

TREC

PSG Hook up Procedures

Compumedics Sleep Monitor

Preparing Supplies

Below is a list of supplies for single person use (however, make sure you pack extras):

- 1 tube EC-2 paste
- 4 X 4 gauze pads
- 1 bottle Pre-Tac adhesive synergist
- 1 tape measure
- precut 1 x 1 gauze squares
- 1 scissors
- 1 small bottle acetone or acetone prep pads
- 2 cotton tip applicators
- 1 roll Transpore tape
- 1 roll Hypafix or Medipore tape (cut into 1x1”squares) or Cover All Gauze
- 1 roll Scanpor Surgical Tape
- Surgitube tube gauze (cotton wire cover)
- 2 hair pins
- 1 bottle NuPrep
- 2 disposable snap ECG pads (Medtronics Cleartrace)
- 1 wax pencil (do not use red, if possible)
- 1 oximeter (attached to cable connected to recorder)
- 1 thermistor
- (2) towels
- 1 tray
- drinking straws
- soap solution
- small cup
- face mirror
- non-latex gloves
- disposable underpads (Chux)
- plastic trash bags

The In-Lab Visit

When participant arrives, identify yourself and show identification. Explain the purpose of the visit. Explain/obtain informed consent (if not already obtained). Be professional and courteous to your participant at all times. Help the participant feel at ease and comfortable. Explain all procedures before and as you do them.

Listed are some features that will assure a successful visit:

- 1) Be courteous, professional, have ID.
- 2) Be sensitive to participant's needs.
- 3) Provide overview of the Sleep Study.
- 4) Be patient/Be interested.
- 6) Make sure he/she understands all aspects of study/Have subject demonstrate or repeat critical areas (e.g., detaching oximeter if needed).
- 7) Provide participant with telephone number to call for "help".
- 8) Schedule morning pick-up of the Eden-tec according to participant's needs.
- 9) Keep a Positive Attitude.
- 10) The participant's comfort always comes before study needs.

The Setting

Set up can be done in any comfortable chair. Clear a flat surface area to set up supplies. Set all materials on a tray or disposable pad and position for easy access. Have the subject sit close to your supply tray during hookup. Make sure you have easy access to subject's head, chest, etc.

If the participant has not taken a shower (24 hrs) prior to your arrival, ask him/her to wash his/her face and chest with soap and water before applying electrodes. Explain that the electrodes will adhere better and a better study will be produced if the skin is cleansed in this manner.

TIP: If the setting is poorly lighted, you may consider using a camping style headlamp to help illuminate the scalp, the neck and other areas in which placement is critical.

Sensor Placement

Proper sensor placement is very important for effectively recording sleep patterns. Because you will be connecting the sensors to the patient, you should become familiar with each sensor and learn how to correctly place and connect them. All sensors should be labeled to simplify their identification and connections.

[Note: When connecting the sensors, be sure to hold the sensors by the ends, **not** by the wires. Also, for cleanliness, use non-sterile patient-care gloves when applying electrodes.

Below are general rules for good sensor placement:

- 1) Have subject shampooed, shaved, showered and in bedclothes.
- 2) Prep only areas of skin that electrodes cover.
- 3) Use only small pieces of tape but enough to secure the sensor and wires.
- 4) Provide for "stress" in wire/cables.
- 5) Secure loose wires/cables with tape.
- 6) Use non-dominant hand for oximeter placement.

You will use 13 electrodes (2 ground [Cz and Ref], C3, C4, A1, A2, left EOG, right EOG, 3 chin EMG, and 2 ECG [snaps]). You also will be using abdomen and chest belts, an oximeter, thermistor, a snore microphone, nasal cannula, leg sensors and a body position sensor.

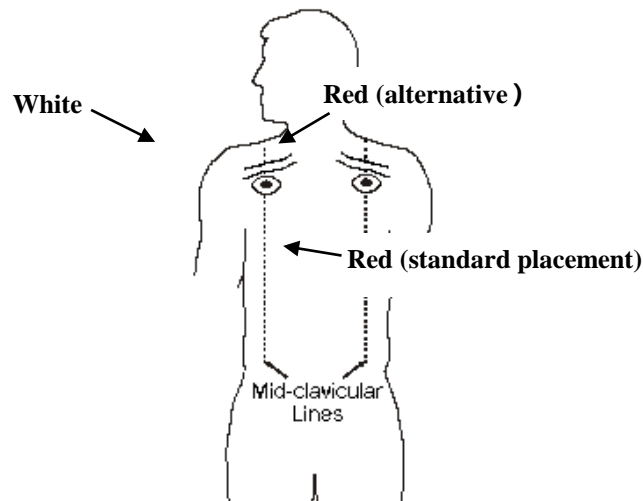
Suggested Order of PSG Hook-up:

- | | | |
|-----|-----------------------------|---|
| (1) | ECG (2 electrodes) | White (-) below right clavicle.
Red (+) below the left breast, in a line extending from the midpoint of the left clavicle. <i>Drop electrode wire underneath clothing before attaching electrode to the body and thread wire upwards (over the shoulders).</i> |
| (2) | Leg Sensor | Below the knee, place on the Tibialis Anterior muscle,
Two gold disk electrodes sensors on each leg. |
| (3) | Respiratory belts (2 bands) | Thoracic below left armpit
Abdominal below the lower edge of the left ribcage |
| (4) | Snore Microphone | Neck, below chin disks, to the side on top of voice box |

- | | | |
|-----|----------------------|--|
| (5) | Position Sensor | Velcro square at middle and top of Thoracic band |
| (6) | Gold Disk Electrodes | Head, eyes and chin (leg emg attached earlier) |
| (7) | Oximeter | On the finger of non-dominant hand |
| (8) | Thermistor | Under nose, above upper lip |
| (9) | Nasal Cannula | Under the nose, underneath the thermistor, opens in/or near the nares. |

Step 1: ATTACHMENT OF ECG ELECTRODES

White (-) electrode 3-5 cm. (2 finger breadths) below midpoint of right clavicle.
Red (+) electrode below the left breast crease, in line with the midpoint of the left clavicle.
When determining this site, please be sensitive to patient modesty issues; lift only as much of the upper garment as necessary to determine placement and afford secure attachment of this electrode.



If modesty issues are of concern use alternative placement described below:

Below midpoint of left clavical, for the red (+) electrode can be used if the participant is uncomfortable with the standard placement, or if site cannot be determined due to body mass. This alternate placement is called subclavicular.

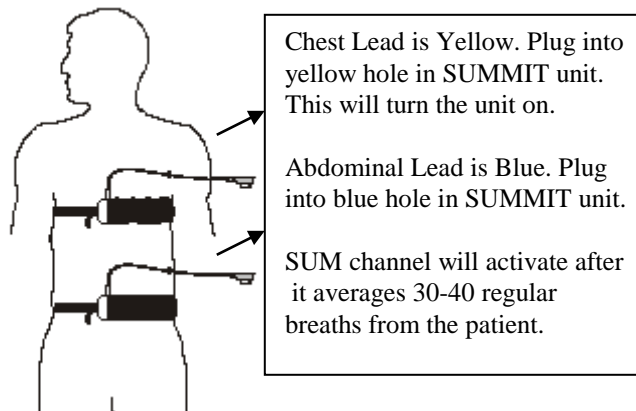
1. Feed electrode end of the wire down under the clothing.
2. Remove electrode from sealed package (e.g., Medtronic Medclear ECG electrodes). Snap electrode to lead wire **before** applying to subject's skin.
3. Prepare the marked sites by lightly abrading with prep gel. Remove excess prep gel before placing the electrode. Remove backing from electrode and place gel electrode on cleansed sites, with gel side down.
4. Indicate the ECG placement used on the **Signal Verification Form**.

