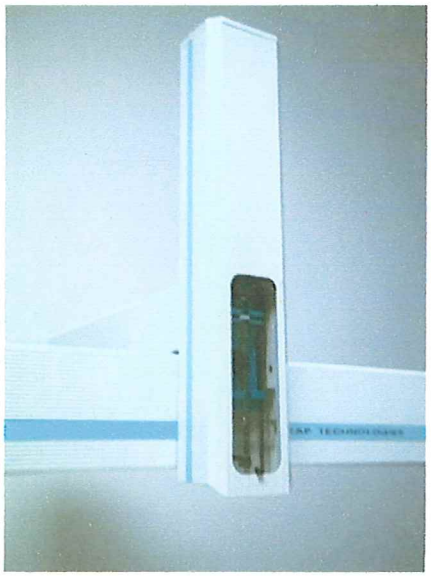
LEAP TECHNOLOGIES

Customer Support Group



PAL Autosampler Injection Unit

Preventative Maintenance Kit Guide

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About This guide

This guide provides information about the procedure and process involved in the recommended annual preventative maintenance of the CTC PAL Injection Unit. This kit addresses the yearly maintenance of the injection unit by a user. It is not a substitute for a PAL preventive maintenance visit, which covers other parts. LEAP recommends a complete annual PAL PM on each system. This kit does provide the necessary replacement parts, grease, oil and all of the specialized tools for all the GC and LC PAL type Injection Units. Some common tools found in the lab (which are not provided) may be needed depending on the version of your injection unit.

Important information to know before starting

- Prior to starting any maintenance on a PAL, a backup of the firmware should be done, using the CTC PAL Loader program.
- This kit is for preventative maintenance. Broken or damaged parts which are not preventive maintenance parts will not be provided in this kit.
- This kit and guide are not necessarily the techniques used by LEAP Field Service Engineers, who would be doing a more detailed, entire PAL system PM, this is a condensed, simplified version for end users.
- LEAP recommends a Full System PM once a year by a certified CTC trained Engineer.
- By the use of this kit, the end user acknowledges there is no guarantee on success or performance outcome. This kit requires an end user who is comfortable removing and working analytical lab instruments and has experience using the PAL system. LEAP has made every effort to provide a complete comprehensive kit, but gives no guarantees as to it's use.
- The use of PPE (**Personal Protective Equipment)** is strongly recommended. Laboratory equipment is often used with chemicals and samples of unknown origins. Follow your companies PPE guidelines.
- Never work on a PAL with the power switch "ON". Always use the "On/Off" switch on the power supply to do a "Power Down". Pulling the power cord while the PAL is "ON" may damage the electronics and firmware files.

- Each PAL Autosampler came, with it's own "User Manual". The "User Manual" contains additional information, software and pictures which may be needed to fully explain the steps in this kit. Please use it with the kit.
- You will need approximately 3 feet of clean bench area to work on the unit, along with items such as: Kimwipes, IPA and paper towels.
- Read the entire document before starting.

Contents of the Preventative Maintenance kit

Each kit contains enough parts for one (1) injection unit.

