MYOSITE PLANNING FOR COAPT GEN2™
PLANNING EMG ELECTRODE SITES FOR COAPT GEN2™ PATTERN RECOGNITION

Pattern recognition loves information. The more information it can be fed, the better it will work. Valuable myoelectric (or, EMG) control information can come from all over a user’s residual limb, so, unlike a conventional single- or dual-site myoelectric system, you will be planning for several pattern recognition electrode contacts to capture all their limb has to offer.

You are likely already aware that pattern recognition is quite different than conventional single- or dual-site myoelectric control. Maybe it is no surprise that myotesting and evaluating users for electrode placement is quite different too. Yes, there may be a higher number of electrode contacts with pattern recognition, BUT, as you will experience, that will produce some wonderful benefits.

Here, Coapt will guide you through the two major electrode site-planning tasks:

1. Determining where there is underlying muscle tissue on the residual limb of your user.
2. Planning the Coapt electrode contacts to reliably cover those areas of residual muscle activity.
Step 1: Have a thorough discovery chat with your user

Before you dive into any palpation for muscle activity with a prospective user, plan to have a thorough discussion with them about what they can feel and do with their limb. Forget instructing them to imagine isolating wrist flexion and extension or simple elbow up/down (we know—it can be hard to change old habits) but instead, have them tell you ALL of what their finger, hand, wrist, elbow, etc. perceptions are.

Why? Well, this is a great way for both you clinicians AND your users to work together, explore and learn what intuitive motions and feelings they may want to use for their prosthesis control. Let them tell you what they can do. And don’t mistakenly limit them by cornering them into the old “flex/extend” box.

**GOALS OF THIS DISCUSSION ARE TO DETERMINE WHAT MUSCLE CONTRACTIONS (MOTIONS) THE USER FEELS:**

1. Are intuitive to use for prosthesis control.
2. Can be performed consistently.
3. Are unique for each intended prosthesis action.
A HELPFUL APPROACH TO LEADING THIS DISCUSSION:

- Ask questions to determine what movements the user can perceive and produce with their phantom limb, such as:
  - “Can you feel your hand? Which fingers do you feel you can move?”
  - “Can you imagine making a fist? What about opening your hand with your fingers spread apart?”
  - “Does it feel like your hand is squeezing down on something?”
  - “Do you feel like you can turn your wrist? Does your hand stay relaxed?”
  - “Does your thumb move? How far? Which direction?”
  - … and so on. Remember, the goal is to learn together what more might be available for control with more multi-site contacts.

- When you have your user perceive these motions, ask that they hold them at a medium intensity and for about 3-4 seconds each. This is good practice for the eventual prosthesis controls’ (and users’ self-led) calibration procedure.

- Encourage the user to mirror their perceived motions with their sound limb if possible.

- Start the discussion with the most intuitive motions and add variations as needed; i.e. try natural hand close for “hand close” and if they have poor perception of hand close but good perception of one specific finger (for example), try practicing the use of that finger perception for “hand close.” In another example, if wrist rotation is difficult to perceive, discuss the feeling of adding thumb or pinky finger ab/adduction to accentuate rotation.

- Focus on motions that are distinct and repeatable.

- Take considerable time with this process.

- Be patient and listen.

- Perform this discussion in a relaxed environment.

- Develop a common vocabulary for specific motions.
Step 2: Determine where there is underlying muscle tissue on the residual limb

Palpation isn’t what it used to be. For single- or dual-site, conventional myoelectric control electrode planning, you may have been used to feeling for strong, isolated contractions using your fingertips. Forget that. For pattern recognition go all in. Use all of your hands to feel as much of their residual limb as possible, at once. Hold on and feel while you repeat and continue the discussion from Step 1.

Why do you want to do this? The continued discussion helps to further discover their intuitive motion plans while, at the same time, lets you feel for the general and global areas of underlying muscle tissue. Remember, pattern recognition doesn’t always require strong and isolated sites, it wants to get info from lots of muscle areas—even the areas that may seem weak and hardly perceptible.

