S (old)	Copper, 5 mm	PEEK	M4
3500003930	Carbon Steel, 5 mm	PEEK	M4

RDE.Steel.S			

Warning

Please refer to the chemical compatibility table for PEEK (Polyether ether ketone) provided at the end of this document.

Note

The 3500003870 tip is an empty 5 mm diameter tip in which any 5 mm sample can be fitted (tolerance: ±0.02 mm). **The inserted disk is not removable.**

2.2 – RRDE electrode tips

The RRDE electrodes are available in a single form factor, shown in Figure 3.

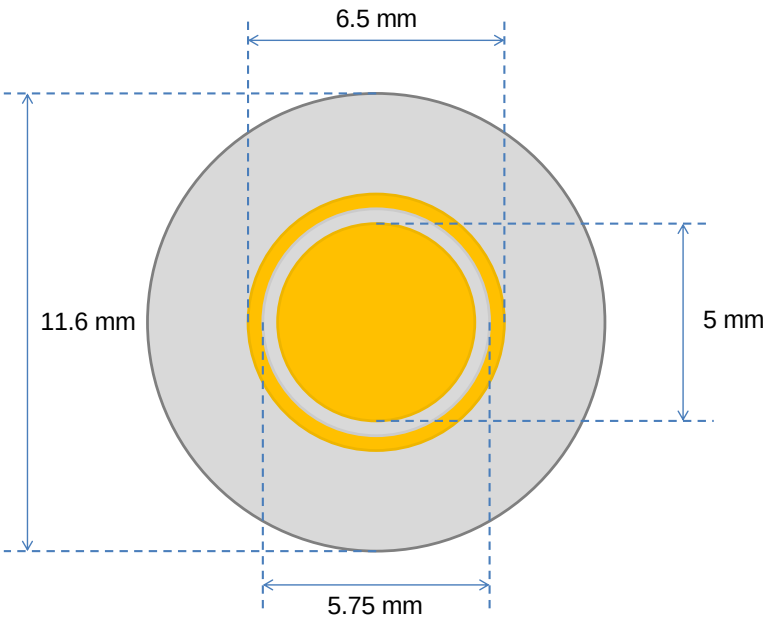

Figure 3 – The RRDE form factor

The disk diameter is 5 mm, the gap between the disk and ring is 375 µm and the thickness of the ring is 375 µm. The theoretical collection efficiency of the RRDE electrode is 24.9%. The plastic parts of the electrode are all made of PEEK.

Table 3 summarizes the available RRDE tips available for the Autolab RRDE.

Table 3 – Overview of the RRDE tips

Item code	Disk	Ring	Shaft material	Thread
RRDE.PTPT.S	Platinum, 5 mm	Platinum	PEEK	M4
RRDE.AUPT.S	Gold, 5 mm	Platinum	PEEK	M4
RRDE.GCPT.S	Glassy carbon, 5 mm	Platinum	PEEK	M4

Warning

Please refer to the chemical compatibility table for PEEK (Polyether ether ketone) provided at the end of this document.

Note

The theoretical collection efficiency of the RRDE tips is 24.9%.

Warning

The RRDE tips are only compatible with the RRDE rotators.

2.3 – RCE electrode tips

The RCE electrodes are available in a single form factor, shown in Figure 4.

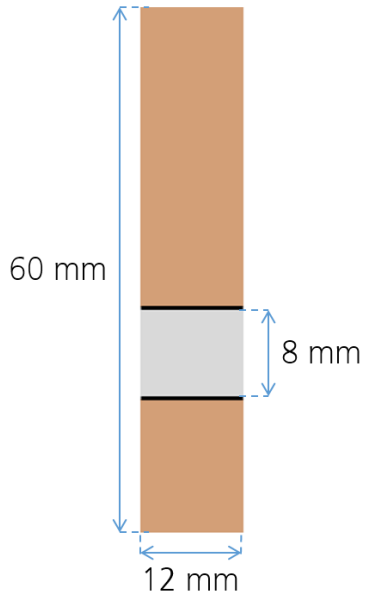

Figure 4 – The RCE form factor

The RCE electrode is composed of a PEEK holder, a cylindrical insert (the sample), and two Viton O-rings. The RCE electrode length is 60 mm, and the outer diameter (OD) is 12 mm. The cylindrical insert is made of stainless steel or carbon steel, and it has a length of 8 mm and a diameter of 12 mm.

Table 4 summarizes the RCE tip and inserts available for the RDE rotators.

Table 4 – Overview of the RCE tip and inserts

Item code	Insert material	Shaft material	Thread
RCE.EL	--	PEEK	M4
RCE.CYL.SS304	Stainless steel 304	--	--
RCE.CYL.CS1018	Carbon steel 1018	--	--

Warning

The maximum rotation rate of the RCE electrodes is 5000 rpm.

DO NOT rotate the RCE at higher rotation rates.

Warning

Please refer to the chemical compatibility table for PEEK (Polyether ether ketone) and Viton provided at the end of this document.

Warning

The RCE tip is only compatible with the RDE-2 rotators.

3 – Installation of the RDE-2 and RRDE rotator

After unpacking, inspect the unit to make sure that there is no damage.

Warning

The RDE-2 and RRDE rotators contain sealed mercury contacts. In case of damage to the unit please handle with care. Do not throw the unit with ordinary waste.

3.1 – Mounting the electrode

In order to mount the electrode tip on the RDE-2 shaft or on the RRDE shaft, press the shaft block button shown in Figure 5 and rotate the axis manually until the button engages completely and locks around the shaft. This will lock the RDE-2 and the RRDE shaft.

While holding the button, mount the electrode tip on the shaft and turn the tip until it is firmly in place. Once the electrode tip is attached, release the blocking button. Turn the working electrode shaft gently with your fingers. The shaft should turn freely. If it does not turn freely make sure that the shaft blocking button is completely released.