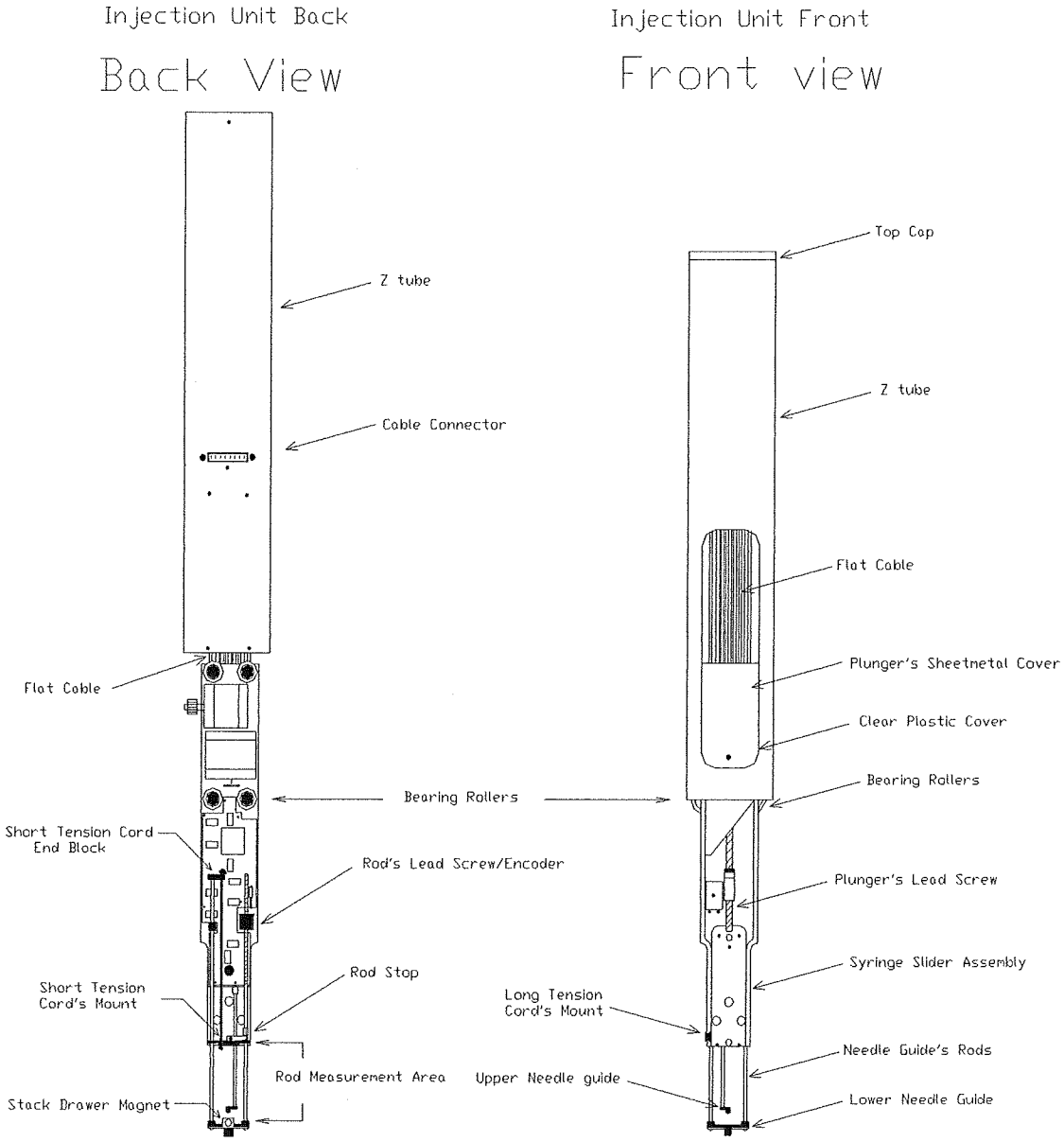
- Plastic sectioned box
- Ruler 15cm
- Swabs: 1 narrow, 1 wide
- Tension cords: 1 short, 1 long
- Magnet: Stack drawer
- PAL Grease
- Tri-Flow oil .25oz
- Torx: set
- Hex: 2.5mm
- Guide

How to identify your model

The *CTC Analytics* PAL autosampler, normally is divided into two platforms; GC and LC. The GC models include: GC PAL and the COMBI PAL. The LC group includes: LC PAL, HTC and HTS PAL. There are other models but theses listed are the most common. The injection units comes in two basic lengths: 39cm *(the shorter model-MZ-06)*and the 44 cm *(the longer model-MZ-01, MZ-02 and MZ-09).* The lengths are noted here because the method in which to remove the unit from the PAL can differ depending on the model. The model and serial number of each injection unit is usually found on the back of the injection unit body.

Diagram of Injection Unit

Diagram of various parts of the Injection Unit. Front view and a back view during disassembly. The black sheet metal cover has been removed for clarity form the back view, and the Long Tension cord has been removed from the front view (Zoomed close-up views are at the back of the document under Addendum).



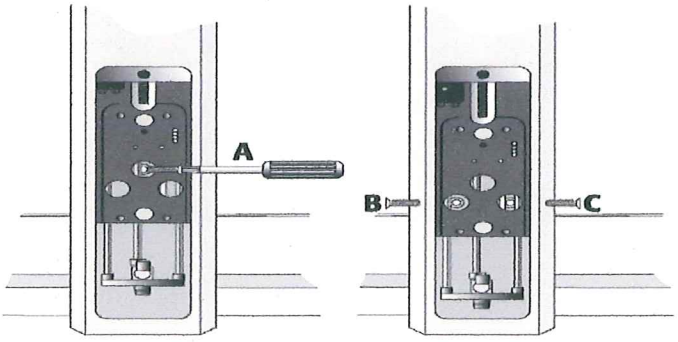
Step 1 *(the job begins)*

- Using the "PAL Loader" software, make a backup of the PAL's firmware on a computer. This is also explained in the User Manual.
- Power down the PAL using the "On/Off" switch at the back of the power supply. (Note: never switch power back on immediately! Wait 10 seconds before switching power back on, otherwise the firmware can become corrupt or locked up).