**THIS WHOLE-HANDED PALPATION SHOULD:**

1. Feel for all “areas of interest” corresponding to any and all underlying muscle activity related to the control motions.
2. Keep note/remember these “areas of interest” as good locations to place electrode contacts.
A HELPFUL APPROACH TO PERFORMING THIS PALPATION:

- Perform this exercise in a relaxed environment
- Take time with this process.
- Be patient and listen.
- Grasp and cover as much of the user’s limb as possible; do not use only your fingertips to feel.
- Have the user perform and hold (3-4 seconds) each of the useful motions discovered during the discussion phase.
- Feel for the overall muscle activity – like what the pattern recognition algorithm does – by sensing the patterns of activity at multiple areas simultaneously.
- Do not ignore areas of slight/subtle/weak underlying muscle contraction (these signals are just as valuable).
- Note any unique and unexpected areas of underlying muscle contraction.
  - For transhumeral amputees, this may mean unique muscle activity distal on their residual limb.
- If the user tenses muscles quite hard for all motions, ask them to make contractions a little more softly.
- If desired, make temporary markings on the user’s residual limb to help remember areas of activity.

GENERAL THINGS TO AVOID:

- Do NOT seek only strong muscle contraction sites (subtle signals are important too)
- Do NOT focus only on precise and isolated muscle sites
- Do NOT limit electrode placement to “hotspot” areas
If you’ve performed the discussion and palpation steps of the Electrode Site Planning for Coapt pattern recognition, you will have a good idea of the underlying muscle “areas of interest” on your user’s residual limb. Perhaps you’ve even made a series of temporary markings on their limb or taken some pictures for planning.

Now you are ready to place the electrodes in the socket/liner interface. This section will guide you if this is your first Coapt fitting and provide useful tips if you’re already a pro.

**A few very important things to know before you get started:**

- Electrode contacts with a Coapt system are solid Stainless-Steel Dome Electrodes. Each one will be connected to a wired lead of a Coapt cable harness as described below.

  - Two Dome Electrodes work together to create one “channel” of EMG information.
    - If you picture an imaginary oval encircling the two placed Dome Electrode contact points, this is the general region the EMG channel data will be from. The farther apart the pair of Dome Electrodes, the larger (and deeper) the sensed area will be. Conversely, Dome Electrodes close to each other will detect a more focused channel of EMG.

- The Coapt system has 8 EMG channels (16 Dome Electrode contact points) and one ground/reference contact (17 Dome Electrode contact points in total).

- In some space-constrained fittings, the 17 Coapt Dome Electrodes can be reduced to as few as 9, by way of contact-sharing (see below for details).

The most important thing to remember with electrodes: **Dome Electrodes MUST MAKE CONTACT WITH THE SKIN** to work. Electrodes that do not stay in contact with the user’s skin will lead to serious prosthesis control limitations. Take care in planning and be sure to fabricate a well-fitting interface for all fittings.

**THE POSITIONING OF ELECTRODE CONTACTS SHOULD:**

1. Cover the areas of interest discovered during Palpation.
2. Plan accordingly for socket/liner constraints.
A HELPFUL APPROACH TO POSITIONING THE ELECTRODE CONTACTS:

- Consider starting with locations that correspond to existing myosites when retrofitting existing myoelectric users.
- Identify locations to AVOID electrode contact, such as:
  - Areas that will lose electrode-to-skin contact during use.
  - Areas outside of socket trim-lines or co-located with valves.
  - Areas that have no underlying muscle (i.e. bone only).
  - Sensitive skin areas.
  - Areas with active EMG during positional loading (e.g. deltoids, brachioradialis).

**Contact Spacing** – Plan to place the two electrode contacts for an EMG channel approximately 30–60 mm apart.

**Contact-Pair Orientation** – While it is generally a good idea to align a pair of contacts in the direction of underlying muscle fiber direction, it is ok with pattern recognition to place some of the electrode pairs “off-axis”. This is helpful when fitting a residual limb with unique areas of EMG interest, and for geometrically unique and congenital limb presentations.

