npi
Electronic Instruments
for the Life Sciences

made to measure

ELC-03XS

Versatile All-in-One Amplifier

ELC amplifiers are multi technique systems where researchers can combine traditional patch and microelectrode recording with electrical stimulation, dye application or single cell transfection. All ELC amplifiers enable an investigator to identify a single cell by its characteristic spike train and then electroporate or stimulate this cell in situ. Using the loose-patch clamp technique for recording and stimulation in slice or in *in vivo* preparations, allow investigations under more natural, i.e. non-invasive conditions. Experiments can be executed with minimal damage to individual cells including subcellular structures such as dendrites and axons. Since no gigaseal is required for these types of experiments, the same pipette can even be used for several cells. The ELC incorporates a unique headstage with a resistive-feedback circuit capable of functioning as follows:

1. **patch clamp** headstage with pA sensitivity
2. **high-impedance electrometer** with bridge balance capable of functioning as a conventional bridge amplifier
3. **extracellular amplifier** with differential input for sensitive measurements of field potentials or single unit activity

ELC amplifiers come in 2 versions:
- ELC-01X and the ELC-01MX (modular version) include a simple voltage clamp function for approaching a cell and forming a seal.
- ELC-03XS is a complete patch clamp amplifier for whole-cell and perforated patch with improved series resistance compensation based on a bridge balance circuit.

Therefore, ELC-03XS amplifiers offer an unprecedented combination of capabilities with only one headstage compared to other commercial amplifiers with a more limited functional design. Researchers will find this amplifier an excellent and very cost effective solution for carrying out multiple recording techniques while using several stimulation protocols.

Features:

- recording with patch, sharp, metal or carbon fiber electrodes
- extracellular recordings with high gain
- juxtasomal filling of dyes or DNA
- intracellular recording in CC (bridge) mode with patch or sharp electrodes
- intracellular recording in VC mode with patch electrodes
- improved series resistance compensation
- reliable recording from astrocytes
- *in vivo* recordings with miniature headstages
- headstages with additional extracellular channels
- single cell stimulation
- amperometry, voltammetry and iontophoresis
- telegraph lines for filters and gains
- compatible to all major data acquisition systems
- combined *in vivo* whole-cell patch-clamp recordings with extracellular multielectrode recordings with the NEURALYNX system

npi
Electronic Instruments
for the Life Sciences
made to measure

npi
Electronic Instruments
for the Life Sciences

made to measure

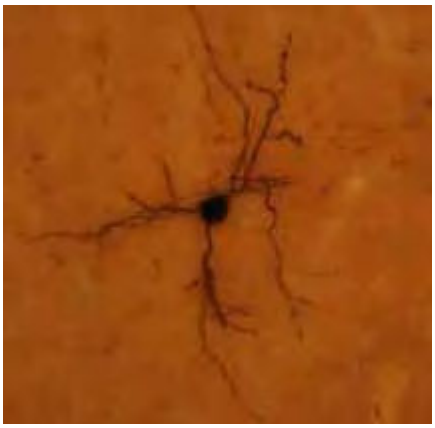
ELC-01X

Amplifier for Extracellular Recording and Electroporation

Features:

- recording with patch, sharp, metal or carbon fiber electrodes
- extracellular recordings with high gain
- juxtasomal filling of dyes or DNA
- single cell stimulation
- iontophoresis
- intracellular recording in CC (bridge) mode with patch or sharp electrodes
- compatible to all major data acquisition systems
- *in vivo* recordings with miniature headstages
- headstages with additional extracellular channels
- telegraph lines for filters and gains

Labeling neurons with ELC amplifiers



Neuron of the rat cortex labeled *in vivo* by means of electroporation using npi's ELC-01 amplifier.