Step 2: PLACEMENT OF LEG EMG SENSORS

Use the same preparation method for leg gold disk electrodes as the scalp gold disk electrodes. Make sure that you are wearing gloves. Locate anterior tibialis muscle on patient's leg. Mark the site and make sure the 2 disks will be 3 cm apart. Prep each site that you marked. Place the gold disk electrodes on to the site (filled with EC2 paste). Use a piece of paper tape to secure the sensor(s). Secure the excess wires with a stress loop or minimally tape the long wires to the patient's clothing at the leg, thigh, and shoulder. These wires can go underneath the respi bands to minimize tangling for the patient.

Total amount of sensors will be 4 (2 on the left and 2 on the right) Refer to PIB chart on page 23.

Step 3: PLACEMENT OF RESPIRATORY BANDS



1. Place the **chest band** under the left armpit, with the lead wire facing upwards. The large part of the inductance band should be placed from sternum to backbone on the patient's left side. Adjust the black extender belt so the belt is secure, but not tight. Run wires upwards and drape over the shoulder. The chest band lead is attached to the interface box using the yellow lead.
2. The **abdominal band** should be around the umbilicus (belly button) or, if this position is not possible, *below* the lower edge of the left rib cage with the blue lead wire facing upwards. Run wires upwards and drape over the shoulder. The abdominal band lead is attached to the interface box using the blue lead.
3. The **SUM** channel is created by averaging 30-40 breaths. If the SUM channel has not activated on the recording, a 'bad cal' light will flash orange on the SUMMIT unit. Remove either the blue or yellow lead and replace to reset the SUM calibration. This will take 5 to 10 minutes.
 - Incorrect application of respiratory bands can cause very poor signals.
 - Do not restrict the participant's comfort or breathing.

Step 4: APPLY EEG SCALP ELECTRODES (Gold Disk):

The process for placing EEG sensors on the adult participant will follow the 10-20 system for electrode placement. This standard was developed to provide consistent application of EEG electrodes for the collection of brain waves. This system is based on measurements from 4 standard points (landmarks): the nasion, inion, and left and right pre-auricular points (see glossary for definitions).

- Electrodes must be placed in the correct locations to yield valid data.
- Electrode sites must be properly prepared prior to electrode placement to insure tight bonding and low impedance values.
- Secure attachment of gold disk electrodes is crucial to successful recording of data.

Identify your landmarks:

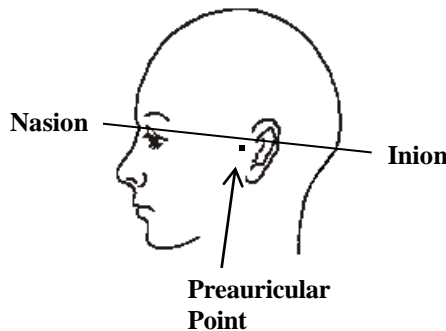
1) Pre-auricular points: Standing at the side of the participant, look at the ear. In front of the ear canal is a small flap of cartilage called the tragus. Just above the tragus is the point at which the top of ear lobe begins to form. The small dimple-like indentation between the tragus and the formation of the top of the ear lobe is the pre-auricular point. If in doubt, ask the participant to open and close his jaw. Look and feel for movement at the indentation above the tragus. Using blue china marker, lightly mark these landmarks on both the right and left sides of the participant.

2) Nasion: Facing the participant, look into his/her eyes. Find the small dip at the bridge of the nose between the eyes. This point at which the forehead meets the nose is the nasion. Lightly mark the nasion.

3) Inion: Using a comb, unpadded cotton swab end or hair clip part the participant's hair down the center, in the back of the head. Starting at the nape of the neck, run a finger up the back of the participant's head until a bony ridge, or bump, can be felt. Having the participant move his/her head up and down may help you to identify this bony ridge. The slight hollow just beneath this bony ridge is the inion. Lightly mark the inion. This landmark may be difficult to feel on some individuals.

When the inion cannot be determined use the following method:

- Re-identify the nasion, which has been lightly marked.
- Re-identify both pre-auricular landmarks, which have been lightly marked.
- Standing on the side of the participant, visualize an imaginary line forming a band around the head using the nasion and preauricular sites that have been marked. The back of this imaginary band should identify the inion. Mark the inion lightly.



Measure for electrode sites:

- Distance measurements are done with a *metric* tape measure, and taken in centimeters (cm.) and millimeters (mm.). When computing percentages to find the electrode site a quick measurement guide can be found below, as well as in the Equipment Maintenance Section. The guide can be photocopied and kept with your prep materials for handy reference.
- All marks on skin must be done with a non-toxic, non-permanent implement, such as a wax-based china marker. Bright blue is most easily seen against dark hair. Red can be misidentified as blood by the participant or family members.
- When working with participants having long or thick hair, create a part in the hair by means of a comb or the unpadded end of a cotton-tipped swab; then hold the hair in place with hair clips while you work. The skin must be visible at the electrode sites because the electrode must rest on the skin, not on hair.
- All scalp electrode sites are determined by creating 2 lines that intersect. The electrode is placed over the point at which the 2 lines cross.

Quick Reference: Measurement Chart

Total Measurement Value (cm.)	50% Value (cm.)	20% Value (cm.)
30	15.0	6.0
31	15.5	6.2
32	16.0	6.4
33	16.5	6.6
34	17.0	6.8
35	17.5	7.0
36	18.0	7.2
37	18.5	7.4
38	19.0	7.6
39	19.5	7.8
40	20.0	8.0

Note: If the *total* value measurement contains a fraction, continue to use the percentage values as the whole number.

Example: Total measurement = 35.2, 35.5, 35.7 continue to use the percentage values for 35.

Remember: The 50% values are used to determine Cz.

The 20% values are used to determine C₃ and C₄.

The 10% values are used to determine O1 and O2. (Half of the 20% values).

To determine Cz (Common Ground):

1) Have the participant sit in a chair. Standing at the side of the participant, place the zero line (0) of the tape measure on the markedinion. Holding the tape measure in place with your non-dominant hand, stretch the tape measure upwards, over the crown of the head, until it reaches the marked nasion. Determine the total distance between the inion to nasion, in centimeters. Remember this number (it may help to write it down).

Compute 50% of this total measurement (or use your measurement guide).

2) Remove the tape measure, and re-position with the zero line on the marked nasion. Stretching the tape measure upwards, over the crown of the head, mark the value for 50% of the nasion to inion total. When marking these sites, make a large enough line so it can be easily found.

