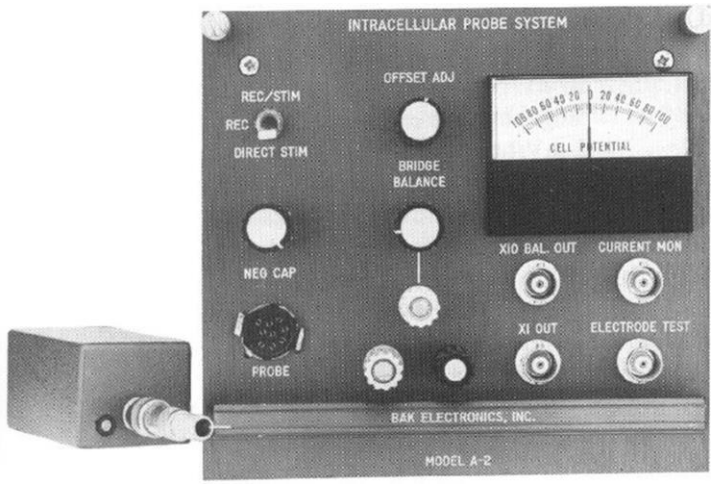
MICROPIPETTE ELECTRODE INTRACELLULAR PROBE SYSTEM

Model A-2



NEGATIVE CAPACITANCE FEEDBACK
HEAD STAGE RELAYS FOR REMOTE STIMULATION, IONTOPHORESIS
MEMBRANE POTENTIAL PANEL METER
CURRENT, VOLTAGE, AND BALLANCE MONITOR POINTS

Description:

solid state device employing negative capacitance feedback, a very stable DC coupled input isolation stage with a separate high quality common, and wide bandwidth for excellent recording of physiological phenomena. It has a small active probe which utilizes miniature reed switches so that the input may be remotely connected to ground when stimulating or passing high currents through the electrode. External voltages can be applied to the electrode for iontophoretic applications through a connector on the probe which is tied through a 10(x10x9) ohm resistor to the input. A DC zero center +100 mV meter is provided so that cell potentials may be monitored. A front panel DC offset control will provide compensation to the input amplifier for cell and tip potentials. Two separate outputs are provided, a X10 and a X1 output which is used when employing bridge balance control for stimulating and recording through an electrode. The Model A-2 features an input connector, current monitor output and three binding posts which are internally connected to a front potentiometer for bridge balance adjustment. The Model A-2 is of modular construction and slides easily into the Model RP-l rack mounted power supply module cage system.

Specifications:

Input Resistance Greater than 10" ohms
Input Capacitance Less than 1 pF
Input Capacitance Neutralization 0-35 pF
Input Dynamic Range +/-1 Volt
Gate Leakage Current Less than 10-12 amperes maximum
Gain X1 1% and X10 1% balanced output
Probe Control 3 position high impedance switch (front panel control)
Bandwidth 0-200 kHz
Output Impedance X1 output 100 ohms, X10 output 100 ohms
Input Offset Voltage Adjustable through zero
DC Level Output Adjustable +/-300 mV (X1 output) +/-3.0 Volts (X10 output)
Noise Level (0-200 kHz) 50 uV p-p; 400 uV p-p typical through 10 megohms source resistance (0-30 kHz)
Drift 2 mV/hr
Rise Time Less than 15 microseconds (10-90% with no overshoot fully compensated thru 10 megohms)
Bridge Balance Control Multiturn potentiometer
Electrode Resistance Check 1 mV/megohm (12 V test pulse in)
Current Monitor Output Set to 10 mV/nanoamp, inverted output
Power Requirements +15 Volts supplied by the Model RP-1
(+40 ma typ.,+120 ma max) and (-35 ma)
Size 5.6w x 5.25"h x 7.25"d

Probe Size 1.4w x l.13"h x 2.25"d
Weight 1.5 lbs

Options:

MODEL A-2B- RECHARGEABLE BATTERIES

The Model A-2B contains rechargeable nicad batteries and can be used as a stand alone unit or it may be powered by the Model RP- 1. A front panel switch selects the power mode. A LED lamp will light when the batteries require recharging. The Model A-2B will operate for approximately 10 hours off a full charge which takes a minimum of 16 hours. The Model RP-1 has been designed for recharging the batteries.

