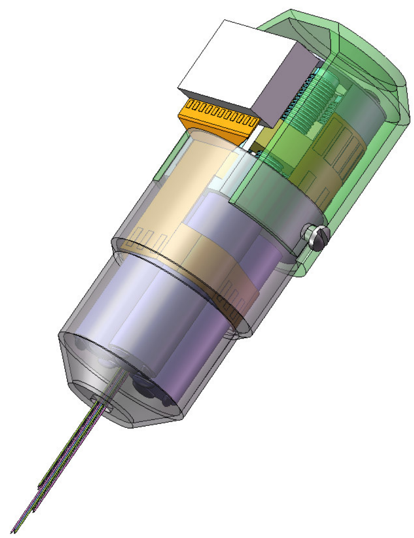
RP Metrix

Three Microdrive Neural Headstage	ND3HS

Lightweight Motorized Neural Probe Assembly for Awake Animal Neural Recording

- **3 independent motorized microdrives.**
- **12 microelectrode circuits**
- **2 reference circuits**
- **3 stimulus circuits**
- **Independent 5-wire motor control circuits**
- **Omnetics Nanominiature connector**
- **3 gram total microdrive mass**



Ordering Information

Motor Configuration	Part Number
MicroMo 0308A003B+03A 125:1S3	ND3HS-1

Accessories

Description	Part Number
JFet Buffer Assembly	ND3BAJ-1
Tether Cable	ND3TC-1
Shuttle Assembly Fixture	ND3SAF-1
Microelectrode Capillary	ND3MEC-1

Absolute Maximum Ratings

Characteristic	Symbol	Min	Typ	Max	Unit
Microelectrode Circuit Current	I_E			10	mA
Reference Circuit Current	I_R			10	mA
Stimulus Circuit Current	I_S		0.020	100	mA
Motor Current per Winding	I_w		110	150	mA
Motor Winding Voltage	V_W		3.8	5.25	V

Specifications

Characteristic	Symbol	Min	Typ	Max	Unit
Gearhead Reduction Ratio	GR		125:1		rotor/shaft
Output Shaft Diameter	D_S		1.6		mm
Output Shaft Thread Pitch	TP		0.2		mm/rev
Shuttle Step	L_{SS}		0.27		µm
Shuttle Travel	L_{ST}			5000	µm
Shuttle Speed	V_S		1	400	µm/sec
Direction Reversal Hysterisis	H_{DR}		100		µm
Microdrive Diameter	D		7.6		mm
Microdrive Length	L		20.8		mm
Microdrive Mass	M		3.0		gm
Electrode Diameter, Tungsten	D_E		75	100	µm

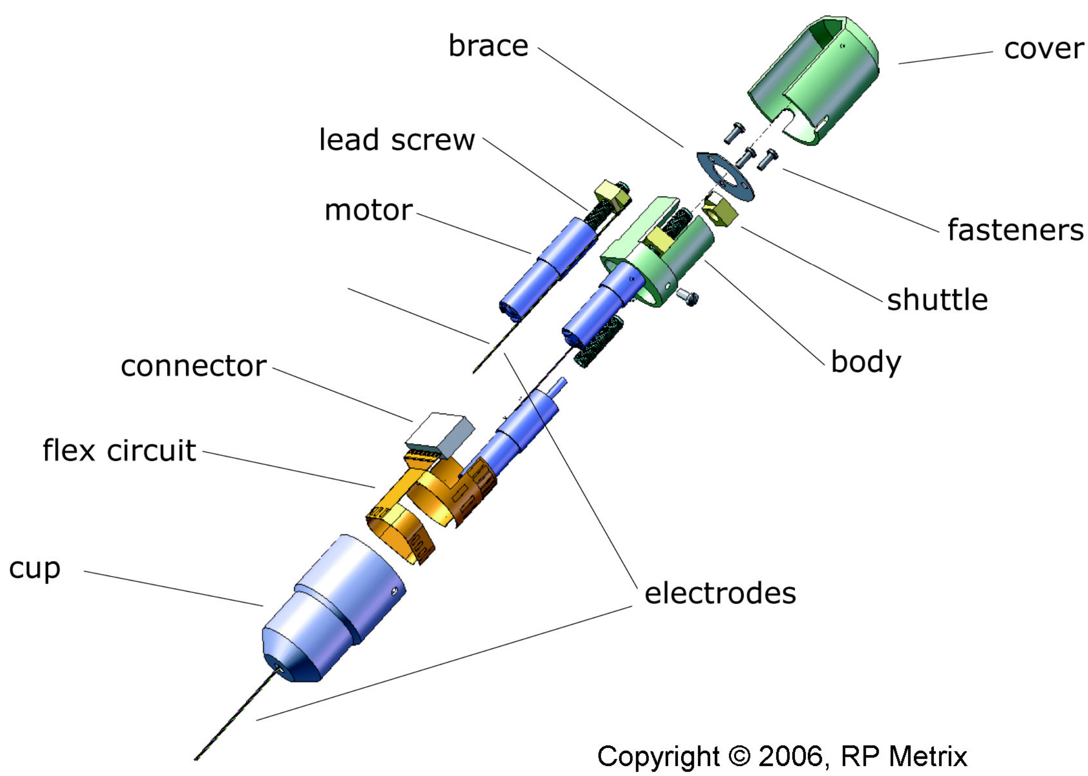


Figure 1 - Headstage Exploded View

Description

The ND3HS headstage incorporates three miniature motors with gearheads mounted on a central body part made of sturdy, lightweight, and chemically resistant plastic (See Fig. 1). The gearheads reduce 125 motor rotations to one output shaft rotation. Each output shaft is a threaded rod, turning in a screw thread within a sliding shuttle. One shuttle can carry from one to four tungsten electrodes. The rotational movement of the threaded rod transforms to longitudinal movement of the shuttle at 0.2 mm per shaft revolution. The minimal motor step is 60 degrees, corresponding to 0.27 µm of longitudinal electrode movement.

