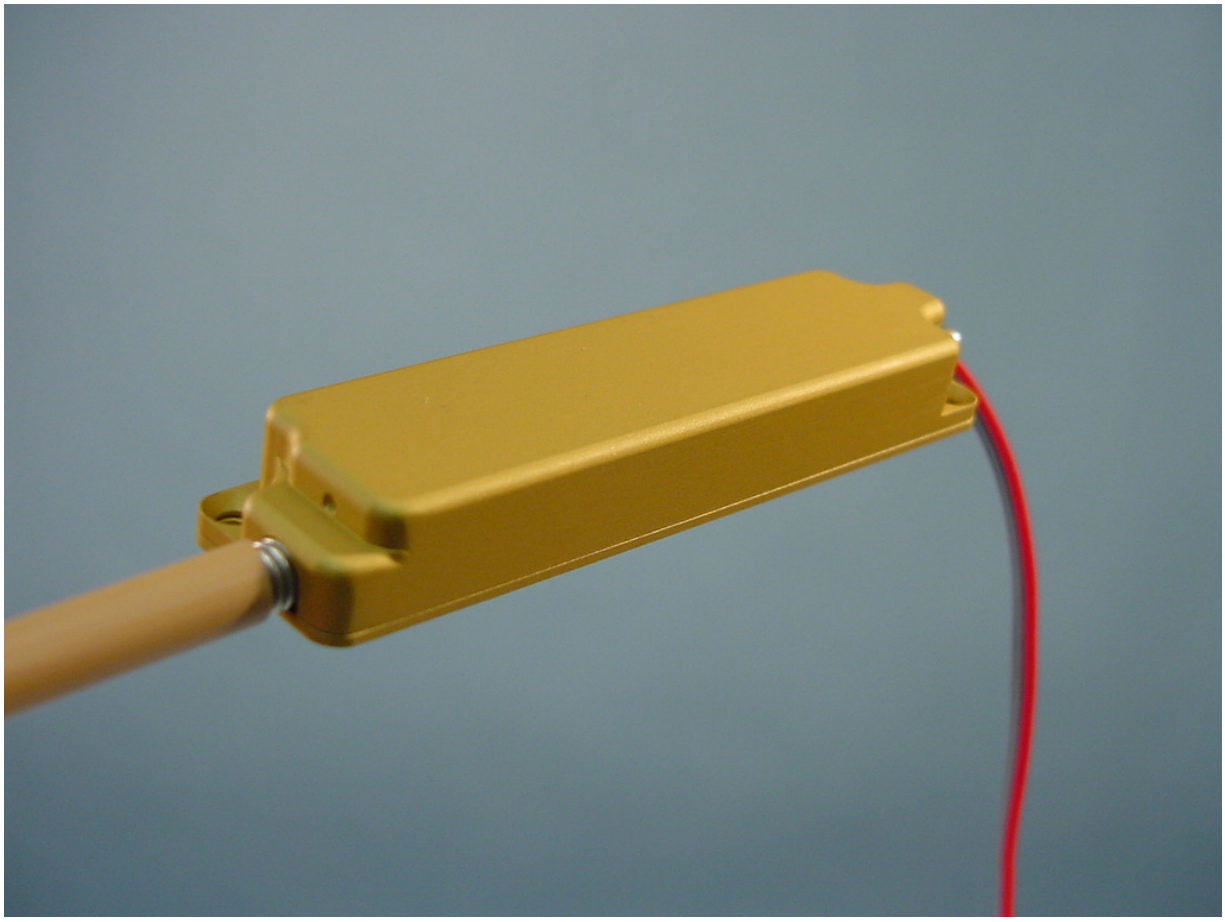
Linear Transducer
LT01/LT02



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The LTI Linear Transducer (LT01/LT02):

This unit is designed to be used as a positional-servo transducer input signal for controlling an appropriate prosthetic terminal device. It allows the user to regulate the position of the prosthetic device through body excursions that pull on the transducer cord (Spectra™ cord). For some popular control strategies, the position of the transducer determines the position of the prosthesis. If the user pulls the transducer cord ½" (full excursion), the prosthesis fully opens. A smaller movement of the transducer cord produces a smaller movement of the prosthesis. This motion of the prosthesis, tracking the motion of the transducer, is called "servo control". When used to control a powered prosthetic hand for example, the transducer's position relates directly to the position of the hand – a fully-pulled transducer equals a fully opened hand.

Generally the Linear Transducer is used as a single-site input signal for controlling a hand prosthesis that is equipped with a built-in controller circuit with a single-site control strategy option. These "microprocessor-based" prosthetic terminal devices (i.e. Sensor-Speed, bebionic, iLimb Pulse, ETD-Pro, etc.) can be programmed to operate off a single input signal. In some cases these terminal devices have more than one single-site control option, but often a voluntary-open, automatic close control strategy is used. In this case, when the transducer cord is pulled, the hand opens and when the cord is released, the hand closes. The user's range of motion and physical capabilities determine what body movement is best used to actuate the linear transducer.