- Depending on the model of the injection unit, the next steps will explain how to remove the Injection Unit off the PAL Autosampler.

Step 2A *(Longer Injection Unit removal, also explained in the "User Manual")*

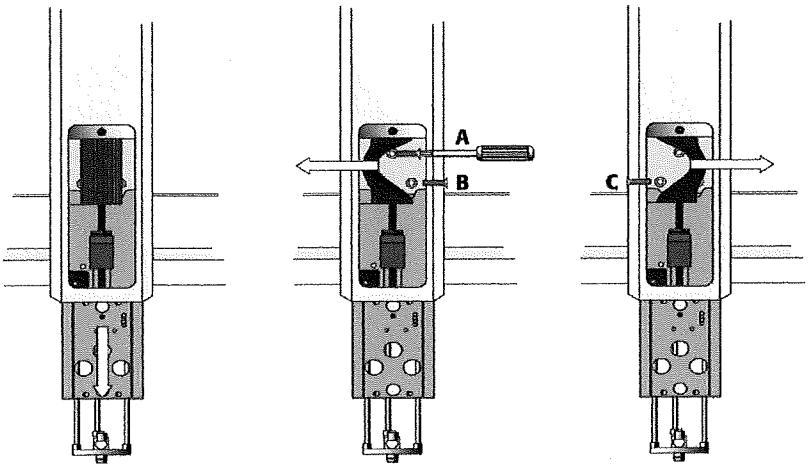
- Step 2A will be for the longer 44cm-MZ-01, MZ-02 and MZ-09 injection units. **If you have the shorter injection unit, skip to Step 2B.**
- The PAL should be powered down, remove the syringe and syringe adapter from the injection unit.
- Pull the injection unit slowly forward toward you until it comes to it's furthest outward position (closest to you), taking care not to bump the black "syringe slider" and "lower needle guide" assembly which may have slid down after a power down.
- Slide open the clear plastic cover. Locate the three large holes in the black anodized "syringe slider" assembly. Slide the "syringe slider" assembly up or down until the top hole is centered over a Torx screw head. Using a T-20 Torx wrench, unscrew the T-20 screw. Place this screw in a safe place.



- Now move the assembly until the remaining two screw heads are visible from the other two holes. Using the same T-20 Torx wrench remove the other two screws. Maintain a grip on the injection unit to prevent it from falling. Place the screws in a safe place.
- Now, the injection head will pull off the "Y" arm of the PAL a short distance (still connected by a "flat cable and two alignment pins"). Carefully remove the flat cable connector. The injection unit should now be free, set it gently on a clean work bench.

Step 2B *(Shorter Injection Unit removal, also explained in the "User Manual")*

- Step 2B will be for the shorter 39cm-MZ-06 injection units.
- The PAL should be powered down, remove the syringe and syringe adapter from the injection unit.
- Pull the injection unit slowly forward toward you until it comes to it's furthest outward position (closest to you), taking care not to bump the black "syringe slider" and "lower needle guide" assembly which may have slipped down after a power down.
- Slide open the clear plastic cover. Pull the black "syringe slider" assembly down to it lowest level. Locate the black sheet metal cover in this assembly, above which you will find a black flat cable. You must be able to see the metal cover and this flat cable, if not then your Injection unit is not low enough to expose the (3) mounting screws



- It is also possible that you will not be able to physically move it lower due to your GC configuration. In that case you must remove the entire PAL off it's mounting bracket, then remove the (3) screws. If you can see the black metal cover and a flat cable, then push the flat cable to one side and

expose the (3) Torx screw heads. Using a T-20 Torx wrench, unscrew the (3) T-20 screws. Maintain a grip on the injection unit to prevent it from falling. Place these screws in a safe place for re-installation.

- Now, the injection head will pull off the "Y" arm of the PAL a short distance (still connected by a "flat cable" and (2) alignment pins). Carefully remove the flat cable connector. The injection unit should now be free, set it on a clean work bench.

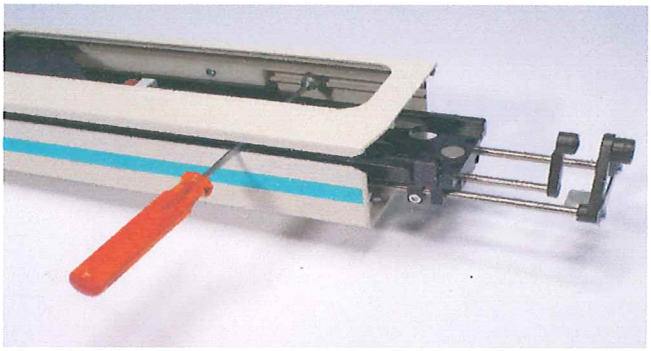
Step 3 *(Opening up the Injection Unit)*

- Now, the injection unit should be lying on a clean bench, plastic cover facing the table. Using a T-10 Torx wrench (supplied), remove the (1) top cap screw.

