797 VA Computrace

The all-round instrument for voltammetry

Ω Metrohm

797 VA Computrace in brief

The 797 VA Computrace is a modern voltammetric measuring stand that is connected to a PC via a USB port. The PC software provided controls the measurement, records the measuring data and evaluates it. Due to the well-laid-out program structure operation is very easy. All the methods described in the Metrohm Application Bulletins and Application Notes are preinstalled.

The new potentiostat with galvanostat built into the instrument guarantees outstanding sensitivity with reduced noise. The unique Multi-Mode Electrode pro (MME pro) and rotating disk electrodes (RDE) made from various materials are available as working electrodes.

The most important applications

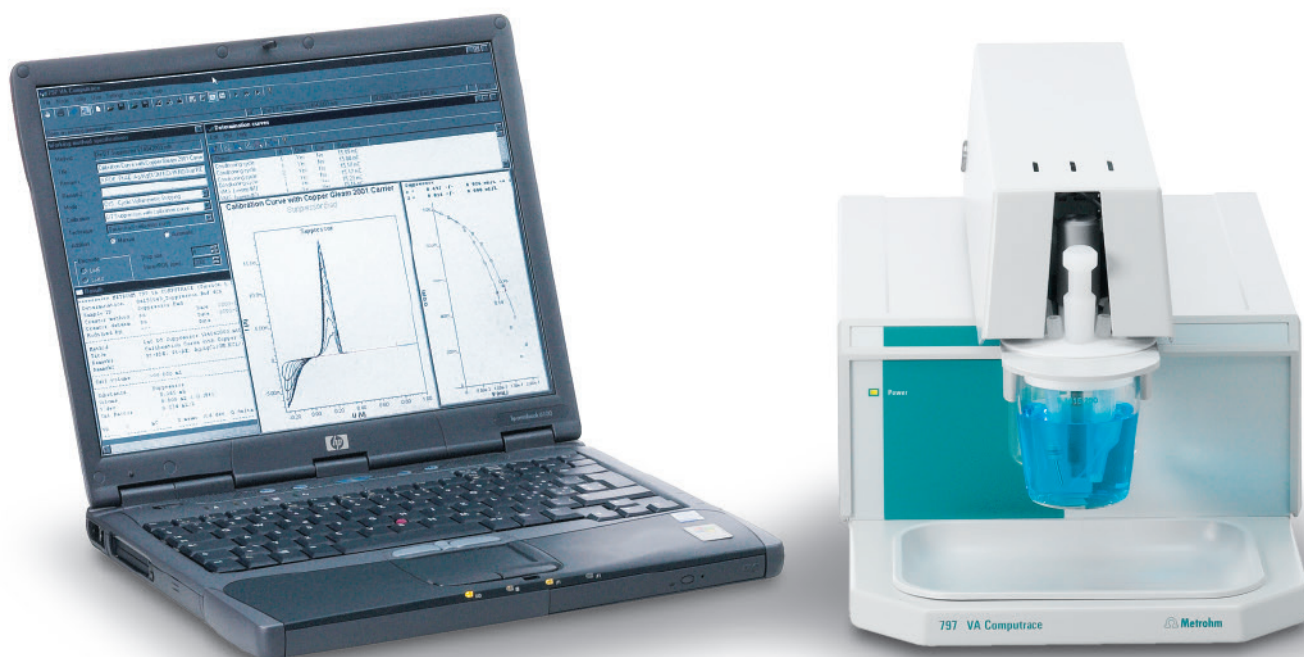| **Stripping voltammetry**	**CVS**	**EXPLORATORY**
Voltammetric trace analysis of metal ions and other substances	Cyclic Voltammetric Stripping for the determination of additives in electroplating baths	The Metrohm concept for electrochemistry training

Highlights

The 797 VA Computrace opens up new possibilities:

- Voltammetric trace analysis and additive determination in electroplating baths with a single instrument

- Outstanding sensitivity thanks to a combination of the unique Multi-Mode Electrode with the newly designed potentiostat

