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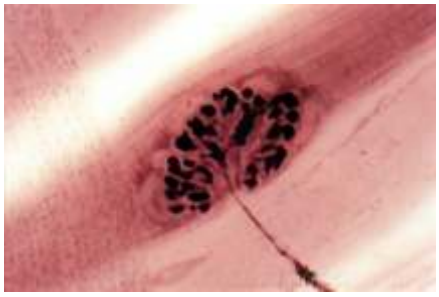

TEC Series

Two Electrode Voltage and Current Clamp Amplifiers

For Oocytes...

TEC-03X

TEC-10CX

...and other large cells

TEC-05X

- Accurate and fast amplifiers with PI-controller
- No virtual ground needed
- Differential potential registration
- Full compensation of the current injecting microelectrode
- Telegraphing outputs

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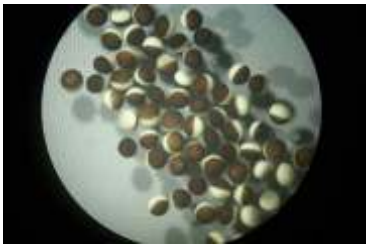

TEC-03X

Two-Electrode Voltage Clamp Amplifier for routine recordings from oocytes

Features:

- The TEC-03X is based on the standard two electrode approach and is an ideal, easy-to-use system for recording from oocytes
- Accurate and fast two-electrode voltage and current clamp (V/C) amplifier with PI-controller for studying large membrane currents
- Differential potential registration and high-voltage current source output, automated electrode resistance test mode which can be used even with the electrodes impaled in an oocyte
- Digital DISPLAYS for current, voltage and electrode resistance
- Two-pole (optionally four-pole) BESSEL filter for current
- No virtual ground needed for recording membrane currents
- OSCILLATION SHUT-OFF unit prevents cells from damage
- Standard current range is ±150 µA into 1 MOhm. Current headstages with selectable current ranges (x0.1, x1, x2, x5 or x0.1, x0.2, x0.5, x1) are also available
- Easy operation with all major data acquisition systems, remote selection of MODE of OPERATION (CC, VC), telegraphing (monitoring) outputs for current sensitivity and filter
- Optional: Built-in interface for data acquisition with CellWorks

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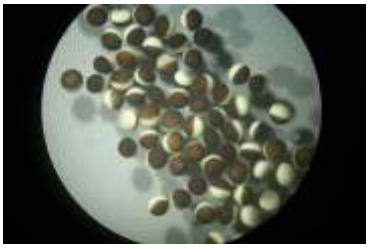

TEC-10CX

Two-Electrode Voltage Clamp Amplifier for sophisticated recordings from oocytes

Features:

- Sophisticated and extremely fast two-electrode voltage and current clamp (V/C) amplifier with PI-controller for recordings from oocytes
- Push buttons for comfortable and fast selection of MODE of OPERATION
- Differential potential registration and high-voltage current source output, automated electrode resistance test mode which can be used even with the electrodes impaled in an oocyte
- VC OUTPUT LIMITER, COMMAND FILTER, INTEGRATOR and SERIES RESISTANCE COMPENSATION for fine tuning of VC circuit
- Current transient compensation prevents data acquisition system from clipping
- Digital DISPLAYS for current, voltage and electrode resistance
- Four-pole BESSEL filter for current
- No virtual ground needed for recording membrane currents
- OSCILLATION SHUT-OFF unit prevents cells from damage
- Standard current range is ±150 µA into 1 MOhm. Current headstages with selectable current ranges (x0.1, x1, x2, x5 or x0.1, x0.2, x0.5, x1) are also available
- Easy operation with all major data acquisition systems, remote selection of MODE of OPERATION, telegraphing (monitoring) outputs for current sensitivity and filter

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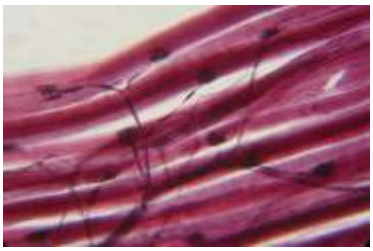

TEC-05X

Two-Electrode Voltage Clamp Amplifier for recordings from small & medium size cells

Features:

