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EPC 800 USB
Patch Clamp Amplifier

If you believe your job is to make new discoveries...

…discover EPC 800:

- Patch clamp amplifier with manual or computer controlled operation via USB
- Can be used with a variety of data acquisition interfaces
- Can be software controlled either by HEKA or third-party acquisition software
- Low noise headstage optimized for single channel & whole-cell recordings
- True current clamp mode for fast AP recordings
- Automatic or manual capacitance compensation

HEKA

HEKA provides the finest instruments today to achieve the needed progress of tomorrow…

For any researcher who desires manual user control through knobs and dials, while at the same time, longs for some degree of computer communication and automatic control, HEKA is excited to release the EPC 800 USB. This amplifier is truly a unique hybrid patch-clamp amplifier with its design and feature-set primarily based upon the manually controlled EPC 8. The EPC 800 USB can be controlled with any data acquisition interface and can be supported, not only by HEKA software, but also with third-party data acquisition programs.

Improvements in comparison to the EPC 8:

- *Telegraphing outputs for Gain, Bandwidth, Mode & C-Slow*

- *Automatic Vp-Offset, C-Fast & C-Slow compensation with the simple push of a button*

- *Improved current monitor filters*

- *USB 2.0 communication for software control of all amplifier functions*

- *Low Frequency Voltage Clamp Mode (LFVC)*

- *CC+Bridge Mode*

- *Improved RS Comp Ranges*

Features

Operating Modes of the EPC 800 USB

The EPC 800 USB can be operated in three modes: **Telegraphing Local**, **Local** and **Remote**. The decision of which mode to use not only depends upon user preference of whether or not to have the functionality to turn knobs and switches, but also upon what data acquisition software and interface the EPC-800 USB is used with.

1. Telegraphing Local:
• Rear panel telegraphing outputs for Gain, Filter Bandwidth, Amplifier Mode and C-Slow allows third-party acquisition software (e.g. IGOR, Labview, pCLAMP) to read the status of these amplifier settings while recording data.

• Manual control by use of the knobs and switches on the front panel.

2. Local:
• Manual control by use of the knobs and switches on the front panel.
• C-Fast, C-Slow and Vp-Offset compensation can be performed manually or automatically with the push of a button.
• Amplifier can be used with any HEKA data acquisition interface (ITC-16, ITC-18, ITC-1600, LIH 1600, LIH 8+8).
• Can be used with any other 2 x 16 bit parallel digital I/O board.
• Acquisition software possibilities include HEKA's PatchMaster, ChartMaster and EPCMaster.

3. Remote:
• Full support of **all** amplifier functions by HEKA's PatchMaster acquisition software.
• USB 2.0 communication. Please note that this is a full speed (12 Mbit/second) connection.
• Front panel knobs and switches of the amplifier are inactive, with the exception of the LCD multi-position switch.
• Can be used with HEKA PatchMaster software or EPCMaster in combination with custom software and appropriate interface.

Acquisition Software Options

1. PATCHMASTER software:

If the EPC 800 USB is used with one of HEKA's interfaces (ITC-16, ITC-18, ITC-1600, LIH 1600, LIH 8+8), then HEKA's PATCHMASTER software can be used for data acquisition on either a Windows (2000, XP and VISTA) or Mac OS X based computer system. PATCHMASTER software is a multi-channel stimulation / acquisition package capable of supporting up to sixteen input and sixteen output channels.

PATCHMASTER supports local and remote modes of the EPC 800 USB. When set in Local mode, the front panel knobs and switches of the EPC 800 USB are under the users manual control. As the controls are changed the values are read and displayed in the PATCHMASTER amplifier window.
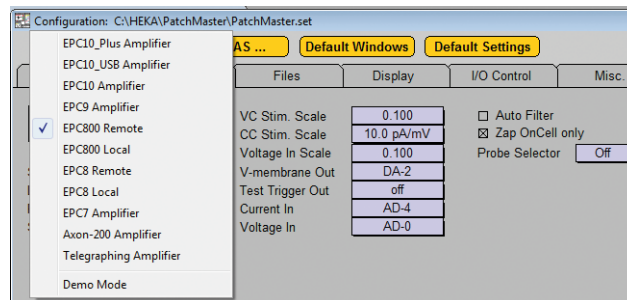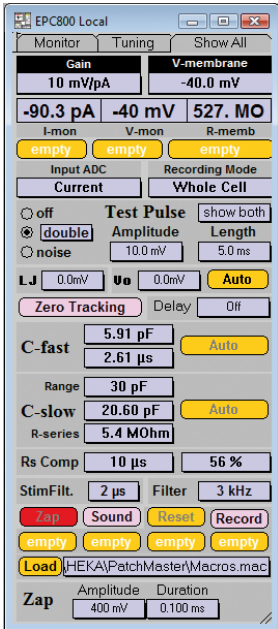
When in Remote mode, the controls and knobs of the EPC 800 USB are inactive. All amplifier settings are fully controlled by PATCHMASTER. The mode of operation is set from within the Configuration / Hardware window of PATCHMASTER.