- Pull the "top cap" away from the "Z" tube enough to expose the "long tension cord" attached inside the top cap cover. Slide the knot out, and let the "long tension cord" retract gently back inside the "Z tube".

- Set the "top cap" in a safe place along with it's screw.
- Now turn the injection unit over, plastic cover facing up. Slide the cover open. Locate the "slider stop". This would be a hex head screw and small rounded assembly mounted inside in a grooved channel near the bottom.
- Using a fine point marker (like a lab Sharpie) mark the position of the "slider stop" on the painted area around it. Now, using the supplied 2.5

mm ball hex wrench, loosen the "slider stop" enough to slide the assembly out. If your injection unit has a "slit" up the side, you can position your wrench through the slit. If not, the ball end will angle enough to loosen the screw, take care to notice the orientation of the assembly for re-assembly.



- Place the "slider stop" in a safe place.
- Now the black "syringe slider" unit should slide down past what was the "slider stop" area and out, though still attached by a cable and or tubing (two pieces now).

- Remove the "long tension cord" from where it is attached near the bottom of the "syringe slider". Tie a knot in the middle of the cord to distinguish it from the new one. Do not discard any parts until the PM is complete.

Step 4 *(Removing the black sheet metal cover)*

- Now the injection unit should be visible as two pieces, a whitish painted outer "Z tube" and the inner black "syringe slider" unit, connected together by a flat cable and gas tube (depending on the model). As you progree to the next steps, you must move these two assemblies together as a unit, taking care not to damage the flat cable or tube which connects them.
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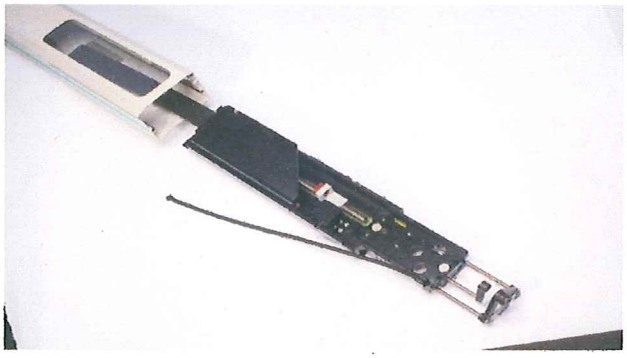
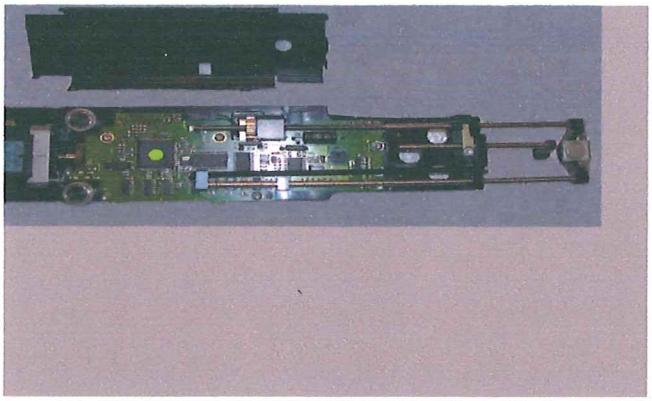


- Now gently flip the assembly over, plastic cover facing the table, It will be assumed that when you are instructed to turn the unit over, it is the two pieces referred to together as stated earlier ("Z tube" + "syringe slider").