- Automation with the 863 Compact Autosampler or 838 Advanced Sample Processor

- Data archiving in the database program Autodatabase with report generator

- More than 220 important analytical methods are supplied

- Output of the result in as many formats as required

- Unique EXPLORATORY mode specially designed for training students in technical colleges and universities. Ideal in combination with the Metrohm monographs «Introduction to Polarography and Voltammetry» and «Practical Voltammetry»

- Built-in quality assurance with GLP mode, individual rights of access for each user and automatic electrode test

- Simple operation thanks to the clearly laid out user interface oriented on Windows operating procedures

Application 1 – voltammetric trace analysis

Analysis of heavy metals – total concentration …
For a fraction of the purchase price of an AAS or ICP instrument it is possible to carry out metal analyses with the same or improved sensitivity. The only thing required apart from small amounts of reagents is a small amount of pure nitrogen. No expensive flammable gases, no specially constructed fume hoods in the laboratory, no costly metal vapor lamps.

… and speciation
Spectroscopic methods can only determine the total concentration of the metals. With voltammetry it is also possible to differentiate between various oxidation states of metal ions or between free and bound metal ions. This allows statements to be made about the biological availability and toxicity of heavy metals and makes this technique a valuable tool for environmental analysis. In contrast, spectroscopy requires complicated separation of the metal species before comparable statements can be made.

High ionic concentrations? No problem with VA!
Samples with high ionic concentrations are no problem for voltammetry. This means that voltammetry is predestined for the analysis of:

• Water, wastewater and seawater
• Salts, pure chemicals
• Electroplating baths
• Foodstuffs

| Detection limits		
Antimony	Sb^{III}/Sb^{V}	200 ppt
Arsenic	As^{III}/As^{V}	100 ppt
Bismuth	Bi	500 ppt
Cadmium	Cd	50 ppt
Chromium	Cr^{III}/Cr^{VI}	25 ppt
Cobalt	Co	50 ppt
Copper	Cu	50 ppt
Iron	Fe^{II}/Fe^{III}	50 ppt
Lead	Pb	50 ppt
Mercury	Hg	100 ppt
Molybdenum	Mo	50 ppt
Nickel	Ni	50 ppt
Platinum	Pt	0.1 ppt
Rhodium	Rh	0.1 ppt
Selenium	Se^{IV}/Se^{VI}	300 ppt
Thallium	Tl	50 ppt
Tungsten	W	200 ppt
Uranium	U	25 ppt
Zinc	Zn	50 ppt

1 ppt = 1 ng/kg

Specific analysis of organic compounds

Not only metals, but also many different organic compounds can be determined by voltammetry. VA can be used in organic chemistry, e.g. for the analysis of contaminants, or in pharmaceutical chemistry for the determination of the active substance concentrations. Examples of interesting applications:

- 4-Carboxybenzaldehyde in terephthalic acid
- Free styrene in polystyrene
- Vitamins in juices, vitamin preparations

Determination of anions

A range of special anions can also be determined voltammetrically. Of particular interest is the analysis of the environmentally relevant species cyanide, sulfide or nitrite and nitrate.
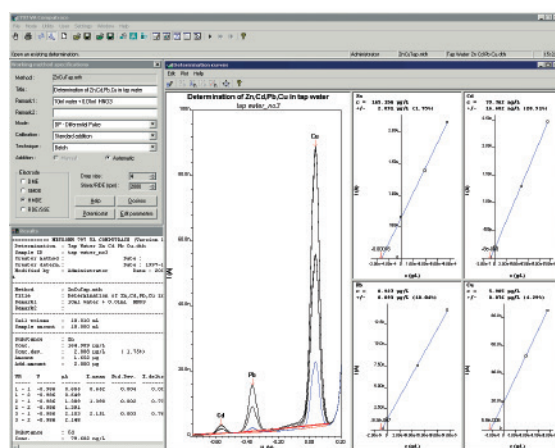
Application 2 – CVS for the determination of organic additives in electroplating baths

Cyclic Voltammetric Stripping Analysis (CVS) and Cyclic Pulse Voltammetric Stripping Analysis (CPVS) are widely used methods in the electroplating industry for the determination of organic additives in electroplating baths. For many technical coatings, particularly in the manufacture of PCBs and semiconductor components, this method is an essential part of production control. The quantitative determination of the additive is carried out indirectly via its influence on the deposition of the main component of the electroplating bath. As the measurement is based on an electrode reaction that corresponds to the production process, the activity of the additive and thus its effectiveness in the galvanization process can be measured directly.