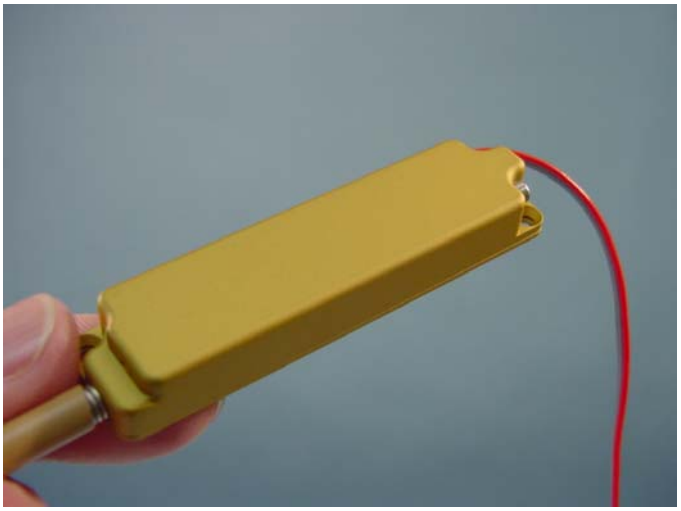

Figure 1 - Servo Transducer

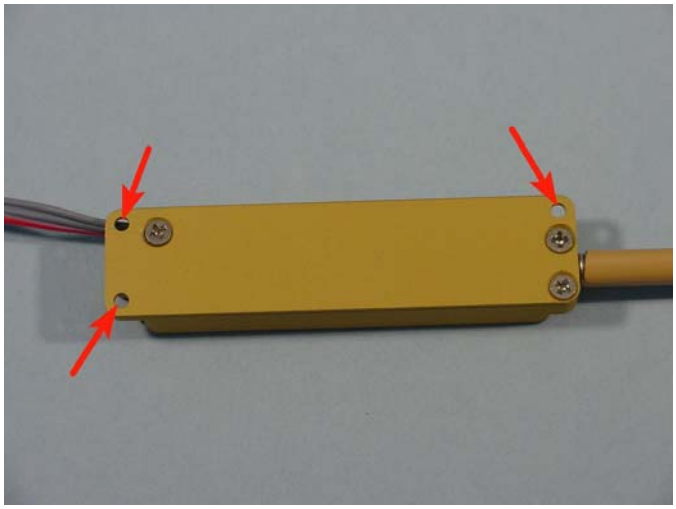

Figure 2 - Mounting Holes

Description:

The Servo Transducer consists of a linear potentiometer in a small case with an attached 8" (200mm) Bowden sheath. A Spectra™ cord (about 16" or 400 mm) exits the sheath and is supplied with a loop strap for attaching to the harness. Pulling the cord changes the resistance of the potentiometer, thus changing the speed and position of the prosthetic device. As originally set-up, the Spectra cable moves a total of ½ inch (13 mm). Depending on where you place a knot in the cord when setting up the transducer, the cord can be set to travel ½ inch or 1 inch (13 or 25 mm). The potentiometer has a small return spring which is supplemented by a secondary, adjustable spring for matching the resistance to the needs of the user.

Mounting the Transducer:

Mount the transducer on a flat surface, using the 3 flat-head #2 self-tapping screws provided (Fig 2). Alternatively, a cavity can be molded into the outer socket and the transducer can be placed between the inner and outer sockets to conceal it.

Actuation of the Transducer:

The actual location of the Transducer is less important than the location of the end of the Bowden cable. Typically, a point near the end of the sheath is fixed to a point on the posterior wing of a transhumeral socket. The other action point is the attachment of the cord running through the Bowden sheath, often on the contralateral side of the posterior harness. Forward motion of one or both shoulders (protraction) takes the slack out of the cord and then moves the transducer mechanism.

Adjusting Length of Travel:

The unit is shipped with the Spectra cord secured to the Delrin piece as shown in Figure 3. This is the 0-½ inch travel setup. Generally this is the preferred configuration. If the user requires more travel, you can change to the 0-1 inch travel setup by removing the cover and rerouting the Spectra cord. Drill a 0.05“ diameter hole (#55 drill) through the case where shown in Figure 4. A dimple has been provided to center the drill. Cut off the knot at the black “pulley block”, and straighten the cord. Now loop the cord through the hole in the Delrin block – passing it in one hole and back out the second hole (180°), then out through the new hole in the case. Tie a “figure 8” knot just outside the case. The Spectra™ cord is slippery (ultra high-molecular-weight polyethylene), so you should trap a little “superglue” (cyano acrylic cement) in the interior of any permanent knot or it will work loose. Have your user try both travel set-ups before gluing any knots.