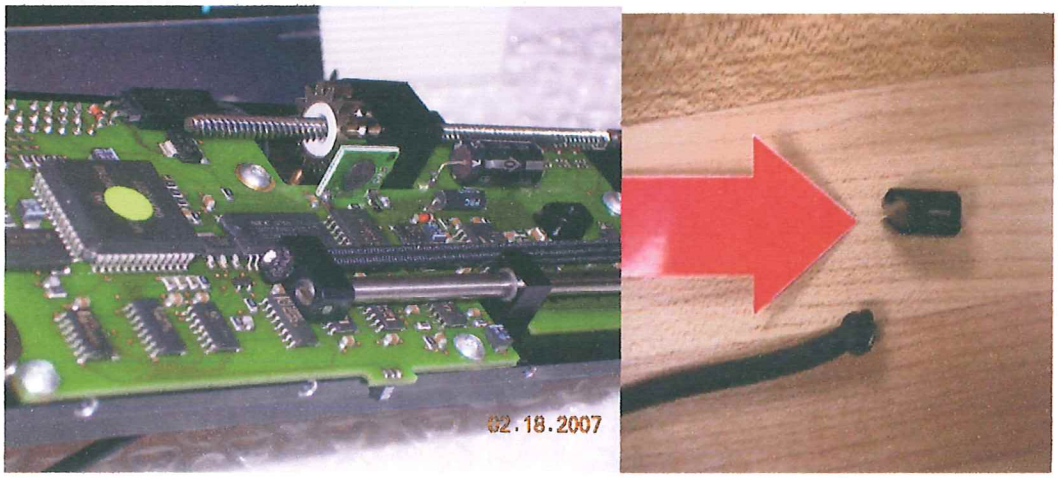
- Now you should be able to see a black sheet metal cover held on by (5) screws. These can be small Phillips screws or more commonly T-8 screws. Using the supplied T-8 wrench (or Phillips from your lab), remove the (5) screws with washer and put them in a safe place.

- Gently lift the black cover off, set this in a safe place with the screws and washers.



Step 5 *(Removing the short tension cord assembly)*

- Locate the "short tension cord" assembly. Gently stretch the "short tension cord" so as to relieve tension off the black "end block" (red arrow pointing at it) which is at the end of one of the steel rods.
- When the tension is relived, slide the black "end block" off the end of the steel rod.



- Now hold on to the end knot of the "short tension cord" and pull/stretch the old tension cord so as to make it's diameter narrower, then pull/slide the "end block" off the old cord through it's narrow slit. Keep this "end block" in a safe place, you will have to put it on the new "short tension cord" later.

- Remove the "short tension cord" fully from where it's attached on the slider assembly and tie a knot in the old cord to distinguish it from the new cord.

Step 6 *(Cleaning and lubricating)*

- At this point the "lower needle guide" and it's rods are free from the tension cord. You should be able to move the "lower needle guide" assembly up and down smoothly. One rod has a lead screw/encoder as part of it, the other is a straight rod.
- Using a soft paper towel or a Kimwipe and IPA, clean all parts of the rods including the middle (shorter) "upper needle guide" rod (3 rods in all). Clean and move them in and out, clean again. Never apply solvents to any of the round sealed bearings above as it will dry them out.
- Using the supplied "Tri-Flow" oil (shake tube well before using as it has suspended Teflon particles in it), apply several drops along the smooth surfaces of the needle guide rods. Work the lubricant into the rods and polymer bushings wiping off all visible traces of the oil afterwards with Kimwipe (lint free). Apply in the same manner some Tri-Flow oil to narrow foam swab from the kit, then apply/dabbing it to the rod's lead screw/encoder wheel area (threads), again wiping up all visible oil afterwards (a thin micro layer will be left behind, anything more will attract dust and moisture).
- <u>The "needle guide" assembly and rods should now be clean, lubricated and freely move up and down without any hesitation.</u> If not, try repeating the cleaning and lubrication steps. If the lead screw/encoder threads are blackened with buildup or grime, you can use a narrow brush (toothbrush) and Kimwipe and IPA to clean the threads. The Tri-Flow oil also works as a penetration oil going in and helping loosen the grime and buildup. Be careful not to drip any oil or solvents on the circuit board or components.

If the rods will not move freely (distorted) then they may have to be replaced.

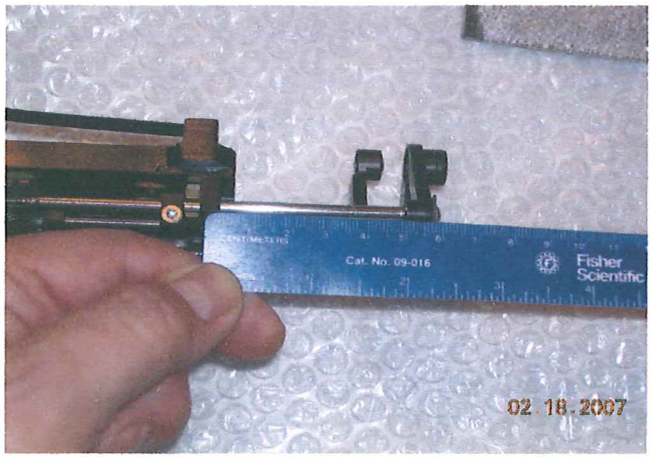
Step 7 *(Replacing a worn "Stack Drawer Magnet")*