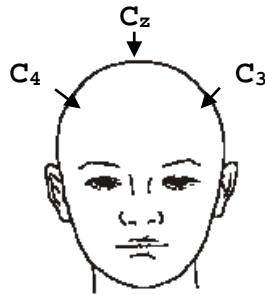
3) Remove the tape measure and stand behind the participant. Place the zero line of the tape measure on the left pre-auricular mark. Stretch the tape measure over the top of the head, and along the mark that has just been made, until it reaches the right pre-auricular mark. Determine the total distance from pre-auricular to pre-auricular in centimeters. Remember this number (it may help to write it down). Compute 50% of this total measurement (or use your measurement guide). While firmly holding the tape measure at the left preauricular mark allow the tape measure to drape over the crown of the head while marking the value for 50% of the total measurement. This mark should intersect the previously made line. The point at which the lines intersect is the site for the Cz electrode placement.

To determine C4:

1) Continue to stand behind the participant. Place the zero line of the tape measure on the site for the Cz electrode placement. While firmly holding the tape measure in place, allow it to drape over the right side of the participant's head until it reaches the right pre-auricular mark. Compute 20% of the total pre-auricular to pre-auricular measurement (or use your measurement guide). Continue to hold the tape measure in place as you make a mark at the 20% location. Without moving the tape measure make another line, following the edge of the tape measure, to intersect the 20% mark. After removing the tape measure, extend both lines so they intersect. The point at which the lines intersect is the site for the C4 electrode placement.

To determine C3:

1) Stand in front of the participant. Place the zero line of the tape measure on the site for the Cz electrode placement. While firmly holding the tape measure in place, allow it to drape over the left side of the participant's head until it reaches the left pre-auricular mark. Compute 20% of the total pre-auricular to pre-auricular measurement (or use your measurement guide). Continue to hold the tape measure in place as you make a mark at the 20% location. Without moving the tape measure make another line, following the edge of the tape measure, to intersect the 20% mark. After removing the tape measure, extend both lines so they intersect. The point at which the lines intersect is the site for the C3 electrode placement.



To determine O1 and O2: Locate the inion. Measure up the head 10%. This is Oz or the central O. Mark this spot with a china marker. Measure to the left 10% for O1. Measure out to the right for O2. Visually, these channels should be symmetrical on the patient's head behind the eyes.

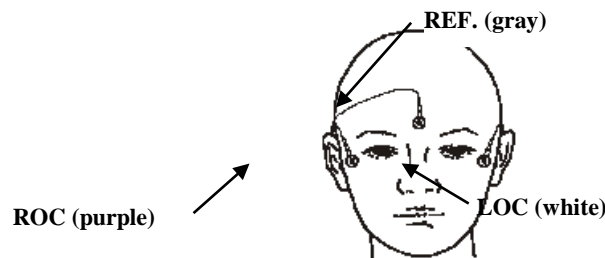
O1 and O2 are only used for the Sleep Vigilance concentration test. The channels are not recorded with the sleep studies.

To determine A1 and A2:

These placement sites are on the mastoid process (bone behind the earlobe). The electrode should be placed on the skin between the crease of the earlobe and where the hairline begins. Lightly mark these sites. A1 is placed on the left mastoid, A2 on the right.

To determine EOG placements:

The EOG recording electrodes are placed about 1 cm. (one finger breadth) lateral to and 1 cm. below the outer canthus of the eye, (on the ridge of the orbital bone). Lightly mark these sites, and then stand in front of the participant to make certain that they are symmetric. Asymmetric placement of the EOG electrodes can create uncertainties in the data interpretation.

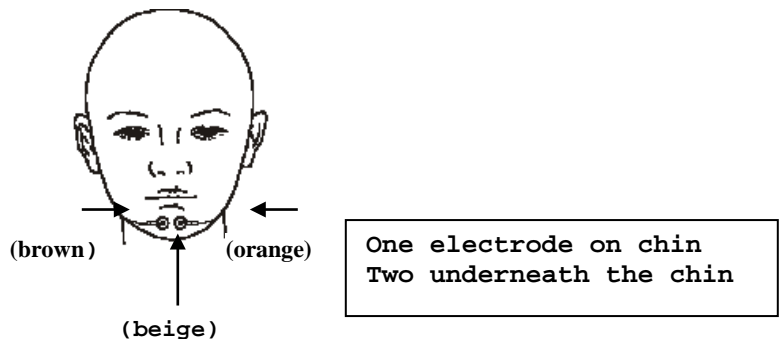


To determine EMG placement:

- The EEG waveforms in REM sleep resemble the waveforms of wakefulness. The facial muscles however, relax in REM sleep; therefore these EMG electrodes are crucial in correctly identifying REM sleep. These electrodes must be attached firmly to prevent displacement and to yield quality data through the recording period.

Place one chin EMG electrode on the face below the lower lip, on the ledge of the chin, this provides a stable area for attachment. For proper pickup of muscle activity, a distance of at least 3 cm must separate the electrodes.

The other two EMG electrodes are placed on each side of the submental, which is a large muscle located underneath the chin. Having the participant activate this muscle may be helpful for determining the placement of the EMG electrodes. To activate the muscle, place your hand under the participant's chin, between the tip of the chin and the neck. Ask the participant to swallow. You will feel the submental muscle move. The electrodes are placed on each side of this muscle but at least 3 cm. apart from each other. Placing one electrode on the ledge of the chin (below the lower lip) and two electrodes on the belly of the submental muscle is also acceptable but not preferred.



Reference:

A Review of the International Ten-Twenty System of Electrode Placement, 1974, The Grass Instrument Co., Quincy, Mass.

Prepare the Electrode Sites:

Before the attachment of gold disk electrodes the skin at the marked sites must be properly cleansed and lightly abraded. This insures low impedance values. Excessive impedance defeats the passage of signals into the electrode and, in turn, to the recorder. For optimal recording the impedance readings of the electrodes should be $< 10 \text{ k}\Omega$ and should be balanced (values should be approximately the same). One exception is ECG, which can tolerate impedance values up to $30 \text{ k}\Omega$.

- Successful skin preparation prior to electrode placement helps to reduce the level of impedance thereby improving the quality of signal.
- Skin preparation requires abrasion to the top layer of the participant's skin at the electrode site. Although blood is not evident, the field technician must understand that these areas are now non-intact skin and pose a risk for blood borne pathogens. SHHS recommends wearing latex or non-latex gloves as personal protective equipment (PPE) at all times when working with non-intact skin and equipment which has been in direct contact with non-intact skin (i.e. used electrodes).
- Use an abrasive preparation. Preparations such as Nu-Prep and Skin Pure contain relatively less pumice and may be preferred for participants with sensitive or fragile skin. Preparations with higher pumice concentration (such as Lemon Prep) may be useful for participants with tough or oily skin (and for bald participants).