Picture kindly provided by Dr. R. Bruno, Columbia University, New York

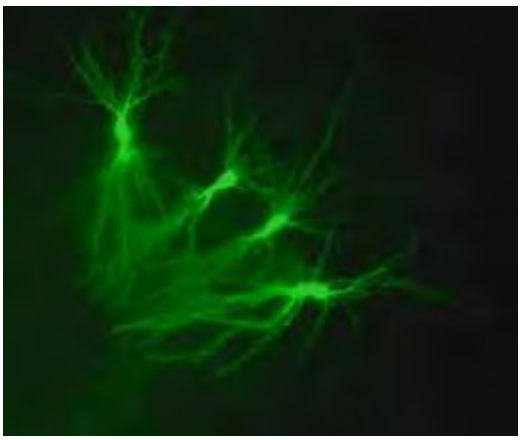
Ref: Bruno, R. M. & Sakmann, B. (2006). Science 312, 1622-1627.

ELC-01MX

Modular ELC amplifier

Rat CA3 pyramid neurons GFP labeled in slice cultures by means of electroporation using npi's modular ELC amplifier. Picture kindly provided by Prof. V. Lessmann and Dr. T. Brigadski, Institute for Physiology, Magdeburg

Ref: Stan, A. et al. (2010). PNAS 107, 11116-11121.

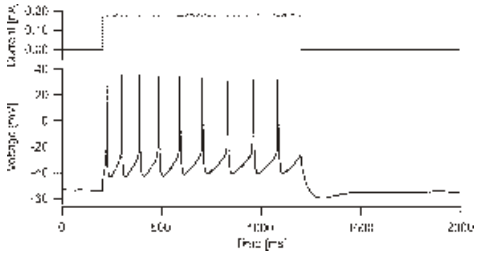


npi
Electronic Instruments
for the Life Sciences
made to measure

Rat, 10 days, Neocortical Layer 5, Pyramidal Cell

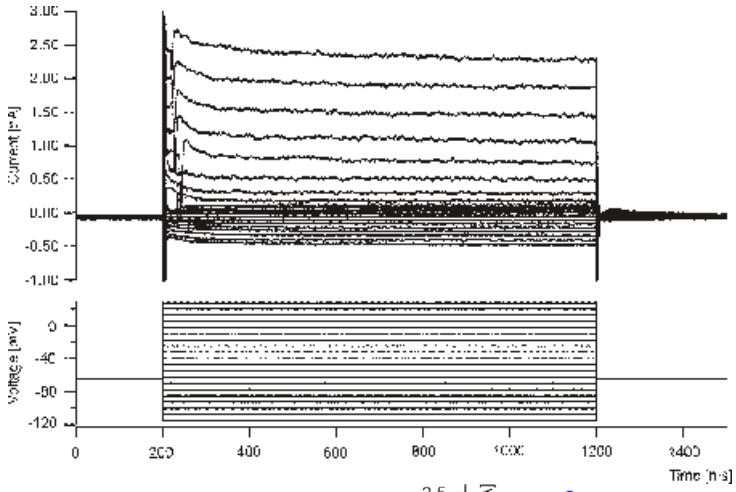
Data recorded with
npi ELC-03XS Amplifier
Kindly provided
by Prof. B. Sutor, Munich