**The most important fields of application for the method are:**

- Acidic copper baths
- Tin-lead baths and tin baths
- Alkaline zinc baths

Quantification of the various types of additives requires special calibration techniques: the so-called brighteners are determined using the Linear Approximation Technique (LAT) or Modified Linear Approximation Technique (MLAT). The determination of the suppressors is carried out by Dilution Titration (DT), the determination of levelers by means of the Response Curve (RC).

In these analyses a simple, robust and inexpensive rotating disk electrode made of platinum is used. The electrochemical conditioning of the electrode, which is necessary before each measurement, is part of the determination method. It is repeated automatically until the measured value remains constant.

With CVS or CPVS the concentration of the additive can be determined with superior accuracy. The effective concentration of the particular additive in the bath sample is shown and printed out directly in mL additive per L bath liquid. This means that topping up to the preset bath concentration can be carried out very accurately. This guarantees continuous and interference-free operation of the unit. In particular, the accuracy of the analytical results has helped the method to become generally accepted in the electroplating industry. Other methods, e.g. the classical Hull cell method, do not allow the concentration to be determined, but only provide an assessment of the quality of the deposited metal layer.
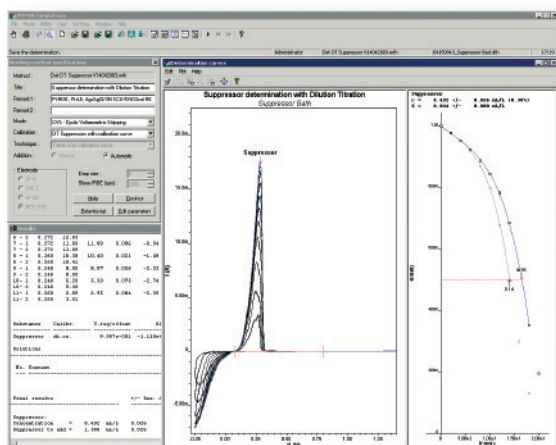
One of the preinstalled methods is loaded to carry out the determination. Once a few parameters have been adapted, the analysis can be started. Additional applications with the corresponding methods are available in the Metrohm Application Bulletins and Application Notes; these can be accessed on our website.

The organic additives can be determined either manually or automatically, depending on the necessary sample frequency for monitoring the electroplating process. Solutions can be added automatically by means of model 800 Dosino dosing systems; fully automated systems can be realized with the 838 Advanced VA Sample Processor, which allows large series of samples to be analyzed.
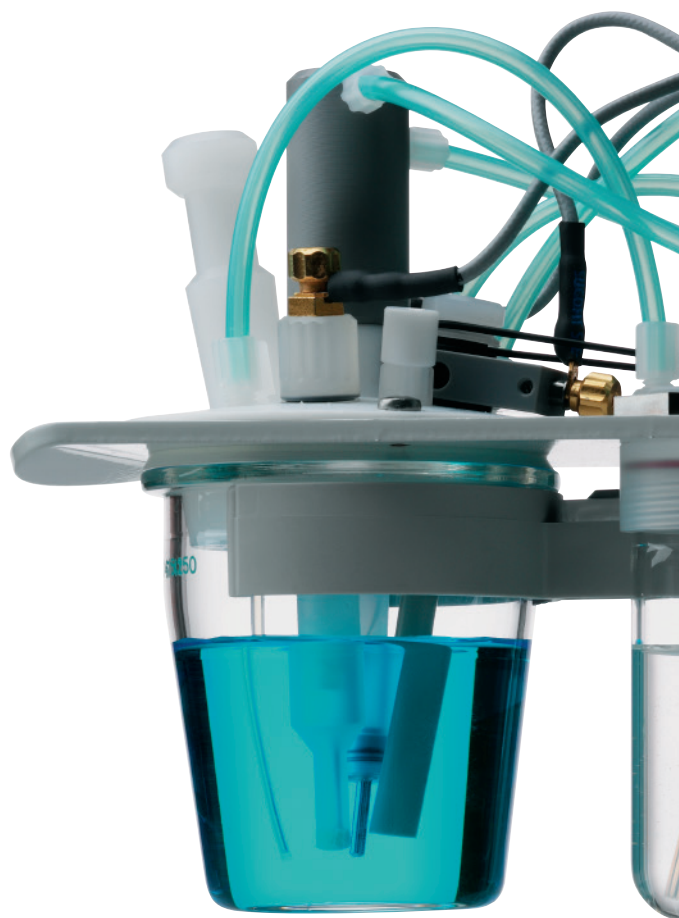
Application 3 – 797 VA Computrace as a training tool