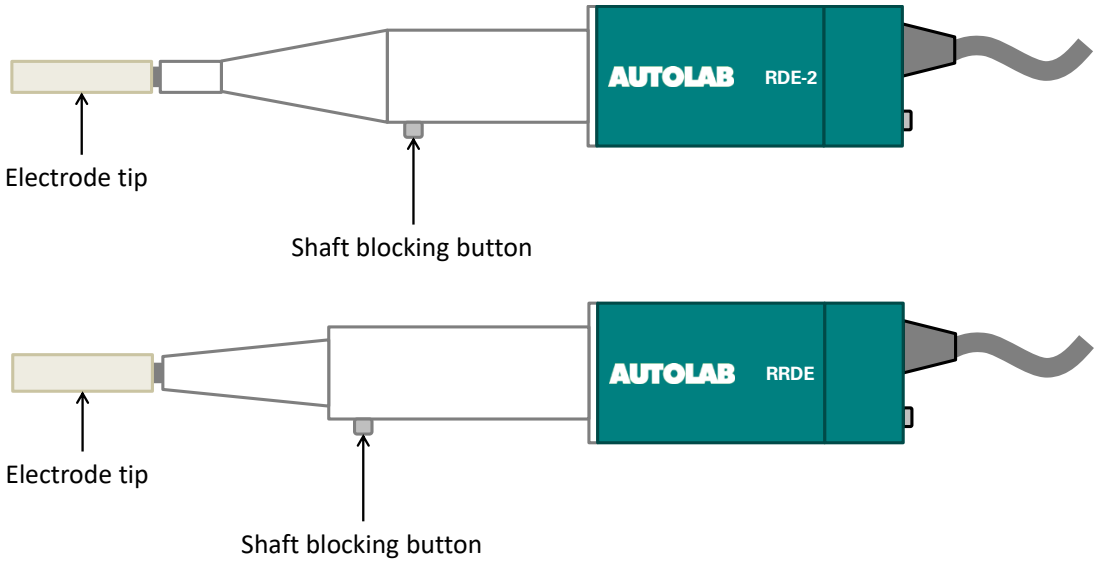

Figure 5 – Overview of the RDE-2 (top) and RRDE (bottom) rotators

Warning

Running the RDE-2 or RRDE rotator with the shaft blocking button not completely released or with the working electrode shaft blocked can result in damage to the motor. If the locking button is pressed accidentally, a force feedback mechanism prevents locking of the shaft during the rotation of the RDE-2 or RRDE.

Warning

Never engage the shaft blocking button with the leads from the Autolab connected to the rotator. Always disconnected the cables before using the shaft blocking button.

3.2 – Connecting the RDE-2 and RCE to the Autolab

The RDE-2 rotator is supplied with a Y shaped cable (item code: AUT.RDE.ELCB), shown in Figure 6, which is used to connect the WE+S banana connector and the ground connector provided by the Autolab PGSTAT.

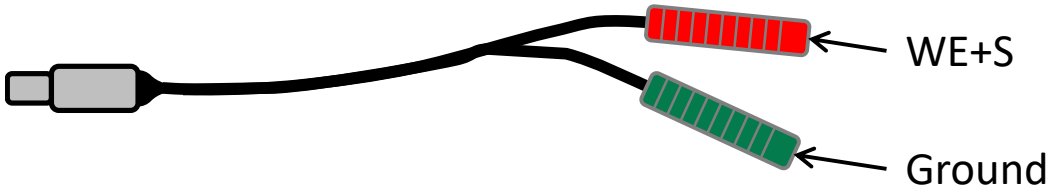

Figure 6 – The Y connector used to connect the WE/S and Ground cables from the Autolab

Connect the Y cable to the top of the RDE-2 (see Figure 7).

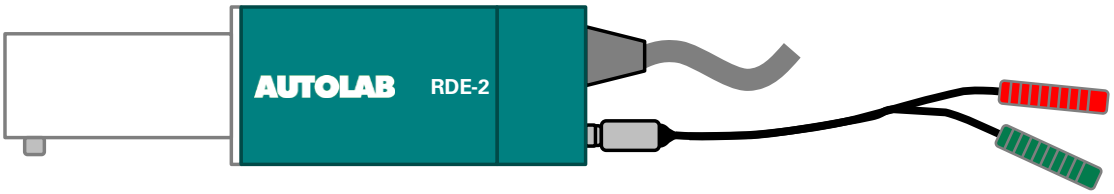

Figure 7 – The Y cable connected to the top of the RDE-2

3.3 – Connecting the RRDE to the Autolab

The RRDE is supplied with a three-way cable (item code: AUT.RRDE.ELCB), shown in Figure 8, which is used to connect the WE+S banana connector and the ground connector provided by the Autolab PGSTAT.

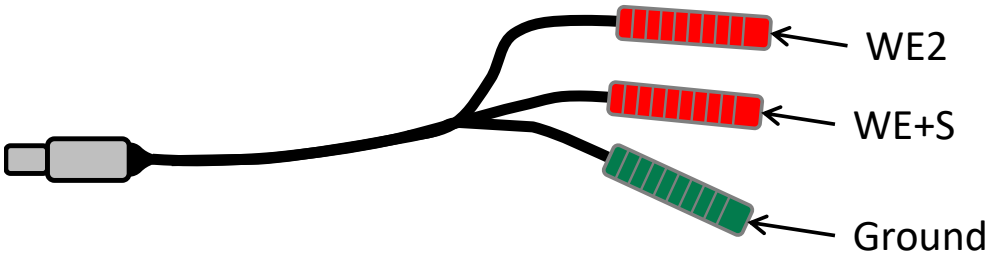

Figure 8 – The three-way connector used to connect the WE/S, WE(2) and Ground cables from the Autolab

An additional connection is provided for the WE(2) provided by the BA module for the Autolab. The BA module can be used in a Bipontentiostat or Scanning Bipotentiostat mode.