- As part of the kit a "stack drawer magnet" is provided. If you see wear marks on the clear plastic packaging around the magnet it is advisable to replace it, (this magnet is used to open up tray drawers, some systems may not have these drawers, and therefore will not show any wear).
- Slide the "lower needle guide" assembly in until it stops, so the rods are retracted up (never replace the drawer magnet with the assembly extended out as it will bend and distort the rods which must be keep straight).
- Using a T-10 Torx wrench, carefully loosen the (2) Torx screws from the bottom of the magnet bracket. Note the orientation of the old magnet (which way it faces). Remove the old "stack drawer magnet" and replace with the new one. Caution, these screws often have thread lock on them and can be very tight.
- Tighten the (2) new screws evenly, never applying undue pressure to the rods (as stated before, if they bend they will have to be replaced).
- Again move the "needle guide" assembly up and down slowly, checking for smoothness. If the assembly moves as if in a "bind", loosen one or both of the "stack drawer magnet screws" and tighten evenly again until it moves smoothly as before you started this step.
- At this point the needle guide assembly and rods should move (glide) up and down smoothly (spinning the encoder wheel as the rods move). If so, move on to the next step, if not go back and investigate.

Step 8 *(Checking the rod lengths)*

- **The length of the needle guide's rod is a critical measurement. It sets the length that the needle extends beyond the lower needle guide. If it is too short, the needle may jam in the lower needle guide while trying to exit. If it is too long it may hold onto vials (not retracting the needle from the vial septa) bending the needles, or possibly dragging the needle across a plate.**

- Remove the clear plastic **15cm ruler** provided in the kit. Check the distance the rods can move as explained below, also see the Diagram or Addendum for a clearer view of the correct place to measure.



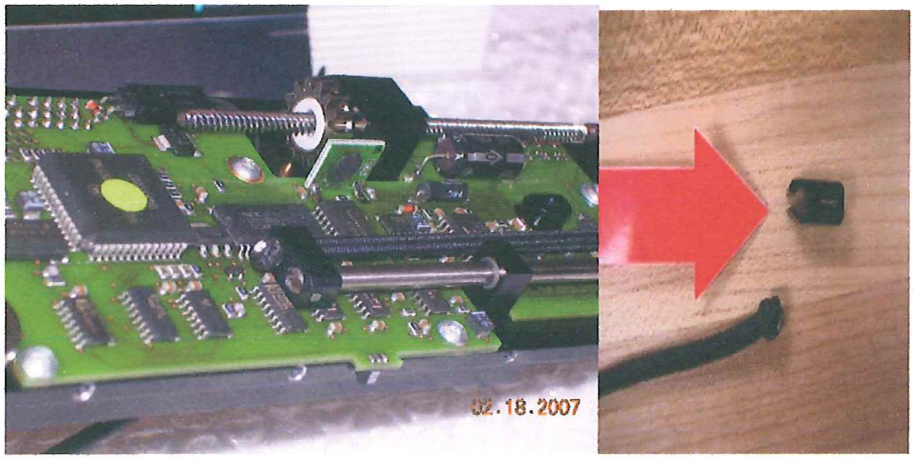
- This measurement will be taken on the rod which has a "lead screw/encoder" as part of it. The specific part to measure is near the magnet end as shown above.
- Slide the "lower needle guide" assembly out to it's furthest position (you will see the little black **"rod stop"** strikes against another part.

- At this point, it is as far out as it can move. Note the orientation of this "rod stop". If you adjust it in the following steps, it must be oriented as you see it now.
- Using the metric ruler, measure the silver area of the rod between the two black surfaces.

- This travel distance should be 50.5mm -0.0mm +0.5mm. You can have a length from 50.5 to 51.0mm (nothing longer or shorter for standard syringe needles). If your distance is different, loosen the "rod stop" and adjust your rod length. Then tighten, keeping the split orientation as before. Make sure this is tight, but do not strip the screw head, or break the "rod stop" block. Re-check your measurement several times.
- The final definitive test later will be when a syringe is installed into the "Injection Unit". The needle should just be inside the lower needle guide hole, not visible from the bottom. If you run your finger under the "lower needle guide" you should not feel the needle. Also, you should then be able to slightly squeeze the upper and lower needle guides together and the needle is just felt. Release it and it disappears, squeeze slightly and it's felt. That is the correct position for a standard syringe.