EXPLORATORY is the program part of the 797 VA Computrace specially designed for training purposes. It is characterized by its clear layout and intuitive operation. The experimental parameters and the associated voltammograms can be checked at a single glance. User interface and ease of operation make the instrument the perfect tool for hands-on training in voltammetry in universities, technical colleges, vocational schools and also in production facilities.

In the EXPLORATORY mode the following current measuring techniques are available:

Sampled DC	Direct current
DP	Differential pulse
SQW	Square wave (according to Osteryoung)
AC	Alternating current (1st and 2nd harmonic, phase-selective)
CV	Cyclic voltammetry
NP	Normal pulse
PSA	Potentiometric stripping analysis (stripping chronopotentiometry with chemical oxidation)
CCPSA	Constant current potentiometric stripping analysis (stripping chronopotentiometry with oxidation/reduction by constant current)
CVS	Cyclic voltammetric stripping (cyclic voltammetry for determination of additives in electroplating baths)
CPVS	Cyclic pulse voltammetric stripping (pulse chronoamperometry for determination of additives in electroplating baths)

EXPLORATORY is curve-oriented. Voltammograms and their associated parameters are shown in 2 adjacent windows. At the end of the measurement the conditions can be varied and the altered signal recorded. The different voltammograms can be superimposed for direct comparison.

EXPLORATORY can also evaluate the measured curves: as in DETERMINATION the peak or wave evaluation can be carried out automatically or manually after displacing the foot points.

These features make the EXPLORATORY part of the program highly useful in developing and optimizing methods for the quantitative determination of substances. The optimized voltammetric parameters can be accepted directly in the determination method in the program part DETERMINATION. Transfer from DETERMINATION to EXPLORATORY is also possible.

The shown curves can also be exported to other programs, e.g. text processing programs, via the Windows clipboard. The curves can also be stored as a file and the list of measuring points can be exported in ASCII format.

Practical Voltammetry

Metrohm offers the two monographs «Practical Voltammetry» and «Introduction to Polarography and Voltammetry» for use with the 797 VA Computrace in vocational training. The «Introduction to Polarography and Voltammetry» is presented in compact form on less than 60 pages. The most important current measuring techniques and the different working methods used in polarography and stripping voltammetry are explained. The monograph «Practical Voltammetry» describes 13 experiments for training in voltammetry. It is an ideal complement to «Introduction to Polarography and Voltammetry». Teachers can select single experiments or decide to do all

13 experiments in their consecutive order, as they prefer. Detailed description of the problem to be solved and references to the literature are followed by examples of curves and solutions. Thus, the basic theoretical know-how is provided in a compact manner. Even technicians working in an analytical laboratory will find that the monograph contains useful information for their daily work.

797 VA Computrace

Manual or automated

Even without additional accessories the 797 VA Computrace is a fully functioning analytical system that meets the highest demands regarding accuracy and sensitivity. An even higher degree of comfort can be achieved with the help of various accessories.