2. CHARTMASTER software

If the EPC 800 USB is used in conjunction with one of HEKA's AD/DA interfaces, the multi-purpose stimulation / acquisition software CHARTMASTER can be used to control the interface. CHARTMASTER software shares many of the features of PATCHMASTER except it does **not** have an amplifier control window. The CHARTMASTER I/O control window allows direct access to the hardware interface. The status of digital and analog input channels is monitored. Digital and analog output signals can be set and defined input parameters are displayed. With this combination of hardware and software, the EPC 800 USB will have to be used in Local mode only.

3. Third-party and customized software

In situations where the EPC 800 USB amplifier is used in conjunction with a custom data acquisition system, HEKA provides the EPCMASTER software for control of the amplifier functions. This software is available free of charge. To integrate the EPC 800 USB amplifier in a customized Windows software package, HEKA can provide the EPC DLL (Dynamic Link Library) at a small charge, which will provide full access to the amplifier settings and acquisition routines.

HEKA's EPCMASTER software is the virtual front panel of the EPC 800 USB. EPCMASTER allows full software control of all of the EPC 800 USB functions. EPCMASTER does not have functions for data acquisition or analysis, but when combined with the EPC 800 USB and a custom data acquisition system i.e. IGOR Pro, Labview, pCLAMP, etc the result is a software controlled version of the amplifier that is extremely flexible in regards to a particular data acquisition interface or software package. This flexibility allows users to easily add an EPC 800 USB to their current setups without the need to purchase or learn a new data acquisition package.

EPC 800
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Acquisition Modes

Three operating modes are provided: Voltage Clamp (VC), Current Clamp+Bridge (CC+Bridge) and Low Frequency Voltage Clamp (LFVC).

Voltage Clamp (VC) mode recordings, ideal for recordings from whole-cell, cell-attached, single channel, loose patch or bilayer configurations.

The **"CC + Bridge Mode"** is an enhanced current clamp mode that allows 100% compensation of the voltage drop across the electrode resistance (R-Series). In this mode, the stimulus artifact typically generated when injecting current is fully eliminated. The voltage follower current clamp circuitry allows recording of fast action potentials (AP) with patch or intracellular electrodes.

The **"Low Frequency Voltage Clamp"** (LFVC) mode will automatically inject an appropriate amount of current to preserve the membrane potential at a desired level during current clamp measurements. This is accomplished as follows: the measured membrane potential is first low-pass filtered and compared to the user specified LFVC membrane potential. A current is then injected into the cell to preserve the LFVC V-membrane potential at the desired level during current clamp measurements. There are five time constants (1, 3, 10, 30 and 100) available for the LFVC mode that specifies the speed of regulation. The feedback speed is highly dependent upon the Gain Range settings.
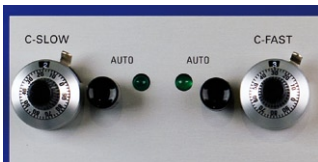
C-Fast and C-Slow Compensation

Both C-Fast and C-Slow compensation routines can either be performed manually by turning the knobs or automatically by pressing the Auto button on the front panel. Both C-Fast and C-Slow compensation can be applied in all three headstage gain ranges. The C-Fast range is 0 to 15 pF in all gain ranges. C-Slow is up to 1000 pF in low and medium gain range and 100 pF in high gain range.

Multi-parameter Display

An LCD panel can display the following parameter pairs: I / VMon, C-Fast / -fast, C-Slow / R-Series, RS Range / Comp, VP / LFVC, I / VHold, and Noise. The displayed parameters can either be individually selected via a multi-position switch or automatically set. If the Auto display mode is activated, the LCD panel will automatically display the value of the control as its modified by the user.

Holding Potentials and VpOffset

Ten-turn potentiometers are available on the front panel for VPOffset (± 200 mV), VHold (± 500 mV), IHold (± 500 pA) and LFVCHold (± 200 mV). VPOffset can be adjusted either manually or automatically by pressing the Auto button.

