Implanting an Adult Rat with the Single-Channel Epoch Transmitter for Recording Electrocardiogram in the ‘Type II’ electrode configuration.
**Recommended Surgical Tools**

A. Scalpel handle  
B. Scalpel blade (#15)  
C. Fine scissors  
D. Burr tool  
E. Fine burr (FST #19007-09 or equivalent)  
F. 4x Hemostats (curved)  
G. Toothed forceps  
H. Absorbent spears or cotton-tipped applicators  
I. Needle drivers  
J. Accelerant (Loctite 7452 or equivalent)  
K. Cyanoacrylate (Loctite 4541 or equivalent)  
L. Suture (Vicryl 4-0)  
M. Electrocautery unit  
N. 20 Gauge 316 SS hypodermic needle tubing, 12” long, blunt  
O. Polymethylmethacrylate (dental cement, acrylic)
Sterilize Transmitter

**Ethylene Oxide**
- Place transmitter in Tyvek pouch
- Gas for a complete Kill cycle
- Off-gas for at least 24 hours

**Isopropyl Alcohol**
- Soak in 95% ethanol for 1 minute and allow to air-dry
Place Animal in Anesthesia Chamber

- Anesthetize animal (4% isofluorane) and maintain anesthesia (1-2% isofluorane) according to IACUC-approved protocol.

- Transfer to a rodent bane.
Shave Skull

• Using clippers, gently shave the scalp of the animal from behind the ears to between the eyes.
Shave Chest

• Flip the animal over and shave a portion of the chest next to the animal’s right front paw and below the animal’s left front paw.

• Be careful around the animal’s nipples.
Fix Position in Stereotaxic Frame and Sterilize Scalp

- Each ear bar tip must be properly positioned in auditory meatus
- Do not excessively tighten ear bars
- Make sure head is centered and anesthesia nose cone is secure
- A heated water blanket or heating pad is used under the animal to keep it warm during surgery
- Periodically check depth of anesthesia with corneal reflex, limb pinch, or pulse oximetry.
Sterilize Incision Site and Protect the Animal’s Eyes

• Swab the scalp with alternating applications of 70% ethanol and betadine.

• Start in the center of the scalp and make increasingly wider concentric circles.

• Apply lubricant eye ointment to each eye.

• A mixture of mineral oil (20%) and white petrolatum (80%)
Scalp Incision

- Incision is made slightly behind the eyes along the midline, approximately $\frac{3}{4}$".
Exposing the Scalp

• Use hemostats to grasp scalp.

• Gently pull scalp away from midline at four corners.

• Look for anatomical landmarks in the skull such as Bregma and Lambda.
Clean and Dry the Skull

• Remove periosteum from the exposed surface of the skull.

• Use an electrocautery unit to stop any surface bleeding on the skull.

• Skull must be completely dry prior to gluing transmitter.
Drill Anchoring Screw Holes

• Create two burr holes outside of the footprint of the transmitter.

• Use sterile self-tapping wood screws.

• Use “0” x 1/8 inch 303 stainless steel screws or equivalent.

• Insert screws with sterile “jewelers” screw driver.

• Screws should be snug with the head of the screw and one or two threads exposed.
Check Fit

- Check the fit of the transmitter.

- Transmitter should fit between the two anchoring screws.

- ECG electrodes should exit caudally.

- ECG ground electrode should be on the animal’s right side and working electrode on the animal’s left side.
Apply Cyanoacrylate

• Liberally apply cyanoacrylate on the base of the transmitter around the outside edge.

• Make sure to avoid coating the electrodes where they exit the transmitter.

• Make sure skull is completely dry before gluing the transmitter.
Apply Dental Acrylic

- Apply polymethylmethacrylate around the cyanoacrylate at the base of the implanted transmitter and over the bone screws using a spatula.
Let Dental Acrylic Set

- Make sure acrylic has hardened before proceeding.
Suture Skin in Front of the Transmitter

• Suture the skin around the base of the transmitter, only in front of the transmitter.

• Top of transmitter must be above skin to efficiently transmit signals.

• Skin should be reasonably tight around the transmitter.
Rotate Animal

• Remove the animal from the stereotaxic frame and place on the rodent bane for anesthesia.

• Rotate the animal ventral side up and tape arms down.
Incision for Ground Electrode

- Make a small incision in the skin to expose the animal’s shoulder.
- Use blunt dissection techniques.
Incision for Working Electrode

• Make a small incision at the base of the rib cage on the animal’s left side below the arm.
Tunnel Electrode Wires

- Rotate the animal dorsal side up.
- Using a sterile, 12" piece of 20 gauge 316 stainless steel hypodermic needle tubing (blunt), angle the tubing under the skin at the base of the skull towards the animal’s left side.
Tunnel Electrode Wires

• Rotate the animal slightly to expose the left ventral incision.

• Carefully insert the hypodermic needle tubing under the skin.

• Angle the tubing towards the incision on the animal’s left side until the tubing protrudes through the incision.

• Do not force the tubing but use blunt dissection techniques.
Tunnel Electrode Wires

• Insert the working electrode wire through the bore of the hypodermic needle tubing as far as the wire will go without kinking.

• The majority of the wire should be inside the hypodermic needle tubing.
Tunnel Electrode Wires

• Carefully pull the hypodermic need tubing through the incision on the animal’s ventral side.

• This will expose the electrode wire.

• Continue until the hypodermic needle tubing is completely free.
Tunnel Electrode Wires

- Wire should extend out of the ventral incision.
- Repeat this procedure for the ground electrode wire on the animal’s right side.
Trim Electrode Wires

• Cut each electrode wire such that 1 cm free extends from the ventral incisions on each side.

• Carefully remove the insulation from the electrode wires using smooth-tipped forceps while holding the electrode wire with a hemostat.

• Expose ~1 cm of the braided stainless steel wire.

• Do not put excessive force on the electrode wire.
Suture Electrode Wires to the Muscle Wall

- Using Vicryl suture, directly suture the exposed electrode wires to the intercostal muscle of the animal.

- Note, this may require blunt dissection of the connective tissue surrounding the muscle to form good electrical contact between the wire and the muscle.
Suture Electrode Wires to the Muscle Wall

- Repeat the procedure on the animal’s right side for the ground electrode wire.
Suture Skin

- Suture the skin closed using Vicryl suture.
- Be sure the skin moves freely.
- Swab the skin with Betadine solution when finished suturing.
Suture Behind Transmitter

- Rotate the animal.
- Suture the skin closed behind the transmitter using Vicryl suture.
- Be sure the skin moves freely.
- Apply Betadine solution around the wound.
Remove Animal

- Remove animal from stereotaxic frame and place on heated blanket for recovery.

- A triple antibiotic can be applied to the sutures and around the base of the transmitter.

- Animals should be warm and mobile before returning to their home cage.
Recover Animal

• Once animal is active, moving around, and grooming, it can be returned to its home cage.
• 500 Hz sample rate is recommended
Care and Housing

- Recordings may commence directly after animal has recovered from surgery.

- Sutures may need to be removed from the scalp after one week.

- Check for signs of necrosis around the transmitter and treat where needed.