Automatic addition of auxiliary solutions with model 800 Dosino dosing systems

The voltammetric determination takes place by standard addition or calibration curve und and can be carried out automatically if model 800 Dosinos are used. Connections are available for a maximum of three 800 Dosinos. Of course, all other auxiliary solutions such as buffers or complexing agents can also be added automatically.

Fully automatic analysis of small series of samples with the 863 Compact Autosampler

The 863 Compact Autosampler enables fully automatic trace analyses. It is suitable for the precise and reproducible investigation of several samples. The sample rack accommodates a maximum of 18 samples. The built-in peristaltic pump of the 863 Compact Autosampler transfers them from the turntable into the measuring cell of the 797 VA Computrace, where they are analyzed.

838 Advanced VA Sample Processor – fully automated CVS analysis

In combination with the 838 Advanced VA Sample Processor it is possible to carry out fully automated determinations of organic additives in electroplating baths. A maximum of 56 samples can be analyzed for their suppressor content; the brightener content of up to 28 samples can be determined automatically. Of courese, the 838 Advanced VA Sample Processor is also suitable for trace analysis.

Automatic rinsing of the measuring cell with 843 Pump Station

Rinsing and emptying the measuring cell after each analysis can be carried out automatically by the 843 Pump Station. This option is available for both manually operated systems and, of course, for VA Computrace systems with an Autosampler. The reproducible and efficient rinsing process minimizes carryover and in this way increases the accuracy of the analyses.
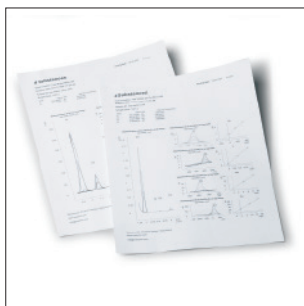
Autodatabase

The analysis data can either be stored individually on the hard disk or in a database using the Autodatabase software with report generator. With Autodatabase all the data can be assessed at a single glance and individually arranged printouts can be generated.

MVA – Metrohm VA systems

Complete voltammetry systems – the right system for each application

The MVA systems are ready-to-use packages, which are customized to suit particular applications. All you have to do is connect your package to a PC and you can start working. Each MVA system comes with all the necessary accessories. MVA accessory kits enhance capabilities of the MVA basic system to suit special applications.

MVA systems for voltammetric trace analysis

MVA-2 – partly automated routine trace analysis

Automatic addition of auxiliary solutions

MVA-2 is an easy-to-use VA system for the routine analysis of traces of heavy metals in environmentally relevant samples or in production control. Just add the sample to the measuring cell from a pipet and start the analysis. The rest of the determination takes place automatically. This system is intended for users who require elegant and convenient operation at an attractive price, without having to use a sample changer.

MVA-3 – fully automatic analysis of small series of samples

MVA-3 is the optimal 797 VA Computrace system for fully automated trace analysis. One or two parameters can be determined in small series of up to 18 samples. The samples are placed on the sample rack of the 863 Compact Autosampler. Transfer and analysis of the samples takes place automatically, controlled by the software of the 797 VA Computrace.

MVA systems for the CVS technique

MVA-12 – our recommendation for the determination of additives by CVS

Partly automated 797 VA Computrace system for the comfortable determination of additives by CVS

MVA-12 is the standard system for the routine determination of organic additives in single samples without using a sample changer. It enables determinations with hardly any work required on the part of the operator. The automatic addition of auxiliary solutions such as VMS, intercept or standard solutions is carried out by model 800 Dosinos. For the determination of brighteners only the sample has to be added manually; even this step is automatic when suppressors are being determined. If the optional rinsing equipment is used, the measuring vessel can be rinsed automatically after each determination.

MVA-13 – fully automatic determination of organic additives in series of samples

Fully automatic system with sample changer for CVS analysis in the routine laboratory

MVA-13 is our high-end system for determining additives in electroplating baths. The the samples are provided automatically by the 838 Advanced VA Sample Processor. The suppressor content of a maximum of 56 samples can be analyzed. When determining brighteners up to 28 samples can be analyzed. The possibility of recalibrating methods within a series of samples guarantees outstanding accuracy. It is also possible to combine different methods in a single measuring procedure. With the aid of the 843 Pump Station the measuring vessel is emptied and rinsed automatically after each sample.