- Ideal amplifier for medium size cells such as invertebrate ganglion cells, muscle cells or neuromuscular junction preparations
- Can be used with sharp microelectrodes, and patch pipettes in the whole-cell and perforated-patch configuration
- Single electrode recording in BRIDGE mode: **True current clamp operation** with measured membrane potential and complete cancellation of series resistance (potential electrode)
- Two-pole (optionally four-pole) BESSEL filter for current
- Digital DISPLAYS for current, voltage and electrode resistance
- BUZZ and ELECTRODE CLEAR facility with remote hand or foot switch
- OSCILLATION SHUT-OFF unit prevents cells from damage
- From pA to µA - low voltage (±15 V) and high voltage (up to ±150 V) versions available
- Easy connection to all major data acquisition systems, TTL control of MODE of OPERATION, telegraphing outputs for current sensitivity and filter
- **Now optionally with** Dynamic Hybrid Clamp (DHC) Mode - measuring of conductances after APs
  Voltage Clamp controlled Current Clamp (VCcCC) Mode - Current Clamp experiments at controlled resting potentials

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Standard Current Headstage

Potential Headstage

Current Electrode Holder Adapter

Technical Data

MODES OF OPERATION

RPel: Potential Electrode Resistance Test; CC: Current Clamp Mode; VC: Voltage Clamp Mode; RCel: Current Electrode Resistance Test; BR: Bridge Mode (TEC-05X); DHC Mode (TEC-05X, option); VCcCC Mode (TEC-05X, option); MODE selection: rotary switches (TEC-03X, TEC-05X), or push buttons (TEC-10CX) , LED indicators; remote selection by TTL inputs (VC, CC)

HEADSTAGES

Potential headstage:

Operating voltage ±15 V; Size (approx.): 70x26x26mm (TEC-05X: 100x43x26mm), holding bar diameter 8 mm, length 150 mm; Electrode connector: BNC with driven shield or SMB with driven shield (TEC-05X); Ground connector: 2.4 mm connector or headstage enclosure; Reference connector (bath): gold-plated SMB, grounded shield; Input resistance: >10E+13 Ohms; Differential input: cmr >80 dB

Current headstage (150 V):

Operating voltage: ±150 V (standard); Size (approx.): 105x55x35 mm, grounded enclosure; Electrode connector: gold-plated SMC connector, grounded shield; Input resistance: >10E+12 Ohms

Current headstage (15 V, TEC-05X):

Operating voltage: ±15 V; Size: 100x43x26mm, Electrode connector: gold-plated SMB with driven shield; Ground: 2.4 mm connector or headstage enclosure; Input resistance: >10E+13 Ohms

Current range:

±150 µA / 1 MOhm (±150 V) or ±150 nA / 100 MOhm (±15 V) or ±1.5 µA / 10 MOhm (±15 V);
Current range switch for high voltage (±150 V) headstage (optional): x0.1, x1, x2, x5, or x0.1, x0.2, x0.5, x1
Current range switch for low voltage (±15 V) headstage (optional): x0.1, x0.2, x1, x2, x5, x10

Bandwidth and Speed of Response:

Full power bandwidth (Re = 0): >100 kHz; Rise time (10 % - 90 %, current pulse of 100 µA applied to Re = 1 MOhm): <30 µs; Bandwidth switch: wide band or 10 Hz for parallel patch clamp recordings

Current Electrode Parameter Controls:

Offset compensation: ten-turn control, ±500 mV; Capacity compensation (optional, TEC-05X): range 0 - 30 pF, ten-turn potentiometer

Potential Electrode Parameter Controls:

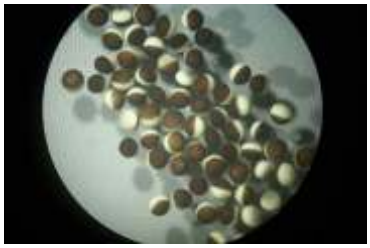
Offset compensation: ±300mV, ten-turn control; Capacity compensation: range 0 - 30 pF, ten-turn control

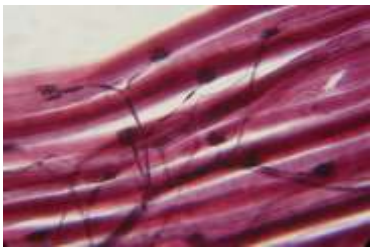
POTENTIAL OUTPUTS:

Potential electrode: sensitivity x10 mV only (TEC-03X), or x10 mV and x40 mV (TEC-05X, TEC-10CX), voltage range ±15V;
Current electrode: sensitivity x10 mV, voltage range ±15 V; DISPLAY (selected by switch): XXX mV

AUDIO MONITOR:

Pitch correlated with potential signals, selected by switch





OSCILLATION SHUT-OFF:
Turns off current injection and capacity compensation, function indicated by red/green LED, disabled/off/reset switch, threshold set with linear control (0 - 1200 mV)

ELECTRODE RESISTANCE TEST (both electrodes):
100 mV/MOhm, obtained by application of square current pulses ±10 nA, display XX.X MOhm or XXX MOhm (TEC-05X)

CURRENT OUTPUTS:
Uncompensated output signal: sensitivity 0.1 V/µA or 0.1 V/nA (TEC-05X), voltage range ±15 V; Compensated/filtered output: sensitivity: 0.1 V...10 V/µA (0.1 V...10 V/nA for TEC-05X) in 1-2-5 steps, selected by rotary switch, with lowpass Bessel filter, DISPLAY: X.XX µA (X.XX nA for TEC-05X)

CURRENT SIGNAL PROCESSING:
Transient compensation unit (TEC-10CX): three overlapping time ranges (max: T1 = 3.3 ms, T2 = 330 µs, T3 = 33 µs), time constants set by ten-turn controls, amplitudes set by one-turn linear controls, leakage compensation max. 1 µA

CURRENT OUTPUT FILTER:
Two-pole (TEC-03X, TEC-05X, standard) or four-pole (TEC-03X-BF and TEC-05X-BF and TEC-10CX) lowpass Bessel filter with 16 corner frequencies, 20 Hz - 20 kHz; frequency monitor: -8 V...+7 V, 1 V/switch position

CURRENT CLAMP (standard headstage):
Inputs: 1 µA/V with ON/OFF switch (TEC-10CX); 1 µA/V (TEC-03X); 1 nA/V with ON/OFF switch (TEC-05X); input resistance >100 kOhms: HOLD: X.XX µA (TEC-03X, TEC-10CX), X.XX nA (TEC-05X), ten-turn digital control with -/0/+ switch, maximum 10 µA (TEC-03X, TEC-10CX) or 10 nA (TEC-05X); BRIDGE balance (TEC-05X max. 10 MOhms or max. 100 MOhms (switch selected) with ten-turn digital control;
Speed of response (1% settling time; potential output signals after application of square pulses of 1 V with 1 MOhm electrode resistance): potential electrode <10 µs

VOLTAGE CLAMP:
Inputs: :10 mV (TEC-03X) :10 mV and :40 mV (TEC-05X, TEC-10CX) with ON/OFF switches, input resistance >100 kOhms; HOLD: XXX mV, ten-turn digital control with +/0/- switch, maximum 1000 mV; RISE TIME LIMIT: 0 - 0.2 ms; GAIN: 10 µA/V - 10000 µA/V (TEC-03X, TEC-10CX) or 100 nA/V - 10 µA/V (TEC-05X), ten-turn linear control; INTEGRATOR TIME CONSTANT: 200 µs - 2 ms, ten-turn control (TEC-03X) or control with ON/OFF switch (TEC-05X, TEC-10CX) ; VC OUTPUT LIMITER (TEC-10CX): 0 - 100%, linear control; COMMAND FILTER TIME CONSTANT (TEC-05X, TEC-10CX): 10 µs - 1000 µs;
TEC-03X Modes: NORMAL (gain only), FAST (series resistance compensation), SLOW (integrator is active)

SPEED of RESPONSE (VC Mode):
1% settling time: <80 µs for 10 mV step and <100 µs for 100 mV step applied to a cell model (Re = 1 MOhm, Rm = 100 kOhms, Cm = 0.1 µF, standard headstage)

POWER REQUIREMENTS and DIMENSIONS:
115 V/230 V AC, 60 W (1.25 A/0.63 A fuse, SLOW)
19" rackmount cabinet, 19" (483 mm) wide, 14" (355 mm) deep, 5.25" (133 mm) high
weight: approx. 8 kg.

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