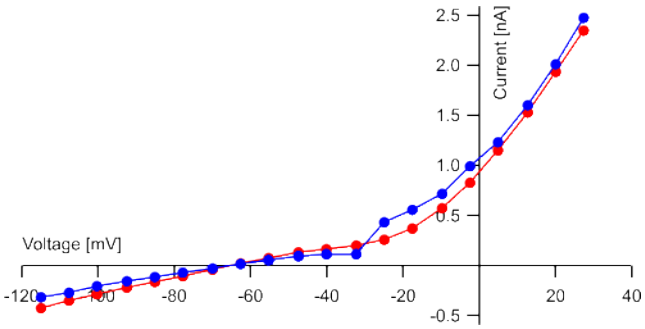
Current Clamp (Bridge Mode), RP: -59 mV



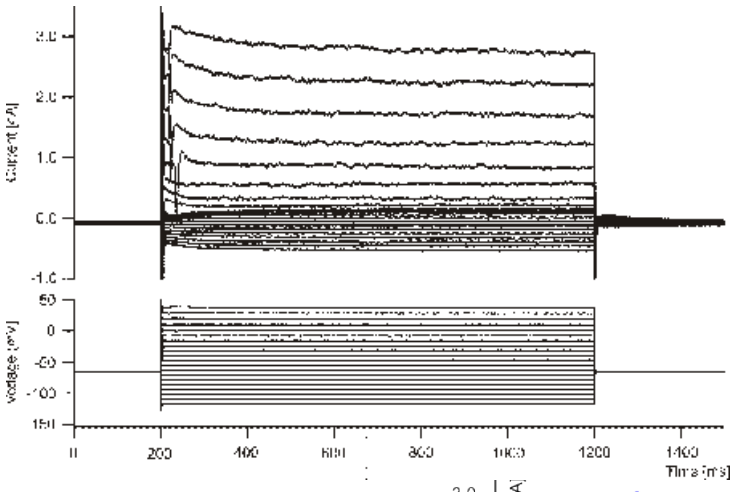
Voltage (Patch) Clamp, HP: -60 mV, Access-Resistance: approx. 5 MΩ

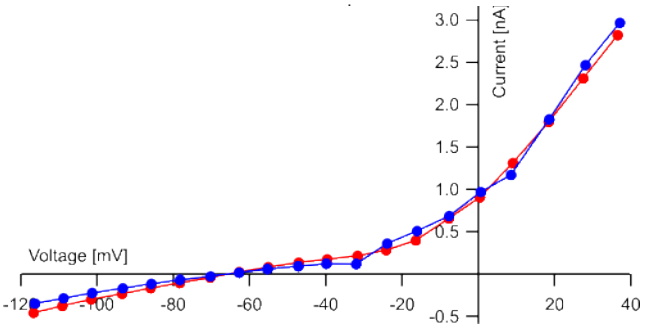
without RS-compensation, 2 kHz current filter





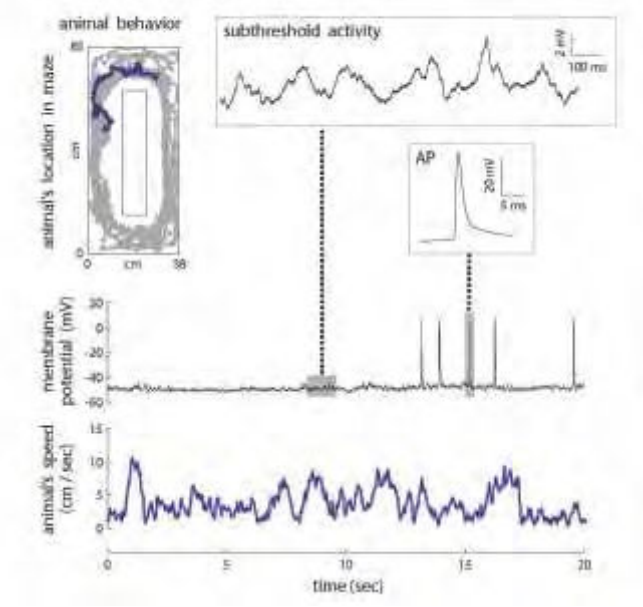
68% RS-compensation, 2 kHz current filter





Ref: **Riedemann**, T et al. (2016). Determination and compensation of series resistances during whole-cell patch-clamp recordings using an active bridge circuit and the phase-sensitive technique. *Pflugers Arch - Eur J Physiol* **468**, 1725-1740.

Whole-cell recording of a hippocampal neuron in a freely moving rat
(Doyun Lee & Albert Lee w/ npi ELC amplifier+mini-headstage)



Miniature Headstage for Whole-Cell Recordings

Refs: Tang, Q. et al. (2014). Juxtacellular recording and morphological identification of single neurons in freely moving rats. *Nature Protocols* **9**, 2369–2381.

Lee, D. et al. (2014). Anesthetized- and awake-patched whole-cell recordings in freely moving rats using UV-cured collar-based electrode stabilization. *Nature Protocols* **9**, 2784-2795.

Lee, D. et al. (2012). Hippocampal Place Fields Emerge upon Single-Cell Manipulation of Excitability During Behavior. *Science* **337**, 849-853.