MVA accessory kits

MVA accessory kits can be used in combination with all Metrohm MVA basic systems to extend their range of applications.

MVA-Hg – complete accessory kit for the voltammetric determination of mercury

MVA-Hg contains a complete set of electrodes for the determination of mercury by stripping voltammetry according to Application Bulletin 96. It contains all the necessary accessories that are not included in the standard equipment of the Metrohm VA instrument. These comprise a rotating gold electrode, a glassy carbon auxiliary electrode and a reference electrode.

MVA-As – complete accessory kit for the voltammetric determination of arsenic

MVA-As contains a complete set of electrodes for the determination of arsenic by stripping voltammetry according to Application Bulletin 226. It contains all the necessary accessories that are not included in the standard equipment of the Metrohm VA instrument. These comprise a rotating gold electrode, a glassy carbon auxiliary electrode and a reference electrode.

MVA-CVS – complete accessory kit for the determination of additives in electroplating baths by CVS

MVA-CVS contains the complete set of electrodes necessary for the determination of additives in electroplating baths by the CVS technique. It contains all the necessary accessories; these include a rotating platinum electrode, a platinum auxiliary electrode and a reference electrode. MVA-CVS allows the determination of organic additives in combination with the systems MVA-1, MVA-2 and MVA-3.

909 UV Digester for the digestion of aqueous samples

909 UV Digester for the elegant sample preparation of water samples with a slight to medium pollution load. It is the ideal addition to all Metrohm VA systems used for testing natural waters or polluted water samples.

Quality assurance –
no problem with the
797 VA Computrace

Access rights
Access rights to each program part can be freely defined for each user. This permits convenient user management.

Validation with the GLP Wizard
The software automatically checks the validation intervals of the analysis system and informs the user. Each report shows whether the validation is still valid. The GLP Wizard guides the user step-by-step through the various validation tests and automatically evaluates their validity.

Diagnosis
The built-in diagnosis program allows the individual components of the instrument to be checked. This diagnosis is a part of the GLP Wizard, but it can also be carried out independently.

Electrode test
The electrodes used are automatically checked before each determination. If problems occur then the faulty electrode is identified and the fault shown on the screen. This test can, of course, be triggered manually to check the system.

Curve evaluation
The software of the 797 VA Computrace automatically evaluates the measured curves and calculates the final result. The algorithm has been completely revised and functions even more reliably. Among other things, the automatic elimination of outliers has been implemented. The calculation of the final concentration has also been perfected. This has led to a considerable improvement in the reproducibility and accuracy of results.

Certified quality
The 779 VA Computrace and its software have been developed and are manufactured according to the highest quality standards, which we guarantee by issuing a quality certificate. The reference electrode and the electrolyte and standard solutions contained in the accessories can be identified by their serial number and are supplied together with an individual certificate.

Application Bulletins

Metrohm has published about 50 Application Bulletins describing polarographic or voltammetric methods. The examples shown here demonstrate just how versatile voltammetry is.

Application Notes

The Application Notes present applications in compact form. There are currently about 180 Application Notes in English for voltammetry; these are supplied in printed form together with the instrument. They can also be downloaded from the Internet under **www.metrohm.com**. The methods for carrying out these applications are included in the software of the 797 VA Computrace.

Standards

Numerous standards describe voltammetric methods for the determination of traces of metal and organic compounds. A small selection is given below:

ISO 713	Zinc – Determination of lead and cadmium contents. Polarographic method
ISO 3856-4	Paints and varnishes – Determination of «soluble» metal content. Part 4. Determination of cadmium content. Flame atomic absorption spectrometric method and polarographic method.
ISO 6636-1	Fruits, vegetables and derived products. Determination of zinc content. Part 1. Polarographic method.
EPA 7063	Arsenic in aqueous samples and extracts by anodic stripping voltammetry (ASV)
EPA 7472	Mercury in aqueous samples and extracts by anodic stripping voltammetry (ASV)
EPA 7198	Cr(VI) in water by polarography
ASTM D 3557-02	Standard test methods for cadmium in water
ASTM D 3559-03	Standard test methods for lead in water
AOAC 968.16	Fumaric acid in food. Polarographic method.
AOAC 972.24	Lead in fish. Polarographic method.
AOAC 972.46	Bismuth compounds in drugs
AOAC 979.17	Lead in evaporated milk and fruit juice
DIN 38406, Teil 16	Determination of 7 metals (Zn, Cd, Pb, Cu, Tl, Ni, Co) in water by voltammetric methods
DIN 38413, Teil 5	EDTA and NTA in water samples
HMSO/Br.Dept.Env.	Metal ions in marine and other waters: Zn, Cd, Pb, Cu, V, Ni, Co, U, Al, Fe

Technical specifications

797 VA Computrace	Voltammetric measuring stand with built-in potentiostat and galvanostat.
Materials	Housing: polyurethane hard foam (PUR) with flame protection for fire class UL94VO, CFC-free
	Base plate and measuring head arm: metal, stove-enameled
Working electrodes	Multi-Mode Electrode pro (MME pro) 6.1246.120, pneumatically operated as DME, HMDE or SMDE; requires mercury 99.9999% and nitrogen 99.995%, whose pressure must be reduced with a reduction valve to 1.0 ± 0.2 bar (100 ± 20 kPa). Rotating disk electrodes (RDE) with exchangeable electrode tips made from various materials: «Ultra Trace» graphite, glassy carbon, gold, silver, platinum.
Reference electrode	6.0728.020 or 6.0728.030 Ag/AgCl/KCl 3 mol/L with 6.1245.010 electrolyte vessel
Auxiliary electrodes	6.0343.000 Platinum auxiliary electrode with plastic shaft
	6.1241.020 + 6.1247.000 glassy-carbon auxiliary electrode (option)
Stirrer	Speed 200 to 3'000 min^{-1}
	Speed stability ± 5%
	Material PET
Measuring cell	Working volume 10...70 mL, 50...150 mL (option: 5 mL...70 mL).
	Measuring cell with thermostat jacket as option
	(thermostatting by external instrument – not included)

Potentiostat/galvanostat	Voltage range	± 5 V
	Output voltage	± 12 V
	Current range	± 80 mA
	Current measurement	7 ranges (10 nA to 10 mA)
	Sweep rate (CV)	< 1 mV/s...3 V/s (at 1 mV resolution)
		< 1 mV/s...35 V/s (at 10 mV resolution)

Power supply	Voltage 100...240 V
	Frequency 50...60 Hz
	Power consumption 120 VA
Temperature	Nominal working range 0...45 °C at 20…80% rel. humidity
Safety specifications	Construction and testing as per IEC 61010/EN 61010/UL 3101-1, protection class 1
Dimensions	Width 258 mm
	Height 245 mm (with cover fully raised approx. 630 mm)
	Depth 535 mm
Weight without accessories	9.7 kg

PC requirements

For perfect functioning we recommend a Pentium III processor with a clock rate of 1 GHz or higher. Operating system: Microsoft Windows™ 2000, XP Professional, Vista, or Windows 7 (32 bit versions only) with the following configuration:

|	
RAM	256 MB
Program files	30 MB
Hard disk	Min. 200 MB free
Graphics adapter/screen	Min. resolution 1024 x 768 pixel or higher
Printer	Any supported by Windows™
Connection	1 free USB interface

Ordering information, options

797 VA Computrace

2.797.0010   797 VA Computrace for voltammetric trace analysis. Measuring stand with built-in potentiostat and galvanostat. Three-electrode system with Multi-Mode Electrode pro (MME pro), Ag/AgCl reference electrode and platinum auxiliary electrode. Extendable for rotating disk electrode (RDE). Includes comprehensive accessories for complete setup of measuring place.