Note

The BA module is required to perform rotating ring/disc measurements using the Autolab RRDE.

Note

When a 3 mm or 5 mm disk electrode (6093950xx, 612043xx or 350000xxxx RDE) is used with the RRDE rotator, the contact from the disk electrode is taken by the WE2 cable of the RRDE rotator. Therefore, the WE+S of the PGSTAT cell cables must be connected to the WE2 of the RRDE rotator.

Connect the three-way cable to the top of the RRDE (see Figure 9).

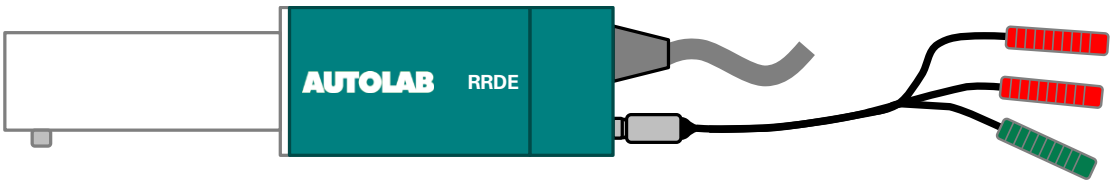

Figure 9 – The three-way cable connected to the top of the RRDE

3.4 – Positioning the rotator in the cell

With the electrode tip attached to the rotator, insert the rotator in the cell lid. The rotator should be located in a vertical position with respect to the solution.

Note

Take care not to submerge the entire electrode in solution!

Note

The rotator must be placed vertically. For RDE, RCE and RRDE experiments, it is recommended to allow for enough room around and below the tip to prevent interference to the hydrodynamic flow. It is recommended to use a large cell volume (cell 6.1415.340 or similar).

Figure 10 shows proper positioning of the tip in the cell, for RDE and RRDE experiments.

Figure 10 – Correct position of the RDE-2 or RRDE tip in the cell

Figure 11 shows proper positioning of the tip in the cell, for RCE.

Figure 11 – Correct position of the RCE tip in the cell

4 – Installation of the motor controller

Make sure that the motor controller is correctly configured for the applicable mains voltage prior to applying power to the unit. The line fuses and mains input range selector are listed in the specifications (see Table 1).

The power line voltage selector is factory set to the mains voltage of the country of interest, along with the appropriate fuses, by default, before shipping.

4.1 – Powering the motor controller

The mains power is applied to the unit by operating the mains switch on the rear panel, labeled **POWER** (see Figure 12).

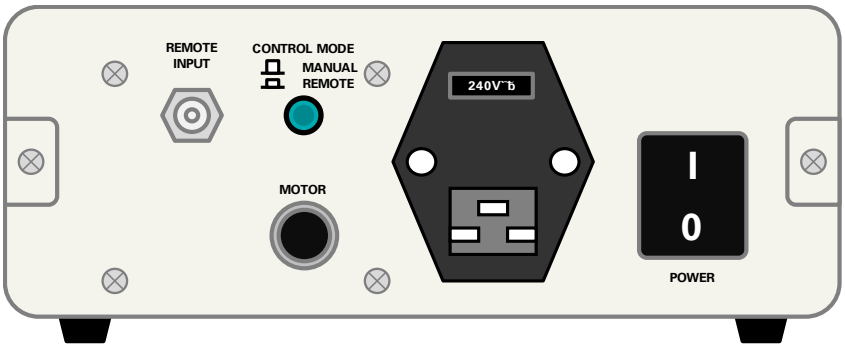

Figure 12 – The rear panel of the Autolab Motor Controller

When the unit is powered, the numerical display on the front panel will be illuminated. The **SPEED** display on the front panel should read 0000 ±4 RPM. The **RUN/STOP** button located on the front panel will blink (see Figure 13).

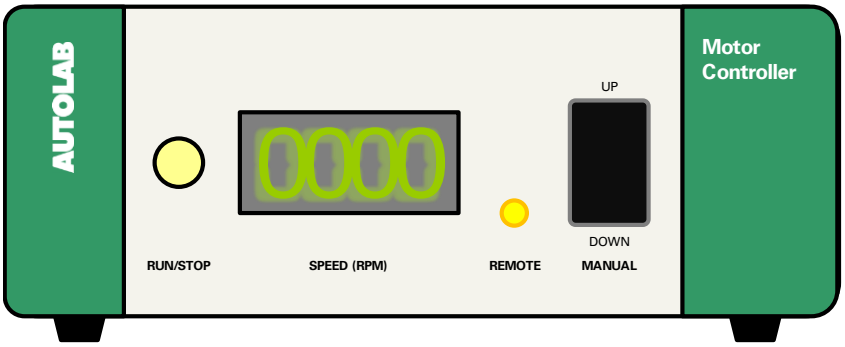

Figure 13 – The Autolab Motor Controller front panel

Note

The front panel display shows the real time rotation rate of the rotator. If the latter is not connected to the motor controller, the rotation rate will be 0 RPM.

4.2 – Connecting the rotator

The RDE-2 and RRDE rotators are fitted with a cable and multipole connector matching the **MOTOR** plug located on the backplane of the Autolab Motor Controller. Connect the cable of the rotator to this plug (see Figure 12).

When the rotator is connected to the Motor Controller, the **RUN/STOP** button will stop blinking and will be switched off. To switch on the rotator, press the **RUN/STOP** button. The rotator will rotate at 100 RPM.