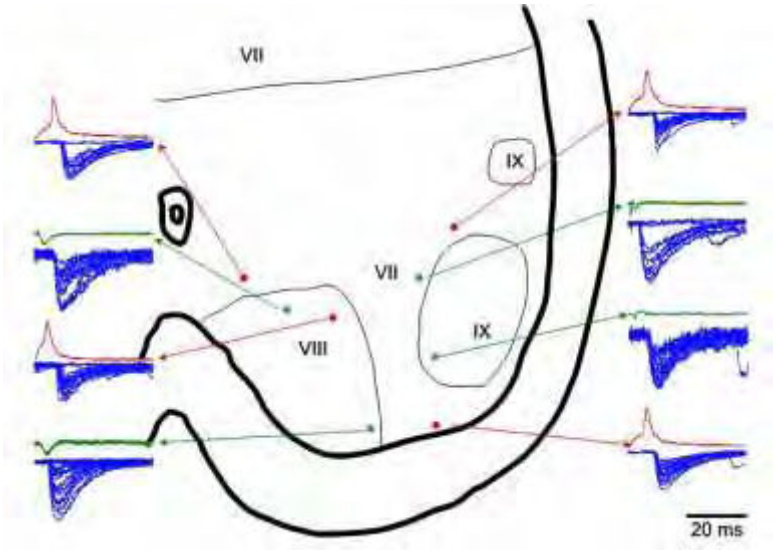
npi
Electronic Instruments
for the Life Sciences

made to measure

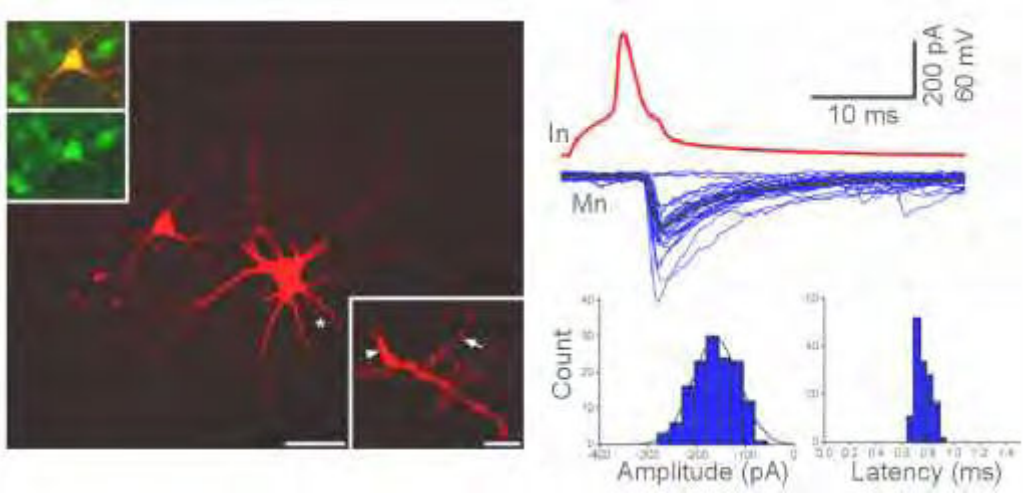
Single Cell Stimulation and Recording in the Mouse

Finding Coupled Neurons in Spinal Cord Slices

Data recorded with
npi ELC-03 Amplifier
Kindly provided by
Dr. M. Beato, London



Because of the low connectivity in the spinal cord, the loose cell-attached stimulation (Barbour and Isope, 2000, J. Neurosci. Methods, 103:199) is the method of choice for detecting coupled cells. Putative pre-synaptic glycinergic interneurons are recorded from with an ELC-03 amplifier in voltage clamp mode (green traces) that can also deliver high voltage stimulation in the loose cell-attached configuration. With 20-30 MΩ seals it is possible to evoke and record a spike, and check for a post-synaptic response in the motoneuron using a second amplifier in voltage clamp mode (IPSCs, blue traces). Since no tight (>500 MΩ) seals are required, it is possible to test up to 20-30 interneurons with the same electrode. After identification of a pre-synaptic interneuron, the loose cell-attached electrode can be retracted, and the cell re-patched with a new electrode, now with a tight seal, and then evoking a spike in the standard current clamp configuration (red traces).