- Abrade only the area at the marked site. Gold disk electrodes have a diameter of 1 centimeter, therefore the abrasion should be limited to an area the size of or just slightly larger than the electrode. On marked sites, remember that the electrode should be placed where the 2 lines intersect.
 - The participant should know what to expect! Please communicate. You may choose to use the following script: “Before I attach the electrodes, I have to get your skin ready. I will be using a special cleaner that sets the skin up for a good contact. You may feel a little bit of scratching on your skin, it may feel a little like sandpaper, but it should not hurt, and it will not harm your skin.”
1. Place a small amount of skin prep abrasive onto a clean disposable surface (i.e.: 4x4 gauze square or small plastic med. cup).
 2. If working in a hairy area, separate the hair in order to see the skin. You may find a comb or hairclips useful to create a part and hold the hair back.
 3. Use a cotton tipped applicator to transfer a small amount of skin prep directly onto the electrode site. Before lifting the applicator, apply a moderate pressure and make small circular motions repeatedly on the skin. Take care that you include the center of the site, not just make circles around it leaving the center un-prepped. You may prefer to use a combination of back and forth strokes along with some circular motions.
 4. Continuing with moderate pressure, slowly count to 5 while you scrub the site (1 one-thousand, 2 one-thousand, 3 one-thousand, 4 one-thousand, 5 one-thousand). You are done when the skin “pinks up”. Expect some participants to have more fragile skin than others; keep an eye on what you do. You may have to adjust the pressure or the count time.
 5. Prep abrasives are not designed as conductors; remove any excessive prep abrasive from the skin prior to electrode placement.
 6. Repeat the above steps for each electrode site. It is much easier to prep 2 or 3 sites, and then to apply those electrodes, provided you do not lose your prepped sites.
 7. Discard the applicator and prep abrasive when finished. Never contaminate your original tube or bottle.

Attach Gold Disk Electrodes:

The gold disk electrodes are applied to the prepared sites with an electrolyte paste. This paste serves a dual purpose: providing both a conductive pathway for the signal to enter the electrode cup, as well as holding the electrode in place on the skin. There are different electrolyte pastes available, as well as different application techniques.

Although different pastes may be used for different electrodes sites (EEG, EOG or EMG sites) both SHHS and manufacturers recommend never mixing pastes for the same electrode.

Adverse reactions to mixing 2 electrolytes together cannot be predicted.

- Assemble your supplies in advance.

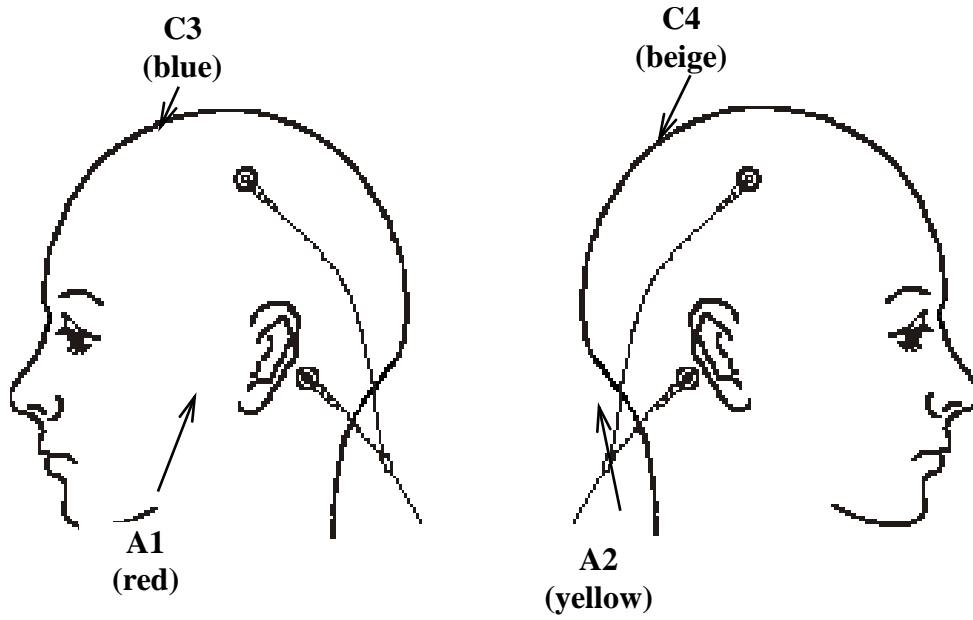
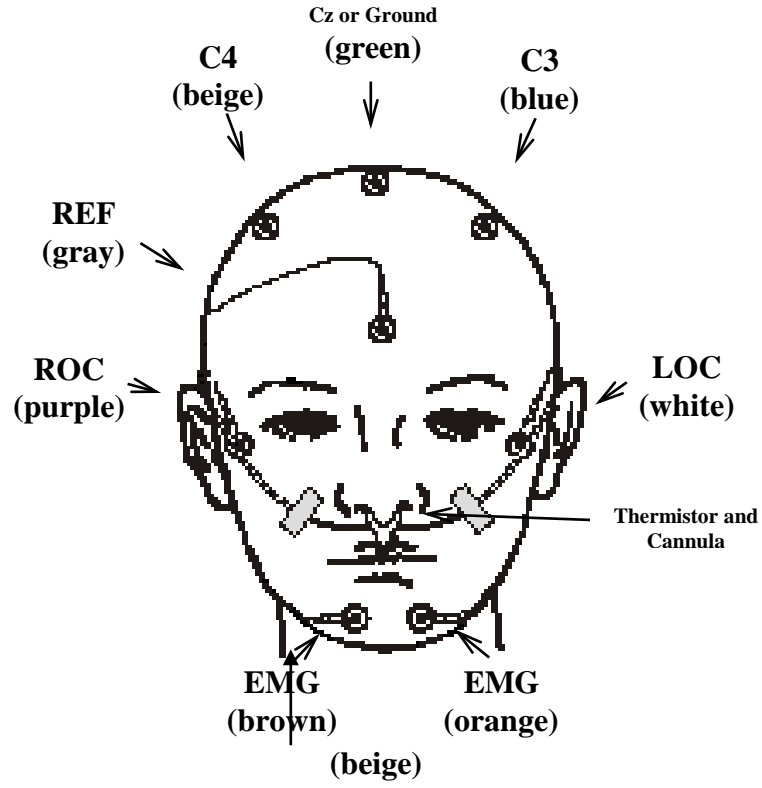
Have several pieces of cut gauze or pieces of tape ready to place on top of the electrode once it is placed on the skin. Gravity can move the electrode from its proper site while you fumble with equipment.

- Prior to attaching gold disk electrodes, cut a sufficient length (approximately 2 arm's length) of Surgitube 1" tube gauze. Run the gold disk electrodes through the length of the tube gauze to create a cotton sheath encasing all of the wires. Secure the Surgitube sheath with a twisty or another appropriate fastener approximately 12-18" from the gold disks. This will allow for the electrodes to be placed according to the color codes and for range of motion at the neck, yet will still provide for bundling of the 10 electrode wires.
- Place a small amount of EC2 electrolyte paste onto a clean disposable surface (i.e.: 4x4 gauze square, small plastic med. cup, or the back of your gloved non-dominant hand).
- If working in a hairy area, separate the hair in order to see the skin. Your site should still be visible from the prep phase.
- If the participant is expected to sweat, there are additional skin preparations that reduce the moisture of the skin (such as PRE-TAC) and help improve the holding power of the adhesive. Try experimenting with such preparations. Generally, these liquids are applied very sparingly to prepped skin and allowed to dry before continuing with electrode application.
- If using tape, ask the participant about sensitivity to tape, latex or adhesives. For participants with sensitivity use Micropore (paper) tape.
- If using EC2 cream on the gauze square to anchor the electrode, it must also be the electrolyte used within the electrode cup.
- When applying disk electrodes, work in a fashion so that the wires on the forehead and top of the head all point to the back of the head and down toward the neck, and the wires on the face and chin point upwards over the ears and then down toward the back of the neck. Use small pieces of tape to hold the wires in place as they course toward the back of the head, but allow enough slack so there is no pull when the participant moves.
- Discard the unused electrolyte paste when finished. Never contaminate your original tube or bottle.