Note

The minimum rotation rate is 100 RPM. Please inquire for lower minimum rotation rates.

4.3 – Control of the rotation rate

The rotation rate of the rotator can be controlled either manually, through the **UP/DOWN** button located on the front panel of the motor controller, or remotely through a connection to the Autolab potentiostat/galvanostat using the NOVA software.

To toggle the control mode, the **CONTROL MODE** switch located on the back plane of the motor controller is used.

- With the switch in the **disengaged** position (⏏), the rotator is controlled manually. In this control mode, both the switch itself and the **REMOTE** indicator on the front panel of the Motor Controller are unlit (see Figure 12 and Figure 13). In this mode, the rotation rate can only be controlled manually.
- With the switch in the **engaged** position (⏏), the rotator is controlled remotely. In this control mode, both the switch itself and the **REMOTE** indicator on the front panel of the Motor Controller are lit (see Figure

12 and Figure 13). In this mode, the rotation rate can only be controlled remotely.

4.4 – Manual control of the rotation rate

In manual control, with the Control switch on the back plane of the instrument in the disengaged position (⊔), the rotation rate is controlled using the **UP/DOWN** rocker button located on the front panel of the Motor Controller.

- Pressing the button up or down once will increase or decrease the rotation rate by 1 RPM.
- Pressing and holding the up or down button will steadily increase or decrease the rotation rate. The longer the button is pressed, the larger the rotation rate increment or decrement becomes. The rotation rate increment or decrement will increase in decades with time. Initially the variation is 1 RPM, then 10 RPM and so on until 1000 RPM.

Once the rotation rate is set, it is possible to switch the rotation off (or on again) by pressing the **RUN/STOP** button on the front panel of the Motor Controller. Setting this switch off or on, the rotation rate of the rotator is stopped (or resumed) with a deceleration (or acceleration) of 4000 RPM/s.

Note

It is also possible to set the rotation rate without a rotator connected to the Motor Controller. In this case, the specified rotation rate will be stored in the Motor Controller and used as the rotation rate as soon as a rotator is connected to the device and the rotation enabled.

4.4.1 – Remote control of the rotation rate

In remote control, with the Control switch on the back plane of the instrument in the engaged position (⊓), the rotation rate is controlled through the NOVA

software using the DAC164 1 → or the Vout output of the Autolab potentiostat/galvanostat.

In order to allow the remote control of the rotator, the 1 m long BNC cable supplied with the Motor Controller must be connected to the female BNC plug located on the back plane of the Motor Controller (see Figure 12).

Warning

To exclude any deviations in remote speed set points due to the load impedance of the controller's remote input please respect the controller's input impedance of 1MΩ ±5%.

The other end of the BNC cable must be connected to the:

- DAC164 ← 1 output located on the front panel of the 8 and 7 Series Autolab PGSTAT (see Figure 14).

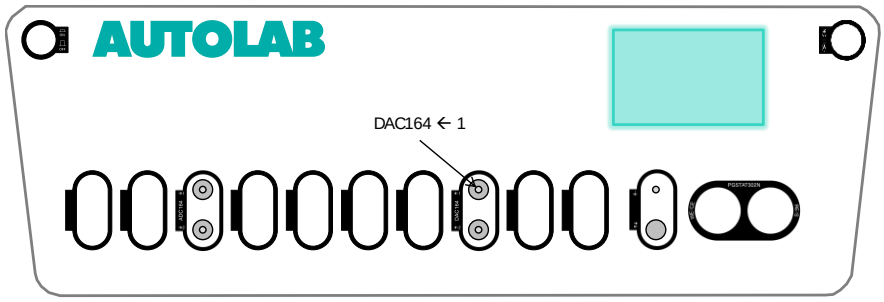

Figure 14 – The DAC164 ← 1 output is used to control the Autolab Motor Controller

- Vout output located on the back plane of the µAutolab type II and III (see Figure 15).

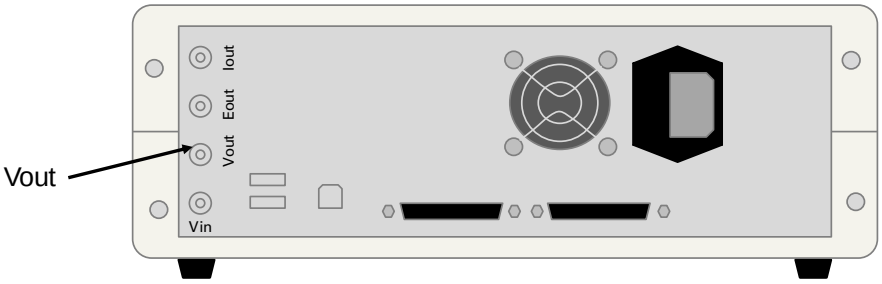

Figure 15 – The Vout located on the back plane of the µAutolab type II/III is used to control the Autolab Motor Controller

- Vout provided by the optional monitor cable for the Autolab PGSTAT101/204 or Autolab M101/M204 (see Figure 16).