A/D D/A Interface choices:

HEKA's PATCHMASTER and CHARTMASTER software support all of the HEKA InstruTECH series A/D D/A interfaces, including the ITC-16, ITC-18, ITC-1600, LIH 1600 and LIH 8+8.

The EPC 800 USB can be used with any A/D D/A acquisition interface; we suggest a minimum of two 12-bit resolution input channels capable of 200 kHz sampling.

Technical Specifications

General

Included Accessories

EPC 800 USB Headstage:	1	
EPC 800 USB Model Circuit:	1	
EPC 800 USB Manual:	1	
Pipette Holder:	1	(1.5 mm is standard, other diameters available upon request at no additional charge)
USB Cable:	1	(3 meter USB 2.0 shielded cable)
Power Cord:	1	(2 meter IEC type shielded)

Rear Panel Connectors

USB:	USB 2.0 female type B (Communication is 12 Mbit/second)
Telegraphing Outputs:	Gain, Bandwidth, Mode & C-Slow

Dimensions Main Unit

D x W x H: (31.1 x 48.3 x 14.5) cm / (12.3 x 19 x 5.7) inch

Weight Main Unit

11.4 kg (24.8 lbs)

EPC 800 USB Headstage

Dimensions:	D x W x H: (90 x 17 x 14.5) mm (3.54 x 0.67 x 0.57) inch

Power Supply

Power requirements are 125 Watts. The logic controlled power supply automatically switches the voltage range. Operational range is from 90-130V or 210-250V at line frequencies of 50 or 60 Hz.
A shielded transformer minimizes noise pickup from the power line frequencies.

Ground Lines

Signal ground is accessible via a Banana plug on the front panel and also via a connector on the headstage.
A Chassis ground is accessible via a Banana plug on the front panel. Chassis and Signal ground are connected via a 100 MOhm resistor.

Voltage Clamp Mode

Current Measuring Resistors

The headstage provides three feedback resistors. The gain ranges can be switched during the experiment.

low gain range:	5 MOhm, ± 2 μA current range
medium gain range:	500 MOhm, ± 20 nA current range
high gain range:	50 GOhm, ± 200 pA current range

Current Gain Settings

low gain range:	0.005, 0.01, 0.02, 0.05, 0.1, 0.2 mV/pA
medium gain range:	0.5, 1, 2, 5, 10, 20 mV/pA
high gain range:	50, 100, 200, 500, 1000, 2000 mV/pA

Input Capacitance

<1 pF

Noise Performance

Noise Performance	DC to 1 kHz < 0.03 pA RMS
	DC to 3 kHz < 0.08 pA RMS
	DC to 10 kHz < 0.25 pA RMS
	(measured with open input, 8-pole Bessel filter, high gain range)

Maximum Bandwidth

medium & low ranges:	100 kHz
high range:	< 60 kHz

Current Filter

The EPC 800 USB contains two built-in filters for the current monitor signal. Filter 1 is a 5-pole, 10 to 100 kHz Bessel pre-filter. Filter 2 is a 4-pole, 100 Hz to 100 kHz Bessel filter. Filter range is controlled by software or from the front panel switch.

Holding Potential

Manual or software controlled adjustment in the range ± 500 mV

Compensations in Voltage Clamp Mode

Pipette Offset Potential Compensation

Automatic or manual adjustment of the offset potential in the range ± 200 mV

Injection Capacitors

The C-Fast compensation signal is injected via a 1 pF capacitor. The C-Slow compensation signals are injected via a 10 pF capacitor in medium and low gain and via a 1 pF capacitor in high gain range.

C-Fast Compensation

Automatic or manual compensation in all gain ranges.
0 to 15 pF, 0 to 8 μs tau

C-Slow Compensation

Automatic or manual compensation in all gain ranges.
0.2 to 1000 pF in low and medium range, 0.2 to 100 pF in high range.
Rs range 1 MOhm to 1 Gohm.

Series Resistance Compensation

Manual adjustment. Range is dependent on cell capacitance.

Equivalent Time Constants:	2 μs / 10 μs / 100 μs
Ranges:	1 to 1000 MΩ (medium range)
	up-to 10 MΩ (low range)

Current Clamp + Bridge Mode

Current Injection

medium range:	10 pA/mV input; up to ± 10 nA
low range:	100 pA/mV input; up to ± 100 nA

Low Frequency Voltage Clamp (LFVC)

Automatic current tracking readjusts the membrane potential to fix any slow voltage drift while in current clamp mode.

Range:	± 200 mV (τ of 1, 3, 10, 30 & 100)

Holding Current

Manual or software controlled adjustment in the range ± 500 pA

HEKA

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