Attachment sites for gold disk electrodes:

Ground	Cz top of head (Green wire)
EEG	C4 right Central (Beige wire) A1 left mastoid (Red wire) C3 left central (Blue wire) A2 right mastoid (Yellow wire)
REF	middle of the forehead, between the nasion and the start of the hairline (Grey wire)
LOC	left eye, below outer canthus (White wire)
ROC	right eye, below outer canthus (Purple wire)
EMG	one on the ledge of the chin and two on either side of submental muscle underneath the chin (Beige, Brown and Orange wires). EMG 1 - Beige (on chin) EMG 2 – Orange (right submental) EMG 3 – Brown (left submental)
Leg EMG	LeftLeg1-LeftLeg2 (left anterior tibialis muscle 3cm apart) RightLeg1-RightLeg2 (right anterior tibialis 3 cm apart)
	Color-coding for sides is important, but more important is spacing (at least 3 cm. Between disks), and that the electrodes are securely attached.

**01 and 02 were used with sleep vigilance testing only



Techniques for disk electrode application:

Bare skin (face, mastoids):

- 1) Using the gold disk as a scoop, fill the electrode cup with electrolyte paste so it is slightly rounded (there must be no “air pockets” which act to increase impedance).
- 2) Place the electrode onto the prepped site, paste side down and cover with a square of gauze or piece of tape (depending on your preference).
- 3) Press lightly on the top of the electrode as well as firmly around the rim of the cup to insure a good seal. Hold in place until electrolyte begins to set and feels secure.
- 4) A larger second piece of tape may be placed over the electrode, if desired.

Scalp with hair:

- 1) Separate hairs to make sure skin is visible.
- 2) Using the above technique, fill the electrode cup with EC2 cream and attach to prepped site.
- 3) Place a small amount of EC2 cream on the gauze or tape used to cover the electrode.
- 4) Press firmly on electrode and hold in place until EC2 begins to set and feels secure.

Bearded chins:

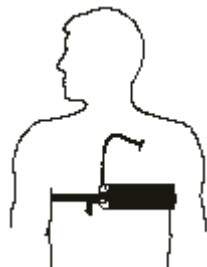
- 1) Separate hairs of beard to make sure skin is visible.
- 2) Fill the electrode cup with EC2 cream and attach to prepped site.
- 3) After attaching electrode to skin, use cotton applicator to place small amount of EC2 cream on top of electrode.
- 4) Crisscross small amounts of beard hair over the electrode, as an anchor
- 5) Place a small amount of EC2 cream on the gauze or tape used to cover the electrode.
- 6) Press firmly on electrode and hold in place until EC2 begins to set and feels secure.

After electrodes are applied:

1. Gather electrode wires together just above nape of neck.
2. Bundle and secure with pieces of tape that have had the ends folded over for easy removal. Bundle the wires approximately every 4-6 inches. This reduces artifact and tangling.

Step 5 : ATTACH THE POSITION SENSOR:

1. Connect cable from the PIB to the main unit. The PIB cable connects to the recorder at the side of the display screen. The connector is shaped so it only fits in one way for proper connection.
2. Attach the position sensor to the Velcro square on the chest band. Ensure that picture on top of position sensor, indicating correct orientation of patient's left and right, is observed (wire should be going toward participant's head). Apply tape as needed to further secure the position sensor.



Step 6 : ATTACH OXIMETER:

- The finger oximeter records pulse and oxygen saturation using a small light that shines through the finger. Oximeter should be placed on the ring finger of the non-dominant hand. (If large rings are worn, may use the middle or index fingers.) Colored nail polish defeats the function of the oximeter. Colored nail polish must be removed from the finger prior to sensor attachment.

Directions for disposable probe: Grip the tabs on the sensor's bottom adhesive cover and peel the adhesive cover off. Place the finger into the sensor nail-side up with the tip of the centerline mark in the curved area. Wrap the tape firmly around the finger. The fingernail should not be covered with tape during this step. Fold the sensor's top over the top of the finger and make sure the two sides are vertically aligned. Do not stretch the tape while applying the sensor. This may cause inaccurate readings or skin blister. Be sure that the emitting and receiving diodes directly "face" each other.

Directions for non-disposable probe: Place probe, white side against adhesive, on the surface of a piece of gauze tape cut so that its width extends approximately .5 cm. on either side of the probe (placed in the middle of the tape) and its length is approximately 1 cm. longer than each top and bottom edge of the probe. Place the probe (covered with this tape) over the top of finger with light sensor nail side up. Be sure that the receiving circle directly "faces" the light-emitting circle. Place a second piece of gauze tape around the probe (perpendicular to the first tape), spiraling the tape so the beginning and end are displaced approximately .5-1.0 cm. (This prevents perfusion problems to the finger). To further secure, place Posey wrap around sensor/finger, so that the sensor is securely in place but not tight.

After securing oximeter sensor, ask the participant if any throbbing is felt. If so, reapply, loosening tape.

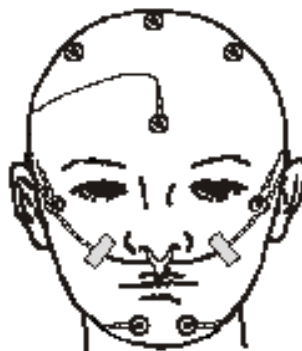
Pass the oximeter cable over the surface of the hand creating a circular "stress" loop, also securing with tape. Use several additional pieces of tape along the hand and lower arm, securing loose areas of cable (to prevent the cable from getting tugged.) Check that the participant can move/bend his hand in all directions; if not, reapply, with more "slack" in the cabling.

Step 7 : ATTACH THERMISTOR:

These are made of temperature sensitive wires which are positioned directly in the flow of air.

Thermistor should be placed under nasal area on participant's upper lip so that the three-thermistor beads are exposed to the patient's nasal and oral airflow. ** See cannula attachment before attaching thermistor.** Secure in place by looping wire around ear and taping wires over cheek. The beads should not touch the lips, skin or nasal mucosa membranes.

Note: The thermistor is sensitive to displacement or moisture. Before leaving, show the participant (in a mirror) and/or a family member how the thermistor should be positioned. Show the participant how to readjust this, if needed. Warn him to try and keep his upper lip dry. Nighttime beverages should be consumed through a drinking straw.