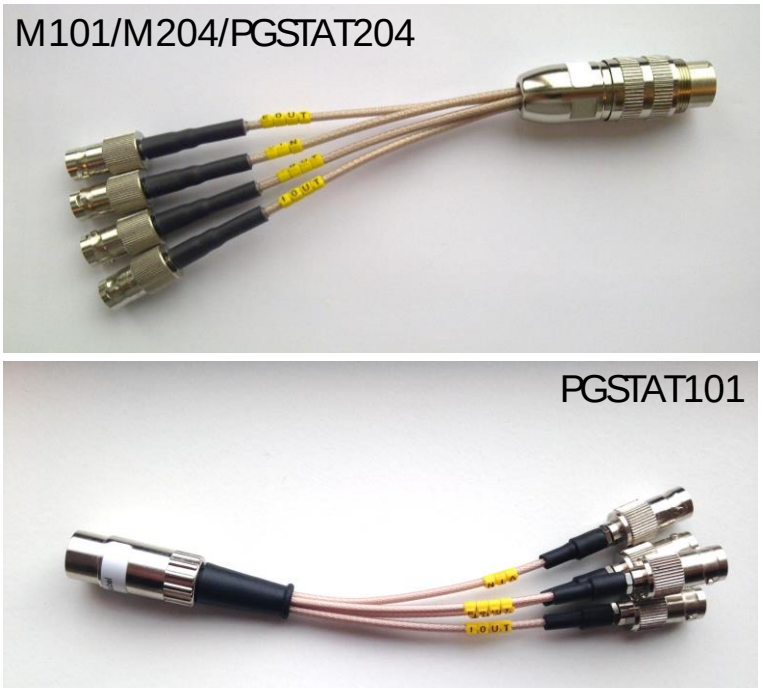

Figure 16 – The Vout provided by the optional monitor cable for the Autolab M101/M204 and Autolab PGSTAT101/204 is used to control the Autolab Motor Controller

Warning

When connected to the PGSTAT302F, the Motor Controller can only be remotely controlled if the PGSTAT302F is set to **non-floating mode**. Please refer to the NOVA User Manual for more information.

Regardless of the type of instrument used to control the rotation rate, the proper settings need to be specified in the NOVA software. In the Hardware Setup window, select the External additional module. From the panel in the frame on the right-hand side, select the *Autolab R(R)DE* option for the DAC164 ← 1 drop-down list (or the Vout), as shown in Figure 17.

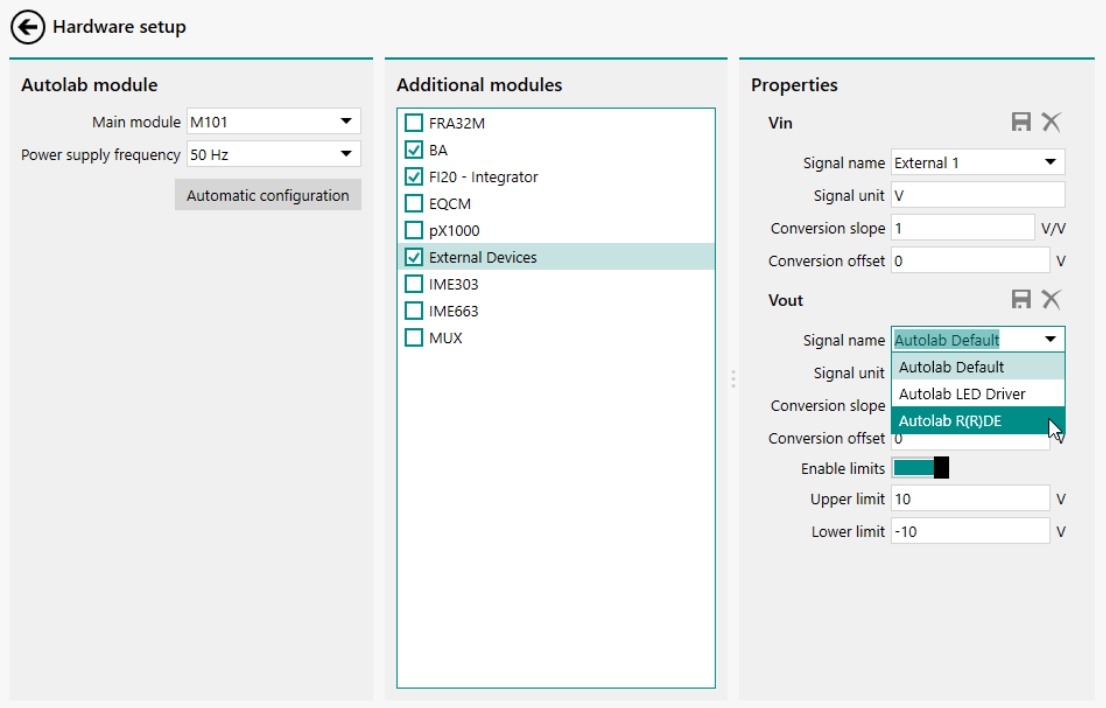

Figure 17 – Selecting the *Autolab RDE* from the drop-down list in the Hardware Setup

Click the button to validate the change and close the Hardware Setup window. Once the hardware setup is specified, the rotator can be controlled remotely from the NOVA software.

Using the NOVA software, the rotation rate can be specified in two different ways:

- Manually, using the Autolab display
- In a NOVA procedure, using the Autolab control command

4.5 – Direct remote control of the rotation rate

Note

The NOVA software controls of the RDE-2 and the RRDE are the same. Both rotators are identified as *RDE* in the software.

Note

For the remote control of the RDE/RCE in INTELLO, please see the VIONIC powered by INTELLO user manual.

To manually specify the rotation rate of the rotator, select the Manual control option from the View menu, as shown in Figure 18.

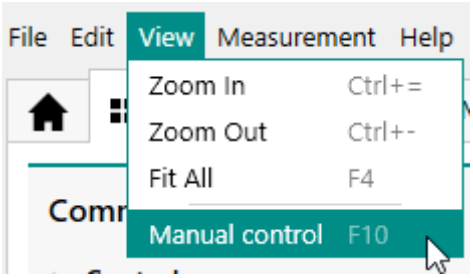

Figure 18 – Showing the manual control in NOVA

The Autolab display window will be shown, with an extra panel at the right side of the window, which can be used to control the rotation rate of the rotator (see Figure 19).

