

## SEC SYSTEMS WITH VCcCC MODE

### **General Description**

The “Voltage Clamp controlled Current Clamp” (VCcCC) or “slow voltage clamp“ (SLOW VC) mode is used for performing accurate current clamp recordings in the presence of membrane potential oscillations. The npi single-electrode current- and voltage-clamp amplifiers (npi SEC 05/10 series) have been modified in a way that slow membrane potential oscillations are exactly controlled by the voltage-clamp module without affecting faster responses, e.g. postsynaptic potentials (PSPs) and action potentials (APs). The response speed of the voltage-clamp feed-back circuit has been decreased by incorporation of electronic circuits with large time constants (1 - 10000 s). In addition, through the current clamp input fast current stimuli (e.g. for conductance measurements) can be applied.

### **Operation**

The VCcCC mode is controlled through two front panel elements (located in the VC part of the front panel): a toggle switch marked “on” / “off” and a rotary switch to set the time constants (1-10-100-1000, [optional 5000 and 10000] sec) for the low-pass filter. To start using the VCcCC mode, the amplifier must be tuned accurately in the fast VC mode (toggle switch “off”). The holding potential control must be set on the desired value, or a holding potential signal must be provided from an external device (e.g. computer). This holding potential will be the preset membrane potential for the VCcCC mode. Under these conditions, PSPs or other changes of the membrane potential will be voltage clamped.

If the toggle switch is set “on” the VCcCC mode is started. Depending on the preset time constant, fast changes of the membrane potential will not be voltage clamped any more. This is a condition that corresponds to an accurate current clamp. Fast changes of the membrane potential are monitored on the potential output, slow changes are compensated by the VCcCC circuit.

The time constant should be selected in a way that the signals under investigation are not altered by the VCcCC (please compare with current clamp recordings).

**Important:** The average membrane potential can be changed only through the VOLTAGE COMMAND INPUT. If changes are necessary, please select a short time constant (1 or 10 s).

### **CURRENT CLAMP INPUT**

The current clamp input (CURRENT STIMULUS BNC connectors) is connected in the VCcCC mode in a way that fast current stimuli can be applied to the electrode. **The condition for such recordings is a ratio of >1:1000 between current pulse duration and VCcCC time constant.** Slow (long-lasting) current signals or DC (such as the HOLDING current) will be removed by the action of the VCcCC system. In the fast VC mode, the current clamp input is disconnected automatically. In this way, using the VCcCC mode, fast current stimuli can be used to monitor conductance changes.

### **LITERATURE**

1. Peters, F., D. Czesnik, A. Gennerich & D. Schild, (2000) Low frequency voltage clamp: recording of voltage transients at constant average command voltage, *J. Neurosci. Meth.* Vol. 99, 129-135.
2. Sutor, B., S. Greiner-Fischer, B. Schlosser (2000) Pharmacologically isolated NMDA-EPSPs recorded at resting membrane potential of rodent neocortical neurons, *Soc. Neurosci. Abstr.*, Vol. 26, Part 1, p 352.
3. Sutor, B., Grimm, C., & Polder, H. R. (2003). Voltage-clamp-controlled current-clamp recordings from neurons: an electrophysiological technique enabling the detection of fast potential changes at preset holding potentials. *Pflugers Arch.* **446**, 133-141.