Step 9 *(Replacing the short tension cord assembly)*

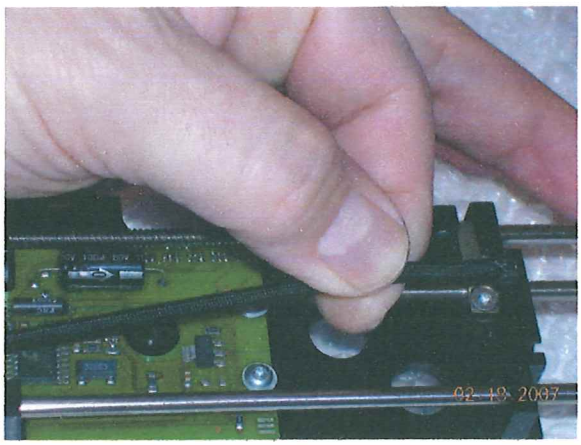
- Remove the new "short tension cord" from the kit. Now hold on to the end knots of the tension cord and gently pull/stretch the new tension cord so as to make it's diameter narrower, then pull/slide the "end block" onto the new cord through it's narrow slit, taking care not to over-stretch or damage the cord.
- In this next step you will be installing this cord and end block onto the end of the smooth rod.



- Look closely at the black "end block", you will see that there is an angled edge at the slit area. This angled side will face the green circuit board. With that in mind you can only put the end block on the end of the rod, in one direction. There is also an alignment cross pin inside the end block which will mate into a notch in the end of the rod. Slide the "end block" onto the end of the rod. The next step is important. Rotate the tension cord with your fingers, so as to move the largest part of the end knot away

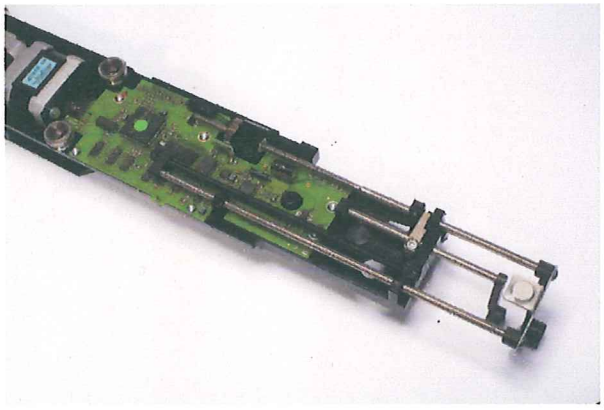
from the circuit board (you want maximum clearance between the knot and the circuit board). Failure to do this will cause the knot to snag on a component of the board as it moves up and down.

- The last step is to stretch the short tension cord (holding on to the remaining knotted end) straight down and fit it into the grove in the syringe slider. Let it snap hard into the groove (short tension cord mount), or make sure it seats fully. You can give it a little tug to make sure it's in.



Step 10 *(Replacing the black sheet metal cover and (5) screws)*

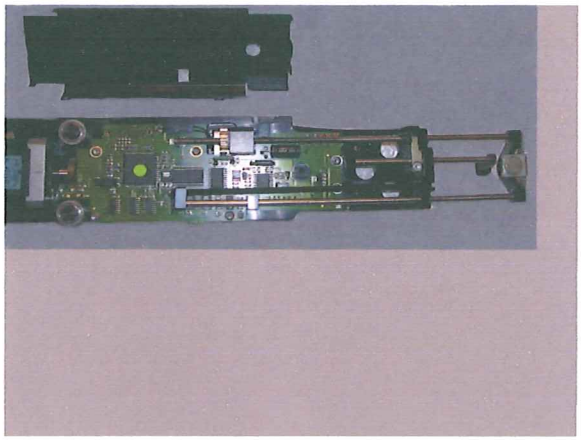
- At this point, you should be able to move the needle guide assembly up and down smoothly, and feel the tension the "short tension cord" gives the assembly.



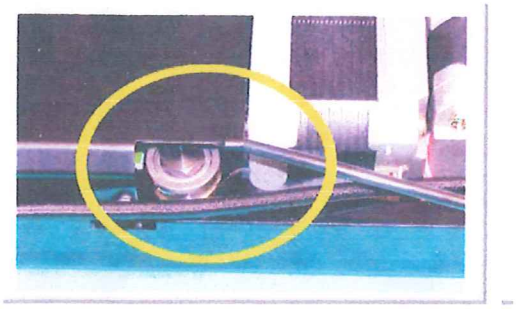
Things to check for before you close up the cover are:

✓ Smooth linear movement, no binding or roughness?

- ✓ Is the "end stop" tight and at 50.5mm measurement?
- ✓ Are the "stack drawer magnet" assembly screws tight?
- ✓ Is the "short tension" cord attached correctly, and is the knot rotated away from the circuit board?
- ✓ Does the Upper and Lower needle guide move and nest into each other evenly and without hesitation? If not adjust for a better fit.
- ✓ Are there any oil drips on the circuit board?
- Place the black sheet metal cover, back onto the circuit board area, being careful to fit the edges of the cover on correctly. If you have a Combi–PAL Injection unit, you will need to guide the gas tubing so as to allow it to exit the cover, protected by the cut-out tab on the cover.
- Start all (5) screws with washers into their respective holes, do not fully tighten until all are finger tight. Final tightening with the Torx-T8 wrench, being careful not to over tighten and strip the threads.