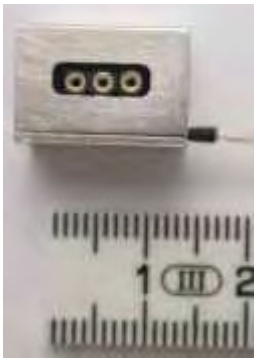


One of the pairs of recorded neurons was identified with confocal microscopy after labelling with biocytin (left side). The latency distribution (right histogram) is narrowly centered around 0.7 ms with a 0.1 ms width, confirming the monosynaptic nature of the evoked glycinergic IPSCs (data from 40 consecutive sweeps).
Confocal data kindly provided by Dr. A.J. Todd and Dr. D.J. Maxwell, University of Glasgow

npi
Electronic Instruments
for the Life Sciences

made to measure

Differential Mini Headstages



Mini headstages for putting directly on the animal's head, e.g. in freely moving rats

Switchable Headstage

Headstages with switchable feedback resistor (x1/x10 or x1/x100) allow higher effective voltages for electroporation, or (x1/x0.1) better current resolution for patch-clamp experiments

The ELC headstages are available with a mounting plate (as shown), a dove tail or a holding bar.
The electrode holder is optional (to be ordered separately).

Mini Headstage with Additional Extracellular Channels

Seal Resistance Test

Measurement of the seal resistance of up to 20 GΩ

Accessories and Options:

- ELC cell model (ELC-MOD)
- ELC with differential headstage (ELC-DIFF)
- ELC with switchable headstage (ELC-SWI)
- ELC with miniature headstage (ELC-MINI)
- ELC with miniature headstage (ELC-MINI-DIFF-X) and X additional extracellular channels (X=2, 4, 6, 8 or 12)
- ELC with seal resistance test (ELC-SEAL)
- ELC electrode holder set (ELC-EH-SET)
- ELC remote control for buzz (ELC-PRS, ELC-03XS only)

References:

- Riedemann, T. et al. (2016). *Pflügers Arch* **468**, 1725-40.
- Chorev, E. et al. (2016). *Nature Neuroscience,* **19,**1367-73.
- Tang, Q. et al. (2014). *Nature Protocols* **9**, 2369–81
- Lee D. et al. (2014). *Nature Protocols* **9**, 2784-95.
- Stroh, A. et al. (2013). *Neuron* **6**, 1136-50.
- Daniel, J. et al. (2013). *Pflügers Arch* **465**, 1637-49.
- Bruno, R. M. & Sakmann, B. (2006). *Science,* **312**, 1622-27.

npi
Electronic Instruments
for the Life Sciences
made to measure

npi Electronic Instruments for the Life Sciences

made to measure

Technical Data for ELC-03XS

Technical data for ELC-01X and ELC-01MX differ slightly due to their reduced functions. Please contact npi electronic for details or visit www.npielectronic.com.