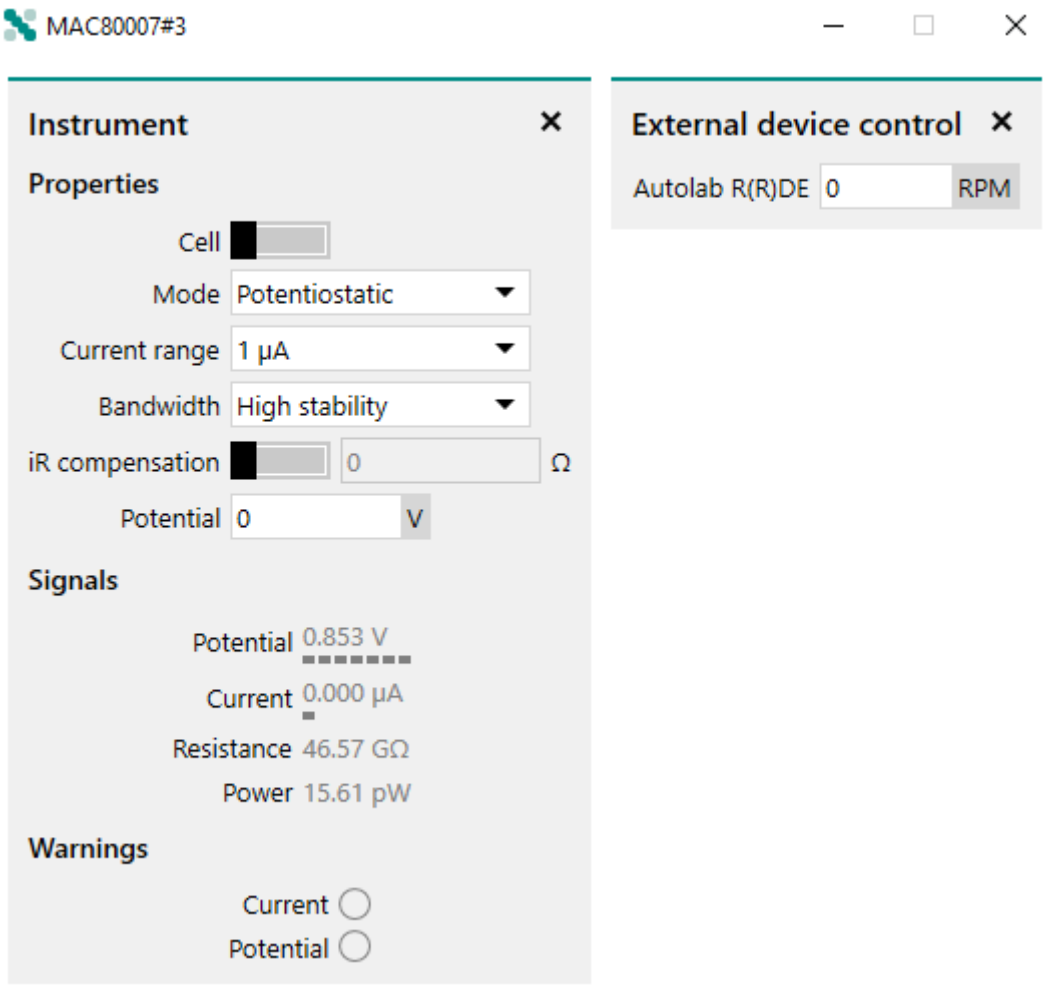

Figure 19 – The Autolab display with the control panel for the rotator

To set the rotation rate, click the **Autolab RDE (RPM)** label and specify the rotation rate (see Figure 20).

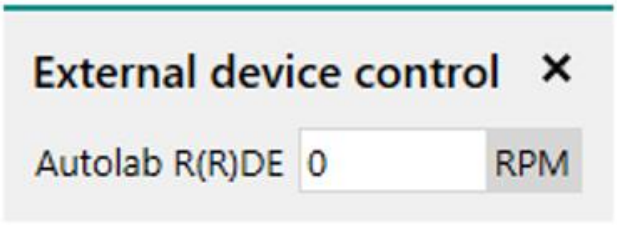

Figure 20 – Specifying the rotation rate (1/2)

Press the Enter key to validate the rotation rate. The specified rotation rate will be set for the connected rotator (see Figure 21).

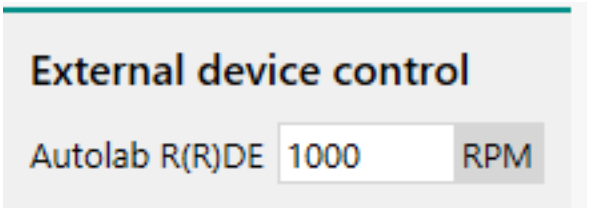

Figure 21 – Specifying the rotation rate (2/2)

Note

The rotation rate indicated in the Autolab display window is the specified rotation rate. The real rotation rate is indicated on the front panel display of the Autolab Motor Controller. This rotation rate is determined using the optical encoder located inside the motor of the rotator.

The rotation rate can be adjusted to any value at any time using the control provided by the Autolab display.

Note

The specified rotation rate must be between 10000 RPM and 100 RPM.

4.6 – Procedure control of the rotation rate

The rotation rate of the rotator can be adjusted at any time in a NOVA procedure, using the *Autolab control* command. The control of the rotator is provided on the properties of the *Autolab control* command section. Click on the More button (see Figure 23).

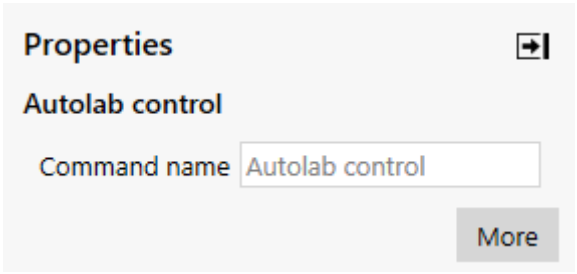

Figure 22 - The properties of the Autolab control command.