**Contact Sharing** – For a limb that is too small to reliably fit all 17 Dome Electrode contacts, it is acceptable to have a few of the EMG channels share an electrode contact. Take care, however, that you do not place the two wires for any EMG channel (same color) on the same Dome Electrode—that will result in zero signal for that channel and not be helpful for pattern recognition. Also very important: All Coapt Conductor wires must be connected to a Dome Electrode contact; do not leave any unconnected.

**Single Reference (Ground) Contact** – The Coapt system requires a single Dome Electrode contact for purposes of EMG reference/ground. This contact should NOT be shared with any other EMG signal wires. The reference contact should be positioned in a location that maintains excellent electrode-skin contact.
Assembly Instructions for placing Dome Electrodes into the prosthesis

For more information, see Coapt’s Dome Electrode Handbook (available on the Coapt website)

1. Push a Dome Electrode through a #4 mounting hole you have made in the prosthesis’ inner socket/liner interface. Place it so the dome side will make contact with the skin of the user, and the thread is on the outer side of the socket wall. Ensure the Dome Electrode stud is pushed all the way in the hole.

2. Place a provided Flat Washer on the threaded side of the Dome Electrode.

3. Place the ring terminal of a conductor cable on top of the Flat Washer. Same-color conductor cables should be planned for nearby Dome Electrodes.

4. If you are “sharing” a Dome Electrode, place the other conductor cable(s) ring terminal(s) (different color(s)) on this threaded stud. Keep in mind that same-color conductors must NOT share the same Dome Electrode. Also, make sure the black (ground) connection is connected to its own Dome Electrode.

5. Place a provided Split Lock Washer on top of the ring terminal(s) of the conductor cable(s).

6. Place and tighten a provided 4-40 Threaded Nut to secure the assembly. Make sure it is tight enough that the conductor cable wire cannot be moved side-to-side with your fingers.

7. Repeat these steps for each Dome Electrode that needs to be connected to a conductor.

8. Do NOT leave any Coapt EMG wires unconnected.

9. Do NOT use any liquid thread locker.

10. Where applicable, trim the excess threaded stud of each Dome Electrode once installed and tightened. Make sure to smooth, remove, or cover any sharp edges.
A FEW THINGS TO BE CAREFUL OF WHEN WORKING WITH THE DOME ELECTRODE HARDWARE

- Be careful not to damage other wires when installing the Dome Electrodes.
- If any part of the metal of the Dome Electrodes and the hardware make contact with conductive materials (e.g. carbon fiber outer sockets) the EMG signal will not be as clear. Take caution to avoid that type of contact.
- Make sure the black (ground) connection is connected to its own Dome Electrode.
- Two wire conductors of the same color should NEVER be connected to the same Dome Electrode.
- Do not cross-thread the nuts on the threaded part of the Dome Electrodes. Try starting the nuts with your fingers first and if not easy to tighten, try adjusting the starting orientation of the nut.
- Make sure the Dome Electrodes are installed with the dome side making contact with the user. The threaded side and other components should be secured behind a mounting socket wall or enclosure.

**Trimmed electrode studs.** Ensure any excess length of electrode dome threaded studs are sufficiently trimmed and smoothed. Sharp edges and protrusions can cause damage to other prosthesis wiring, socket materials, and installed components.

**Conductive socket material.** It is important to consider electrode interference when using of electrically conductive socket materials, such as carbon fiber laminate. Conductive socket material that comes in contact with electrode dome threaded studs can negatively affect prosthesis performance by reducing the detected EMG signal quality. Take care to electrically isolate the electrode dome threaded stud and/or EMG Interface Cable ring-terminals from contact with any conductive socket materials.

NEED TO CLEAN THE DOME ELECTRODES?

- Coapt recommends cleaning of the Dome Electrodes’ skin contact side as needed using isopropyl alcohol on a clean cloth. Avoid using anything abrasive like sandpaper or steel wool.
- These Dome Electrodes are made of a high-grade Stainless Steel. If they appear damaged or corroded, please contact Coapt.