Other BAK equipment often used with A-2:

MDA-2 AC Differential Amplifier for extracellular gain, filtering
DDIS-l Dual Window Discriminator
DIS-l Window Discriminator for extracellular spike recognition
RG-1 Raster Stepper for rastering multiple oscilloscope sweeps
ISI-l Interspike Interval Convertor for generating frequencygrams
IPS-n Micro-iontophoresis Systems for nanoamp currents
BSI-l Biphasic Stimulus Isolator for constant current injection

APPLICATIONS NOTE

A-2 and A-2B INTRACELLULAR PROBE SYSTEMS

The BAK Model A-2 Intracellular Probe System is a complete system for recording, stimulating, and iontophoresing intra- and extra-cellularly using glass micropipettes. It is based on the classic bridge amplifier designed by Tony Bak (Bak, A.F., "A High Impedance Amplifier With Remote Electronic Control Of Negative Capacity Feedback", Proc. 2nd Inter. Conf. on Med. Elect., Paris, France, 1959), updated with current integrated circuit technology and a virtual ground current monitor system. For the ultimate in power supply noise isolation or where the main bridge module needs to be located inside a shielded cage, use the A-2B, powered by internal NiCad batteries which can be recharged from the RP-1 Power Supply.

The two main components of the system are the probe and the bridge. The "Smart Probe" head stage contains the high impedance preamplifier which is located as close as possible to the preparation to minimize noise and stray capacitance. A driven guard plus negative capacitance feedback further optimize performance so that the amplifier may be used with fine-tipped and ion selective micropipettes having several hundred megohms impedance. The preparation may be either grounded or, ideally, floating via an active virtual ground circuit in the head stage which provides an accurate monitor of any current being passed through the system (see Fig. 1) An OFFSET ADJUST compensates for tip and polarization potentials.

The "Smart Probe" is further equipped with multiple relays which allow for remote activation and reconfiguration of the micropipette input circuit to facilitate passage of both low (polarization) and high (iontophoretic) currents through the recording pipette. The REC/STIM mode (Fig. 1) connects an external voltage through a 1000 megohm series resistor into the pipette while it is connected to the amplifier. The resulting current of 1 nA/V is automatically balanced by the bridge circuit so that only the induced voltage across the cell membrane is monitored by the XIO BAL. OUT and the CELL POTENTIAL panel meter. The IR drop accross the pipette impedance is cancelled out in the differential amplifier accross the bridge when it is in balance. The DIRECT STIM mode (Fig. 2) connects the external voltage or current source directly to the micropipette, simultaneously disconnecting and grounding both the input preamplifier and the bridge balance input to prevent damage even when very high compliance voltage sources are used to iontophorese drugs and stains from the barrel of the recording micropipette. The virtual ground current monitor can be used to accurately monitor the injection.

For extracellular AC applications, further amplification and variable bandpass filtering to optimize single unit recording may be inexpensively provided by the BAK MDA-2 AC Differential Amplifier. A fully buffered X1 direct output (unbalanced) is provided for users needing an external bridge circuits. Our MCDA-1 DC Differential Amplifier is suggested as a precision wide-band detector for such applications.

Finally, a simple electrode impedance testing scheme is provided which allows the user to check the actual micropipet impedance at any time, whether intra- or extra-cellular, by simply applying a brief test pulse to the ELECTRODE TEST input and observing the amplitude of the output deflection (balanced or unbalanced). For a 12 V square wave, the output amplitude is lmV/megohm; this scales with changes of the input amplitude.

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