Step 8 : ATTACH NASAL CANNULA:

This is clear tubing that is positioned directly in the flow of air just under the thermistor. Tape the thermistor and cannula together to prevent displacement. The nasal cannula should be placed in the nares of the nostrils. Secure in place by looping wire around ear and taping wires over cheek.

****Make sure that the beads from the thermistor are not inside the patient's nose. Place the beads in the flow of air from the nose. Bend the wires as needed.****

Step 9 : ATTACH SNORE MICROPHONE:

Attach snore microphone to patient's throat, using adhesive tape.

Starting a New Study

1. Turn on the computer.
2. Make sure the control box and Patient Interface Box (PIB) and connected and plugged in.
3. Click on NetBeacon (Record) Icon.
4. "E-Sleep" display box will come up.
5. Double click on the appropriate monitor that you will be using.
6. Viewing window will be displayed. Maximize to full screen by clicking on the upper right hand corner (□).
7. Toggle off of 'View' (single click on the tool bar).
8. Click on 'New' located on the toolbar.
9. Enter patient information:

Surname: = Family and Personi number is entered here.

Given name: = Nothing.

Reference: = Control Module number (266 or 269), technician's initials, PIB number (51255 or 52731) and participant's room number.

DOB: = Nothing

Sex: = Male or Female.

Study Information: Configuration (click on the down arrow to display choices)

Select 'TRECLegs' (it will be highlighted.)

Note will appear: About to apply configuration for new study? Yes/No - click Yes.

10. Click 'OK' at the bottom.

Note: Must at least select 'Configuration' to be able to record.

Note: Double check time available for recording. ****If time available less than 24 hours, delete oldest studies from sleep study drive. (start with deleting 3 studies to make room for new studies.)**

Note: Next to the blinking box on the icon toolbar the patient information will be displayed.

Set the computer to RECORD the sleep study.

1. While in the 'VIEW' screen click on 'RECORD' icon on the tool bar. Make sure you only click once. Twice will turn it off. Check the 'blinking' icon. It should now read REC (in red) for recording.
2. You are now ready to start signal verification.

Signal Verification - Impedance Checks - Calibration:

Documenting Hook-up Procedures – Signal Verification Form

After hook-up, you will test the quality of each signal from each electrode or sensor.

You will check the impedance of each EEG, EOG, ECG, and EMG sensor.

You will also be able to check the quality/accuracy of the tracings or values of the signals. You will record the results of your impedance and signal checks on a **Signal Verification Form** (see Forms).

This form is a log of key events related to the in-home procedures. Data from this document will be used to monitor the technical aspects of the study (time requirements, adequacy of hookups, etc), will be used to identify and document Immediate and Urgent Referrals, and will provide information that may be useful for "trouble shooting" bad studies (e.g. impedance checks). This form includes the following:

1. Lab study date
2. Technician Initials
3. The values of the impedance for each channel
3. View signal quality
4. Calibration check on position sensor
5. Calibration pre-sleep
6. Notes on any problems during hook-up

Checking Impedance and Signal Quality:

- Impedance defeats the passage of signals into the electrode and, in turn, the recorder. For PSG studies, impedance value is measured in Kilohms, or thousandths of an ohm. Later, the manual abbreviation k will be used for Kilohms.
- For EEG, EOG, and EMG you want to achieve impedance of < 10 k. Most important is the balance (difference) between two sets of paired EEG electrodes. For accurate recording the difference in impedance levels between pairs of EEG electrodes should be less than 5 k.

If all electrodes register high:

During the impedance check, if all electrodes register high (>10 k) remove the ground electrodes (at Cz and the forehead), re-prep the sites and replace the electrodes.

If only certain electrodes register high:

1. If impedance of any pair of electrodes (other than ECG) is > 10 k, or the difference between any pair of electrodes is > 5 k, remove the electrode, re-prep the electrode site and replace the electrode.

1. If, on a second placement, impedance is still high there are two possible problems:
 - a) the area of the skin identified for sensor placement has an unusually high impedance or
 - b) the lead wire or sensor is damaged.

Therefore, attempt to address both potential problems by choosing an alternative electrode site (e.g., immediately adjacent to previous site or use of one of the alternative sites indicated above), and change lead wires.

2. If impedance is still high on a third attempt do not attempt to re-prep area. Document your activities on the **Signal Verification** form.

For ECG impedance of < 30 k are acceptable.

When troubleshooting high impedance, first check that the system (all cables) are connected and electrodes are tightly in place. Loose electrodes create excessive impedance.

- Checking of the signal can be done in any order however it is described here in the order of display on the screen.

Steps to Check Impedance and Signals on the Recorder Screen:

1. SaO2 channel only displays a value of oxygen saturation in %. The adequacy of the oximeter reading will be assessed by: Checking that oxygen saturation reads “GOOD”. A reading of “POOR” or “MARGINAL” indicates that the pulse reading is poor, probably due to poor placement or an overly tight probe. Sometimes, a poor or marginal reading will occur during movement. If so, wait 10 seconds and recheck. If still poor, replace sensor.

Check that the reading appears reasonable (>88%). If <88%, re-position, wait 2 minutes, and re-record. If abnormal on a second try, apply to your own finger. If signals are correct on your finger (>88% sat and correct heart rate), try again on the participant using a different finger and/or switch probes. Note oximetry reading on the Signals Verification Form.

2. View the impedance level or the actual live data from each channel. The Signal Verification Form requires you to do both, but you may choose the order in which they are performed.

To Check Impedance

To check impedance: Toggle the IMPEDANCE icon at the top of the screen

When the screen opens you will see the impedances screen displayed to the far right.

The impedance level of the channel will be displayed as > (a number) k.

Change the threshold to 10k.

Select all channels by clicking on this selection.

Impedance values will be displayed.

Toggle the IMPEDANCE icon to close.

For further description of menu options see your Compumedics manual.

3. Note impedance levels of each channel on the **Signal Verifications Form**.

4. Check quality of the live data. As each signal is checked, indicate the quality of that channel on the Signal Verification Form (View Signals area).

Signals will be displayed in the following order: Top windowpane: LOC-A2, ROC-A1, C3-A2, C4-A1, EMG1-EMG2, ECG1-ECG2. Lower window pane: Left Leg1 Left Leg2, R Leg1 Right Leg2, Snore, Nasal Pres, Airflow, THOR EFFORT, SUM, ABDO EFFORT, SpO2, OX STATUS, PULSE, POSITION, and Pulse Waveform.

When viewing live data, use the following procedure for specific channels:

Channel 1 - LOC: Left Eye. Ask patient to stare at a point on the wall and not blink. Trace should be centered and less than 2mm thick on 5mm/s trace speed. Ask patient to close eyes. Trace should be centered and less than 2mm thick on 5mm/s trace speed. Ask patient to look left and right, and keep head still. Have patient look up and down. Trace should be deflect full scale.

Channel 2 - ROC: Right Eye. The same as Channel 1 (LOC).

Channel 3 – C3-A2 (EEG): ask patient to close eyes and relax: trace should be moving about the center, and less than 1 mm thick with trace speed on 20mm/s and scale set to 250uV(default)

Channel 4 – C4-A1 (EEG): ask patient to close eyes and relax: trace should be moving about the center, and less than 1 mm thick with trace speed on 20mm/s and scale set to 250uV(default)

Channel 5 – EMG1-EMG2: Ask the participant to relax. Trace should be about half of full scale (this can be different for different people). Ask participant to smile for a moment. Trace should increase to full scale than recover to previous level as the muscles relax.