To achieve reproducible electrode placement, always move them in one direction. For example, if the main direction is forward, then to move electrodes back, first retract them farther than the desired position by at least the amplitude of the hysteresis (H_{DR} = 100 µm) and then move them forward to the desired position.

Electrodes are glued to the shuttle with epoxy. Electrical connection between electrodes and contact pads on the head stage is made using thin copper wire (40 AWG). It is recommended to embed the electrode wire connection and part of the wire close to the shuttle in epoxy.

During implantation a titanium cup on the headstage is fixed to the skull of the animal with dental cement. The cup prevents contact by motors and other electronics with dental cement and live tissue. To remove the headstage from the animal, first unscrew the central body with motors, shuttles and electrodes from the cup and remove it. The cup remains on the animal until euthanasia. Remove the dental cement from the cup by dissolving it in solvent.

To reduce the number of wires connected to the headstage a 5-wire motor control scheme proposed by Michale Fee[1] is used. Each motor has two common wires and one independent wire. A motor is activated by pulsing the common wires and its independent wire. The other two independent wires, attached to the other motors, are held at a constant voltage. This prevents jerking of the inactive motors.

The circuits for motor control, microelectrode signals, neural reference signals, stimulus signals, and ground reference are provided by a flexible printed circuit wrapped around the central body part. The flex circuit provides solder pads for attachment of microelectrode and reference lead wires. A dual row 22-pin fine pitch connector provides an attachment point for an external tether cable.

I/O Information

ND3HS-NPD-22 (Omnetics Nanominiature Male) 22-Pin Interface Connector

Pin #	Signal	Pad	Input/Output	Pin #	Signal	Pad	Input/Output
1	Probe1	1	Output	2	Probe4	4	Output
3	Probe2	2	Output	4	Probe5	5	Output
5	Probe3	3	Output	6	Probe6	6	Output
7	Reference1	R1	Output	8	Ground	G	--------
9	MotorA	mA	Input	10	StimulusA	A	Input
11	MotorB	mB	Input	12	StimulusB	B	Input
13	MotorC	mC	Input	14	StimulusC	C	Input
15	Reference2	R2	Output	16	Motor Com	mm	Input
17	Probe10	10	Output	18	Probe7	7	Output
19	Probe11	11	Output	20	Probe8	8	Output
21	Probe12	12	Output	22	Probe9	9	Output

[1] Miniature motorized microdrive and commutator system for chronic neural recording in small animals, Michale S. Fee and Anthony Leonardo, J Neurosci Methods. 2001 Dec 15;112(2):83-94.

Electrode Pad Information

Fig. 2 shows the top layer of the headstage flex printed circuit. All electrode and stimulus connections are accessable on this layer. In the **I/O Information** table above, the **Pad** column refers to the pad labels shown in this figure. The pads for the 22-pin interface connector are also labeled in this figure. The top row of connector pads appears in the center with labels ‘1’, ‘2’, ‘3’, ‘R1’, etc. The bottom row of connector pads is obscured by the top row but the labels for these pads appear below the first set of labels as ‘4’, ‘5’, ‘6’, ‘G’, etc. There are two pads for each reference circuit (‘R1’ and ‘R2’) and two pads for the ground circuit (‘G’).

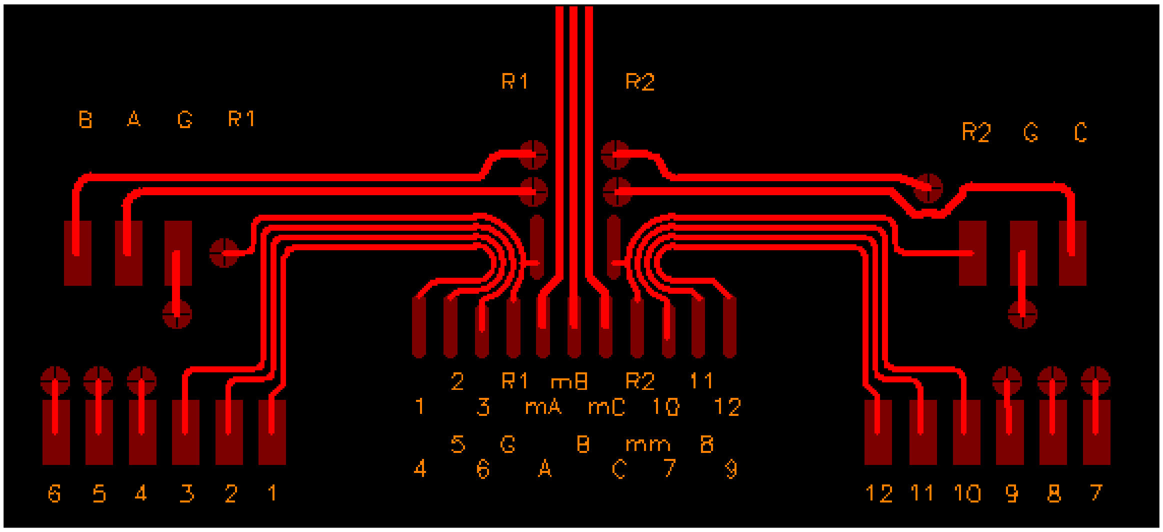


Figure 2 - Electrode pad locations on headstage.