2.797.0020   797 VA Computrace for the replacement of older Metrohm voltammetry instruments already equipped with a multi-mode electrode. With fewer accessories than 2.797.0010; the accessories of the existing VA stand are used instead.

2.797.0030   797 VA Computrace for CVS (Cyclic Voltammetric Stripping) for the analysis of additives in electro plating baths. Measuring stand with built-in potentiostat and galvanostat. Three-electrode system with rotating platinum disk electrode (Pt-RDE), Ag/AgCl reference electrode and platinum auxiliary electrode. Extendable for Multi-Mode Electrode pro (MME pro). Includes comprehensive accessories for complete setup of measuring place.

Options

Automatic solution addition
2.800.0010   800 Dosino
6.3032.120   Dosing Unit 2 mL (glass) for Dosino

An 800 Dosino with Dosing Unit must be used for each auxiliary solution to be added. A maximum of three Dosinos can be connected.

Sample changers
863 Compact Autosampler
2.863.0020   863 Compact Autosampler (VA)
2.843.0040   843 Pump Station (membrane)
2.843.0140   843 Pump Station (peristaltic)

838 Advanced Sample Processor
2.838.0310   838 Advanced VA Sample Processor
2.843.0040   843 Pump Station (membrane)
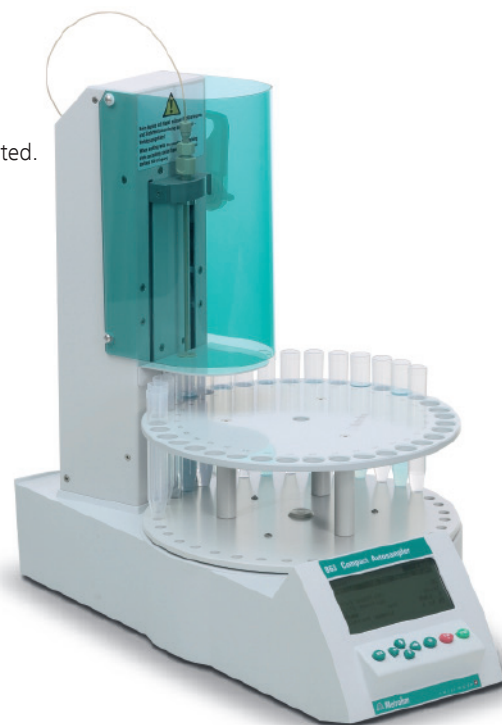
Accessories for rotating disk electrodes (RDE)

6.5327.000   MVA-Hg
Accessory kit for the determination of mercury, for 2.797.0010, 2.797.0020 and 2.797.0030.
Complete equipment with gold RDE, Ag/AgCl reference electrode, glassy carbon auxiliary electrode, measuring cell.

6.5327.010   MVA-As
Accessory kit for the determination of arsenic, for 2.797.0010, 2.797.0020 and 2.797.0030.
Complete equipment with lateral gold RDE, Ag/AgCl reference electrode, glassy carbon auxiliary electrode, measuring cell.

6.5327.020   MVA-CVS
Accessory kit for the determination of additives in electroplating baths by CVS (Cyclic Voltammetric Stripping) for 2.797.0010 and 2.797.0020.
Complete equipment with platinum RDE 6.1204.610, Ag/AgCl reference electrode, platinum auxiliary electrode, measuring cell.

Electrode tips for rotating disk electrode (RDE)

6.1204.180   Ultra trace electrode tip
6.2802.020   Polishing set for ultra trace electrode tip
6.1204.130   Silver electrode tip
6.1204.140   Gold electrode tip
6.1204.150   Lateral gold electrode tip
6.1204.170   Platinum electrode tip 3 mm for CVS
6.1204.190   Platinum electrode tip 1 mm for CVS, glass shaft
6.1204.600   Glassy carbon electrode tip, glass shaft
6.1204.610   Platinum electrode tip 2 mm for CVS, glass shaft

Drives for rotating disk electrode (RDE)

6.1204.210   Driving axle for rotating disk electrode (RDE)
6.1204.220   Driving axle for rotating disk electrode (RDE) with mercury contact

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