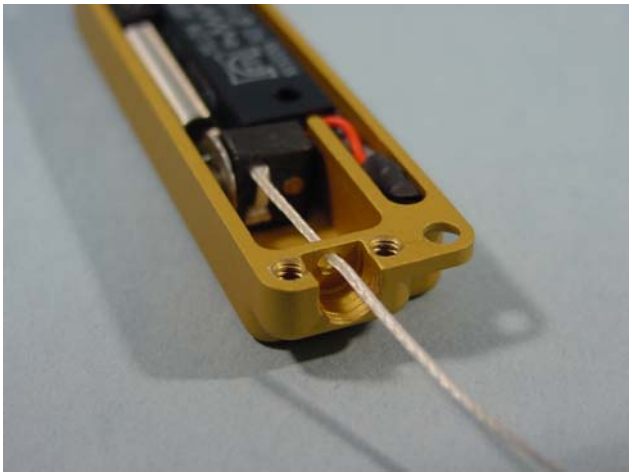

Figure 3 - Single Spectra Cord - ½” Travel

Figure 4 – Drill Hole for Rerouting Spectra Cord - 1” Travel

Spring Return Adjustment:

Usually the transducer is pulled by shoulder motion or by chest expansion. The muscles that initiate these motions are relatively strong and you may need a strong spring for your user to develop the best possible “feel” for where the transducer is in its travel. The spring tension provides feedback to the user. An adjustment screw (Figure 5) is located on the end of the transducer case. Rotating this screw **counter-clockwise**, will **reduce** tension in the spring. Rotating it **clockwise** will **increase** spring tension, assisting the user in feeling when the transducer engages. Most users will need little or no pretension, but will need at least the weakest spring to overcome friction in the system.

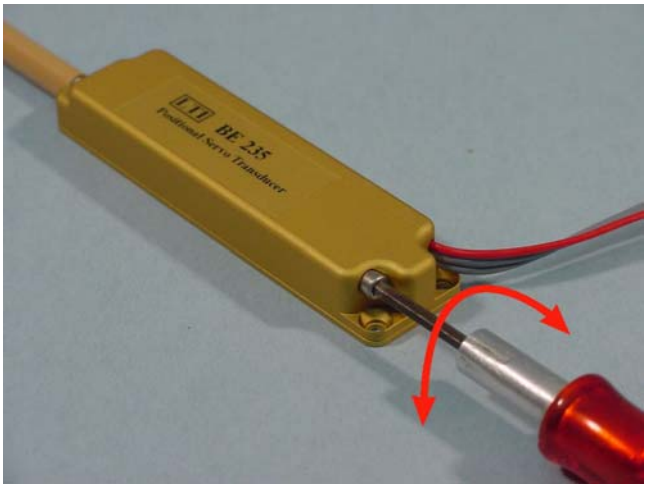

Figure 5 - Spring Tension Adjustment


Figure 6 – Securing the End of the Bowden Cable

The case cover secures the Bowden cable sheath as shown in Figure 6. Once the sheath is in place, tighten the two cover screws, then make sure that the set screw on the top of the case is tight against the Bowden cable. If the sheath is too long, it can be cut to length. Remove the Spectra cord and cut both the Bowden shroud and the inner Teflon liner to the desired length. Then re-thread the Spectra cord through the Bowden cable and attach the end piece.

Routing the Spectra Cord:

The Transducer is supplied with the Bowden sheath attached. The other end of the sheath will be at the socket-side anchor point. For the transhumeral amputee using protraction of the shoulder, this anchor is usually placed right over the abduction axis of rotation on the posterior wing of the socket. The goal for the user is to be able to abduct and forward flex with minimal pull on the cord while maximizing the motion that results when the shoulder is protracted.

Connecting to the terminal device:

The LTI Linear Transducer (LT01/02) is supplied with a Bock-style 3-socket connector on the output cable (see Fig 7). When used with a Bock-style Quick Disconnect (QD) Wrist or Wrist Rotator, the output of the Linear Transducer is plugged into one of the 3-pin myoelectric input connectors on the back of the wrist coaxial plug.

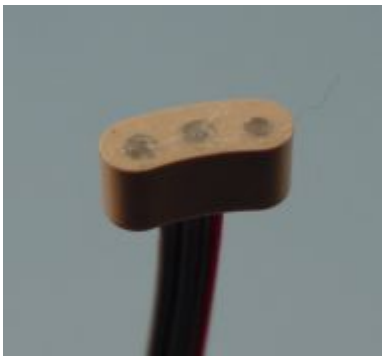
Figure 7 – Bock-style 3-socket connector

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