Channel 6 – ECG1-ECG2: centered, less than 2 mm thick on speed 20 mm/s, scale 2.5 mV

Channel 7 – Left Leg1- Left Leg2: Ask patient to flex his/her ankle forward then backward. Trace should be deflect full scale.

Channel 7 – Right Leg1- Right Leg2: The same as Channel 7 (L Leg).

Channel 9 – Snore Mic: Ask patient to snort out loud. Trace should be deflect full scale.

Channel 10 – THOR Effort: Centered, less than 1 mm thick on default settings (time base 5 mm/s and scale x1), smooth sine wave trace without spikes or noise.

- Change bands if signal is noisy.
- If signal amplitude is too small, adjust Velcro band and shorten strap.
- If signal amplitude is too large, adjust Velcro band and lengthen strap

Channel 11- SUM Channel. Averages THOR and ABD to create this channel from the SUMMIT unit.

Channel 12 – ABDO Effort: The same as Channel 10 (THOR Effort).

Channel 13 – SaO2: Record reading on Signal Verification Form.

Channel 14 – Pulse: Record reading on Signal Verification Form.

Channel 15 – Position: Record reading on Signal Verification Form.

Final Sensor Equipment Check

Now that you have ascertained that all sensors have been properly applied, you will need to check that everything is secured (both to guarantee that leads won't be lost during the night as well as to maximize the participant's comfort and mobility).

1. Make sure that all lead wires on the face and scalp point down and back towards the back of the neck. Wires from the face and scalp should be pulled away from the face and draped to back of subject's head with enough lag to prevent them from being pulled out, but not so much as to restrict head movement. (Check by having subject move head back and forth and ascertaining that sufficient freedom of movement exists).
2. Secure wires at the shoulder.
3. Re-check oximetry signal (see appropriate section) to verify that the probe still giving the same reading as during initial hook-up. Check that the respiratory bands and thermistor are still secure and in place.

Leaving The LAB

Instruct the patient to call the nurse if he/she needs any assistance.

Confirm the time of wake-up. Tell the participant what to expect in the morning and what time you will return.

Clean up, leaving the area as neat as it was before your visit.

Tip: If a male participant reports the need to make frequent trips to the bathroom, consider providing a hand-held urinal for bedside use.

Morning Arrival

Upon awakening the nurse will have stopped the recording of the study.

Note: The blinking red icon will turn to 'DONE'. **That will be your only indicator that the study is done.**

1. Leave the machine as is until the research assistant comes to shut the equipment down or exit the program by clicking on the FILE drop down menu and click exit.
2. Close profusion NetBeacon by clicking 'Done'.

After the study is turned off:

1. Inquire about any problems or questions that may have arisen. To remove electrodes, use a wet gauze pad and soap, lightly rubbing until the electrode is released.
2. Check to see that all equipment and accessories (the main unit, head box, cables, and sensors) are all present.
3. Check that all paperwork has been completed.
 - The analysis, for the most part, is done completely by the program. You will only need to set certain parameters for the computer to work with. From the drop down menu in Profusion, Choose ANALYSIS.
 - From ANALYSIS, choose AUTOMATIC ANALYSIS.
 - Make sure the following are checked;
 - ✓ RESPIRATORY ANALYSIS
 - ✓ SLEEP STAGING
 - ✓ PLM ANALYSIS
 - The AUTOMATIC ANALYSIS process usually takes quite a while (normally 15-35 minutes or so...)
 - Once the computer finishes running the AUTOMATIC ANALYSIS, the computer will present you with a new screen.
 - Close the study. Exit the Profusion 2 program.

Saving the sleep study on CD Rom

1. Go to the Profusion Scoring icon from the main Windows screen and double click. This will open the program.
2. Click on the 'STUDY' drop menu and click on 'OPEN'.
3. Go to C:/ on the bottom of the window and select the study by highlighting it.
4. The click on 'OK'
 - Review the study briefly.
 - Follow the process for burning the study to a CD. Label Study TR0000 (4 digit number). Please date the cd and cd label with the study date, also.
5. Go to the 'STUDY' drop down menu and click on 'CLOSE'
6. Exit this program by going to the 'STUDY' drop down menu and selecting 'EXIT' or you may click on the boxed 'x' in the upper right hand corner of you screen.
7. Insert a new, empty cd into the cd slot.
8. Click on the Create CD icon on the Windows main screen.
9. A small window of selections will appear. Click on 'DATA'.
10. Another small screen will appear. Click on 'DATA CD'.
11. A new screen will appear listing the studies in the upper right hand windowpane. Select the study to be saved by highlighting it. Note: The studies are saved by year/month/date_time. Once you have highlighted the study(s) to be saved click on the 'ADD (+)' icon on the tool bar.
12. The studies you selected will now appear in the bottom two panes and a small prompt screen will appear.
13. Toggle on the 'Create CD' icon.
14. The defaults should read:

Target device	D: HP CD-Writer+ 9100b
Write Speed	8x(1200KB/sec)
Number of copies	1
Create Options	Create CD
Write Options	Track-At-Once
	Close CD

Click 'OK'
15. You will be prompted when the CD is complete. Close the program by going to 'FILE' drop down menu and selecting 'Exit'.
16. To verify that the CD copied go to:

My Computer
Click on the 'D' Drive
The study you saved should be listed. If you would like to view the study you can go to Profusion Scoring and open the study from the CD. You do not need to open the study again. If it is listed on the CD it has been saved.

Opening the study from the CD in Profusion

1. Go the Profusion Scoring icon on the main Windows screen and double click.
2. Click on the 'STUDY' drop down menu and click on 'Open'.
3. The 'Select a Study' screen will appear. On the bottom of this screen there is a drop box to select the drive to locate the study. Select 'D', this is the CD ROM.
4. The studies will be listed. Select the study you would like to view by highlighting it and clicking 'OK'.
5. To close the study go to the "STUDY" menu and select 'CLOSE', then go back to the "STUDY" drop down menu and select 'EXIT' to close the program.

PSG Specific Items - The Lab Visit

1. One to two days prior to the visit, call the participant to confirm.

A). At this time request the participant:

1. To shower or bathe less than 24 hours of their arrival.
2. To shampoo and refrain from using hairsprays, gels, mousse, and/or oils in the hair.
3. Men should be asked to shave before the visit.

Explain that this is not an issue of cleanliness, but that the special procedures require the skin to be as free from oils as possible.

4. To be dressed in a t-shirt, tank top, or 2-piece bed clothes. Encourage the participant to avoid wearing a long nightgown, nightshirt or one-piece garment that would need to be lifted above the waist.

B). Ask about the usual bedtime.

2. Within one day of the lab visit:

Check equipment and supplies.

4. The following morning:

Pick up equipment and questionnaires.

Clean and disinfect reusable surface electrodes (gold disks).

View the data collected on the clinic computer.

Complete form "Sleep Study Evaluation Form".