The control of the rotator is listed in the advanced options (Figure 23).

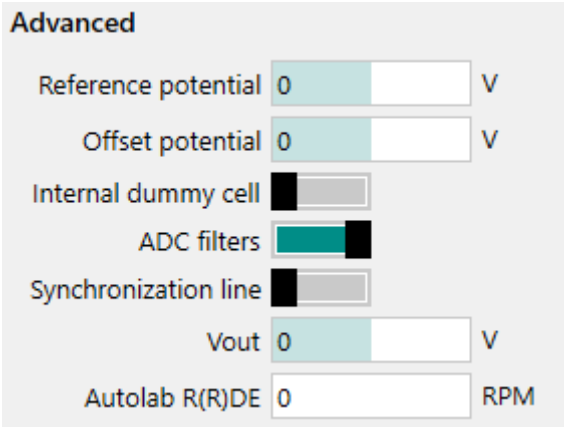

Figure 23 – Setting the rotation rate in the Autolab control window

It is also possible to adjust the rotation rate by using the slider provided in the window (see Figure 24).

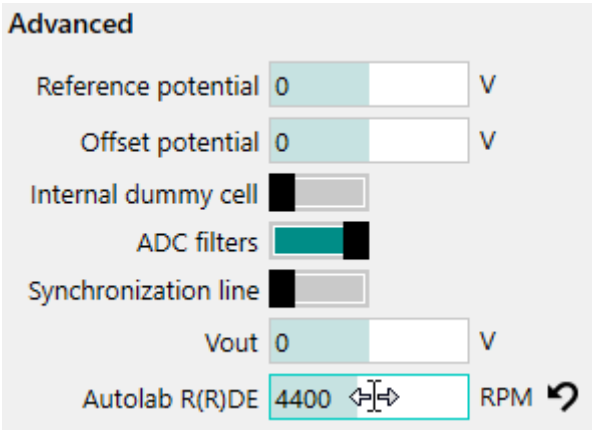

Figure 24 – The rotation rate can also be set using the provided slider

Click the button to close the editor. The properties of the Autolab control command will be adjusted, showing the specified rotation rate (see Figure 25).

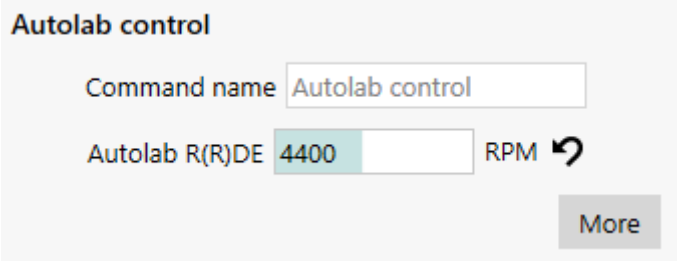

Figure 25 – The specified rotation rate is shown in the procedure editor

NOVA includes a ready-to-use Hydrodynamic linear sweep procedure and a Hydrodynamic linear sweep for RRDE procedure in the Autolab group of procedures. This can be used as a template for NOVA experiments during which remote control of the Autolab RDE-2, RCE or RRDE is required. Refer to NOVA User Manual for more information about the control of the RDE-2 and the RRDE in NOVA.

Note

The **Autolab RDE and RCE can also be connected to VIONIC and controlled in INTELLO**. Please see the VIONIC powered by INTELLO user manual for the RDE and RCE connection details.

5 – Removing the electrode tip

To remove the electrode tip from the rotator, the rotation must first be stopped.

Always remember to press the **RUN/STOP** button on the motor controller unit and be sure the LED is not illuminated. It is important to stop the rotation completely, otherwise damage may result to the shaft blocking button and maybe even to the Hg contact itself.

Remove the rotator from the electrochemical cell being sure to rinse off all solution material/salts. Dry both the electrode and the axis carefully with a soft lab tissue. Block the shaft of the rotator by pressing the blocking button to lock the shaft and very gently, by hand, untwist the electrode tip.

Note

Exert no force beyond that of your own fingers. Do not use tools to remove the electrode.

Warning

If the electrode cannot be removed by hand using the axis locking button, the unit must be returned to Metrohm Autolab for repair! Using excessive force on the axis may break the Hg contact. If the Hg contact leaks, future measurements will be unreliable.

6 – Caring for the electrode tip

It is recommended first to remove the electrode tip from the rotating mechanical unit prior to cleaning and polishing the electrode tips used in your

chemical experiment. Please always follow the manufacturer's suggestions for polishing your particular electrode.

Warning

The Autolab RDE-2 and Autolab RRDE rotators are intended to be used with Metrohm Autolab certified electrode tips only (see

6.1 – Mechanical polishing

When mechanical polishing is required, it is recommended to use grinding materials with low abrasive properties like alumina powders suspended in water or diamond pastes. The electrode tips should be polished by hand only.

Note

Metrohm Autolab recommends the use of the Metrohm 6.2802.010 polishing set for rotating disc electrodes.

When polishing the electrodes, the electrode should be held in vertical position to avoid introducing tilt of the electrode surface.

6.2 – Material carryover

When polishing the RRDE electrode tips, especially in the case where the disk and ring material is not the same, caution should be used to prevent material carryover as much as possible. Electrochemical cleaning may be more suitable than mechanical cleaning.

6.3 – Shaft protection

Make sure that the metallic thread used to position the electrode on the RDE-2 or the RRDE rotator is always protected from solution or cleaning materials to prevent corroding the metallic thread and contacts located in the electrode. Corrosion or damage to the metallic thread may lead to premature failure of the electrodes.