Headstage:	
Input voltage range:	±12 V
Operating voltage:	±15 V
Enclosure:	size: 23 x 70 x 26 mm, grounded
Weight:	approx. 70 g (cable: approx. 70 g)
Mounting plate:	size: 70 x 50 mm
on request	
Holding bar:	length 150 mm, diameter 9 mm
Dove tail:	size: 70 x 17 x 3 mm
Electrode connector:	BNC with driven shield
Ground connector:	2.4 mm connector
Input resistance (CC):	$>10^{13}$ MΩ
Current range:	±120 nA max. (100 MΩ feedback)
	±1.2 µA max. (10 MΩ feedback)
	±12 µA max. (1 MΩ feedback)
Electrode parameter controls:	
Offset:	range ±100 mV, ten-turn control
Pipette hold potential (in VC):	range ±100 mV, ten-turn control
Capacity compensation:	range 0-30 pF, ten-turn control
Bias compensation:	range ±100 pA, ten-turn control
Bridge balance:	
0-100 MΩ	adjustable with ten-turn control
Electrode resistance test:	
Sensitivity 1 mV / MΩ	application of square current pulses of ±1 nA
Display:	3 ½ digits, XXX MΩ, activated by push button
Bandwidth and speed response (CC mode, optimal cap. comp.):	
Full power bandwidth (R_{EL} = 0 MΩ):	>30 kHz, rise time (10%-90%)
	<10 µs (R_{EL} = 100 MΩ)
	<5 µs (R_{EL} = 10 MΩ)
Outputs:	
Output impedance:	50 Ω
Max. voltage:	±12 V
Current output:	BNC connector, sensitivity 0.1....10 V/nA
Current output sensitivity:	Rotary switch, 0.1, 0.2, 0.5, 1, 2, 5, 10 V/nA
Current display:	3 ½ digits, XX.XX nA, resolution 10 pA
Current LP filter:	4-pole BESSEL filter (other available)
attenuation:	-24 dB/octave,
corner frequencies (Hz):	20, 50, 100, 200, 300, 500, 700, 1k, 1,3k, 2k, 3k, 5k, 8k, 10k, 13k, 20k
Potential output x1:	BNC connector, sensitivity 1 V/V
Potential output:	BNC connector, sensitivity 10...1k V/V
Potential output gain:	Rotary switch, 10, 20, 50, 100, 200, 500, 1k
Potential output resolution in AC:	50 µV
Potential LP filter:	4-pole BESSEL filter (other options available)
attenuation:	-24 dB/octave,
corner frequencies (Hz):	20, 50, 100, 200, 300, 500, 700, 1k, 1,3k, 2k, 3k, 5k, 8k, 10k, 13k, 20k
Potential HP filter:	1-pole filter (other available)
attenuation:	-6 dB/octave
corner frequencies (Hz):	DC, 0.1, 0.3, 0.5, 1, 3, 5, 10, 30, 50, 100, 300, 500, 800, 1k, 3k
Telegraph potential LP filter	-8...+7 V, 1V/ step
Telegraph potential HP filter	-8...+7 V, 1V/ step
Telegraph current filter	-8...+7 V, 1V/ step
Telegraph potential output sensitivity	+1...+7 V, 1 V/ step
Telegraph current output sensitivity	+1...+7 V, 1 V/ step
Digital displays:	
Display mV/MW	3 ½ digits, XXXX mV or XXX MΩ
Display current	3 ½ digits, XX.XX nA
Inputs:	
Input impedance analog	100 kΩ
Input range	±12 V
Input impedance digital (TTL)	10 kΩ
Input range TTL	0-5 V
Current stimulus input CC	BNC connectors, sensitivity 1 nA / V
Current stimulus input CCx10	BNC connectors, sensitivity 10 nA / V
Step gate input	BNC connector (TTL)
Gated stimulus CC	with ten-turn control of holding current
	resolution: 10 pA, range: ±10 nA
Gated stimulus CCx10	with ten-turn control of holding current
	resolution: 100 pA, range: ±100 nA
Polarity	selectable with toggle switch
Voltage command input VC	BNC connectors, sensitivity: ÷10 mV
Voltage command input VCx10	BNC connectors, sensitivity: ÷1 mV
Step gate input	BNC connector (TTL)
Gated stimulus VC	with ten-turn control of holding potential
	resolution: 1 mV, range: ±1 V
Gated stimulus VCx10	with ten-turn control of holding potential
	resolution: 10 mV, range: ±10 V
Polarity	selectable with toggle switch

Dimensions:
19" rackmount cabinet
19" (483 mm), 10" (250 mm), 3.5" (88 mm)

Power requirements:
115/230 V AC, 60/50 Hz, fuse 0.4/0.2 A, slow, 25 W

Weight
5.0 kg

For more information contact:

General:
npi electronic GmbH
Phone: +49-7141-9730230
Fax: +49-7141-9730240
sales@npielectronic.com
www.npielectronic.com

North America:
ALA Scientific Instruments
Phone: +1-631-393-6401
Fax: +1-631-393-6407
sales@alascience.com
www.alascience.com

Switzerland:
Science Products Trading AG
Phone: +41-43-4880561
Fax: +41-43-4880562
info@science-products.com
www.science-products.ch