Copy the data to a CD and label with the family's and person's.

Clean equipment.

5. Within 60-90 days after the sleep study:

Prepare and send a participant feedback letter.

Preparing the Equipment

Prior to the visit you will:

- Check that all equipment is cleaned and that the PIB is set up properly.
- Check to be sure you have spare supplies packed.
- Prepare a CD with the Participant ID.

Control Module

The Control Module provides an interface for the Patient Interface Box, DC Channel Expansion (this provides 8 to 10 high level DC inputs ($\pm 1V$), and two Pressure Transducers for measurement of signals such as nasal airflow, CPAP pressure or esophageal pressure. An integrated serial port allows connection of a Nonin XPod pulse oximeter or the External Device Interface Module that can be used to add up to an additional 15 DC inputs. It is connected to the Host PC by Ethernet cabling and uses TCP/IP network protocol for communication. It also provides the user with impedance indicators for electrode channels.

Patient Interface Box (PIB)

The Patient Interface Box (sometimes referred to as a "headbox") is the device that contains amplifiers and filters for proper processing of the physiological signals. All electrodes and probes, other than the oximeter, are connected to this device. The processed signals from this box are sent to the Main Unit by an Analogue cable.

The table below shows the PIB/headbox configuration for Family as it is displayed on the PIB:

22 LOC WHITE (Left Eye)	24 ECG1 WHITE (Chest – Right)	26 LeftLeg1 (Left Anterior Tibialis)	28 RightLeg1 (Right Anterior Tibialis)	30 EMG1 BEIGE (Chin)	32 EMG3 BROWN (Right-Submental)
23 ROC PURPLE (Right Eye)	25 ECG2 RED (Chest – Left)	27 LeftLeg2 (Left Anterior Tibialis2)	29 RightLeg2 (Right Anterior Tibialis2)	31 EMG2 ORANGE (Left Submental)	

Com R Ppz GRAY (Forehead)	1 Fp1		2 Fp2	GND CPz GREEN (Top of Head)
11 F7	3 F3		4 F4	12 F8
13 T3	5 C3 BLUE (Left – Top of Head)		6 C4 BEIGE (Right- Top of Head)	14 T4
15 T5	7 P3		8 P4	16 T6
17 A1 RED (Left Ear)	9 O1 White (Back left)		10 O2 Purple (Back right)	18 A2 YELLOW (Right Ear)

Airflow – blue to black/ white to blue

		35+ AIR FLOW	36+ THOR EFFORT	37+ ABDO EFFORT	38+ SNORE MIC	39+ SUM	40+	41+ BODY POSITION	42+	43+	44+
		35- AIR FLOW	36- THOR EFFORT	37- ABDO EFFORT	38- SNORE MIC	39- SUM	40-	41- BODY POSITION	42-	43-	44-

** Positive leads are blue on the PIB and Negative leads are black on the PIB**

- Display NUMBER OF LEAD WIRES WITH WIRE DESCRIPTION
- Air - Compumedics Triple Thermistor (Blue lead to Blue, White lead to Black)
 - Thor - Thorax Respiratory Band
 - Abdo - Abdomen Respiratory Band
 - Posn - Position sensor
 - Mic - Snore sensor
 - EEG - Four gold cup electrodes (blue, beige, white and purple)
 - ECG - Two snap electrodes (red and white)
 - LeftLeg1, 2 2 Gold Disk 96"
 - RightLeg 1,2 2 Gold Disk 96"
 - EMG - Three gold cup electrodes (brown, beige and orange)
 - EOG/L - One gold cup electrodes (white)
 - EOG/R - One gold cup electrode (purple)
 - EEG-REF- Two gold cup electrodes (beige and red)(A1 and A2)
 - Aux - N/A
 - PtRef - Gray gold cup (pt forehead to the right)
 - GRD - One gold cup electrode (Cz ground)(green)

TIP: You may want to separately gather all right sided electrodes (C4, A2, EOG/R) and all left sided electrodes (C3, A1, EOG/L) and secure them through a Styrofoam cup that has had a hole punched into its bottom. This may prevent tangling, and help with easier identification during placement.

Oximeter Probe and Nasal Cannula are attached directly to the Control Module. Both of these use a clear plastic adaptor. The nasal cannula goes into the airflow port NOT pressure port (the pressure port is for administering CPAP titration which we do not do). When observing CPAP use nasal cannula, cut tubing into CPAP mask port. Can tape to secure. Make sure tubing is not obstructed inside mask. If mask does not have ports in mask then do not do use the nasal pressure measure at all

TREC STUDY TEMPLATE and POLYGRAPH SETUP

The sampling rate for each channel is the number of samples recorded per second. The maximum sample rate for each channel is 256 samples/sec. The storage rate per hour based on the sampling rates selected is displayed in the lower right hand corner.

- The following sampling rates are to be used for all E Series units only:

Channels

Epoch length	30 seconds
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Channel	Name	Sampling Rate (Hz)	Coupling	HP Filter	P-P Range	Imp. Check
1	OFF	0	AC	0.15	8mV	No
2	OX	1	DC	0	Direct	Yes
3	EEG	128	AC	0.15	1mV	Yes
4	EMG	128	AC	0.15	1mV	Yes
5	LEGS	128	AC	0.15	1mV	Yes
6	Sound	256	AC	0.05	1mV	No
7	Respiratory	32	AC	0.05	8mV	No
8	Position	1	DC	0	512mV	No
9	CPAP Pres	1	DC	0	2V	No
10	Nasal Pres	64	AC	0.05	2V	No
11	CPAP FLOW	32	DC	0	2V	No

Trace Settings for TREC Study

Channel	Trace	HP Filter	LP Filter	Notch
1	LOC-A2	0.30 Hz	35 Hz	60 Hz
2	ROC-A1	0.30 Hz	35 Hz	60 Hz
3	C3-A2	1.00 Hz	35 Hz	60 Hz
4	C4-A1	1.00 Hz	35 Hz	60 Hz
5	EMG1-EMG2	10.00 Hz	100 Hz	60 Hz
6	LeftLeg1- LeftLeg2	20.00 Hz	30 Hz	60 Hz
7	RightLeg1- RightLeg2	20.00 Hz	30 Hz	60 Hz
8	SNORE	10.00 Hz	100 Hz	60 Hz
9	NASAL PRES	0.10 Hz	15 Hz	Off
10	AIRFLOW	0.10 Hz	15 Hz	Off
11	THOR EFFORT	0.10 Hz	15 Hz	Off
12	SUM	0.10 Hz	15 Hz	Off
13	ABD EFFORT	0.10 Hz	15 Hz	Off
14	SaO2	Off	Off	Off
15	OX STATUS	Off	Off	Off
16	ECG1-ECG2	Off	Off	Off
17	PULSE	Off	Off	Off
18	POSITION	Off	Off	Off

7/25/01 Heather changed channel 5 EMG1-EMG2 to HP = 1, LP = 35, and 60Hz = off

8/20/01 Carol Rosen changed EMG back to original settings (changed to 256 now back to 128 – original setting)

6/23/2006 Heather changed Leg (PLM) sensors to Gold Disk electrodes from the piezo sensors.