7 – Cleaning and inspection

It is recommended to clean the instrument on a regular basis. Use a damp cloth, with a mild detergent. Never use excessive amounts of water as it may damage the instrument. As a precaution, always disconnect the unit from the mains before cleaning.

Always perform an inspection of the instrument and all its connecting cables before use. If you find any cable with damaged insulation or other irregularities, stop using the instrument until it has been repaired. Damaged equipment or damaged cables may be hazardous!

8 – RRDE and RDE-2 rotators storage

During measurements, take care not to expose the axis to a corrosive environment for long periods of time. Between samples always rinse the rotating tip and dry thoroughly before continuing experiments.

Do not store the RRDE and RDE-2 rotators upside down. Do not store the RRDE and RDE-2 with an electrode attached. Always rinse the RDE-2 and RRDE electrodes with demineralized water, store and dry separately before leaving for prolonged periods.

To avoid damage to the unit, please handle with care.

Note

Long-time storage and use after the storage

Store the rotator in clean and dry conditions with the electrode tip removed, preferably in the original box.
If the R(R)DE rotator was **not used for more than 2 weeks**, it is recommended to set a rotation of 5000 rpm for 3 minutes with the rotator in vertical position, in air (outside of the electrolyte).

Warning

The RDE-2 and RRDE rotators are adjusted within extremely narrow tolerances. Do not drop the rotators. The rotators should be handled with care. Damage to the axis may lead to eccentricity in the rotation, which may lead to invalid data.

Warning

The RDE-2 and RRDE rotators contain sealed mercury contacts. Do not throw the unit with ordinary waste. Mercury seals may break if the unit is dropped or used with excessive force. Breaking a mercury seal will result in irreparable damage and the unit will need to be replaced.

Do not for any reason attempt to open the unit. There are no user serviceable parts. Failure to conform to user specifications described above may result in the void of any warranty claims.

9 – Diagnostics

Problem: The controller does not seem to power up, after toggling the power switch (front speed display does not show any readings).

Cause	The controller is not powered
Solution	Check mains connection
	Check fuses

Problem: The **RUN/STOP** switch illumination keeps blinking and the motor cannot be set to **RUN**, although the controller seems to power up normally and the set point can be set using the front panel controls.

Cause	The motor assembly is not or not properly connected to the controller
Solution	Check the motor connection cable to be sure the RDE-2 or RRDE rotator is attached

Problem: The speed display does not show motor speeds under ~100 RPM, although a set point under 100 RPM is applied to the remote input.

Cause	To meet the controller's accuracy specification, motor speeds fewer than 100 RPM are not allowed. Therefore, the remote set point is internally limited to ~100 RPM on the low end of the speed range
Solution	Do not attempt to set the speeds to values under 100 RPM

Problem: The system cannot be operated at the maximum speed of 10000 ± 4 RPM, while in **MANUAL** control mode.

Cause 1	The mains voltage probably does not meet the lower limit specification (according to the line setting)
Solution	Check line setting (see Installation guide)

Cause 2	The motor assembly is blocked or obstructed in any way (under normal operating conditions the motor requires to run freely, without any additional mechanical loads, except for some inertia of the RDE or RRDE electrode tip and some work due to viscous friction of the air or electrolyte respectively)
Solution	Make sure the motor is able to run freely by ensuring that the motor block pin is released

10 – Limited warranty

The Autolab RDE-2 and Autolab RRDE rotators as well as the Autolab Motor Controller do not contain any user serviceable parts. Any attempt to open or disassemble the rotator and/or the motor controller will void any warranty. Please contact your Autolab distributor or Metrohm Autolab if the rotator or the motor controller requires servicing.

The Autolab RDE-2 and Autolab RRDE rotators are intended to be used with Metrohm Autolab certified electrode tips only (see **Table 2** and Table 3). Using uncertified tips will immediately void any warranty. Please contact Metrohm Autolab for custom electrode tips requests (autolab@metrohm.com).

The tips are considered consumables and no warranty beyond initial operation of the electrodes can be provided. The following properties of the RDE and RRDE tips are covered by the warranty until first use:

- Electrical contact
- Leakage
- Mechanical compatibility with RDE-2 or RRDE rotator

All other properties of the tips are not covered by any kind of warranty and no claims can or will be accepted by Metrohm Autolab.

11 – Chemical compatibility of PEEK

The 3 mm and 5 mm RDE tips as well as the RRDE and RCE tips are made of PEEK (Polyether ether ketone). PEEK is a semi crystalline thermoplastic with excellent mechanical and chemical resistance properties that are retained to high temperatures. It is highly resistant to thermal degradation as well as attack by both organic and aqueous environments.

Some environments however are unsuitable for PEEK. The following table provides an overview of the environment that will degrade PEEK moderately and severely (see Table 5). Metrohm Autolab advises to avoid using PEEK in the environments listed in this table.

Environment	Moderate effect	Severe effect
Aqua Regia		X
Benzene Sulfonic Acid		X
Bromine		X
Carbolic Acid (Phenol)		X
Carbon Bisulfide		X
Chlorine Water		X
Chlorine		X
Chromic Acid, > 10%		X
Fluorine		X
Formic Acid	X	
Hydrobromic Acid > 20%		X
Hydrofluoric Acid > 20%		X
Iodine	X	
Nitric Acid > 50%		X

Phenol (Carbolic Acid)		X
Sulfuric Acid > 10%		X

Table 5 – Chemical compatibility of PEEK

Warning

For other environments not listed in Table 4, the information is either not available or no known effects have been reported. Metrohm Autolab cannot exclude that the used PEEK material could discolour in time.

12 – Chemical compatibility of Viton

For the chemical resistance of Viton, please refer to the following website

Chemical	Website
Viton	https://www.aceglass.com/downloads/eccc.pdf

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