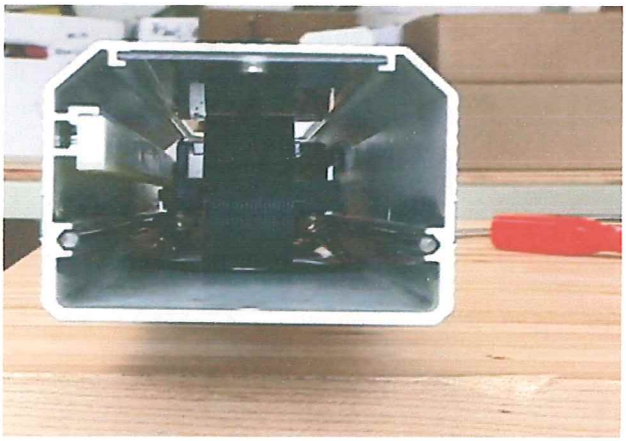
- Now the cover should be on and all (5) screws are tight and if applicable the gas tubing is routed through the circled tab area in the picture below (Gas tube-Combi-PAL only).



Step 11 *(Replacing the Long Tension cord, lube rollers and guides)*

- Remove the wide foam swab and the PAL grease container from the kit. Holding the swab wet the swab's foam body with the PAL grease. In this step you will be rubbing this wetted swab up and down the (2) steel rail rods inside the "Z Tube" housing. Inside the "Z Tube" housing you will see (2) embedded steel rods one each side of the inner wall. A matching set of bearing rollers on the "syringe slider assembly" fit into these steel rail rods, thus the "syringe slider" assembly can glide up and down (like a train on a track). Rubbing the grease over these (2) steel rail rods will clean them (never use a solvent on these rods) this rubbing action also re-applies fresh grease to the rods, you can also use a Kimwipe on a hemostat. You can angle the swab through the clear plastic door opening or at either end. Be careful not to break the small cylindrical magnet sensor embedded on one side.

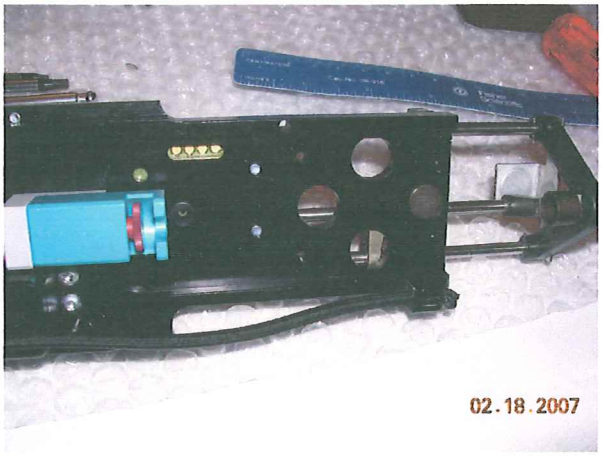
- You will most probably have to try all openings to adequately grease and clean the length of the entire (2) steel rail rods. This is a top view down into the "Z tube" from above, showing the two embedded rail rods.



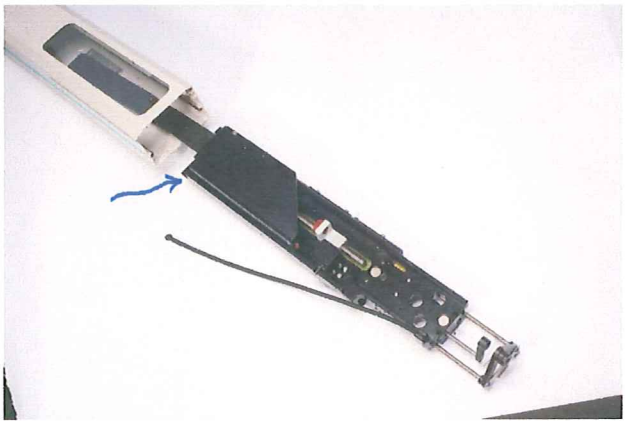
- You should see blackened residue on the swab when you are done, and fresh grease on the steel rail rods. Now do the same for the (4) round bearing rollers on the syringe slider assembly. Apply grease to the roller's curved surface, then with a Kimwipe or paper towel, wipe the grease off. The fresh grease will loosen the buildup (if there is buildup), then wipe it off (the curved surfaces must be free of black buildup). When the surface is clean, apply a final thin layer of fresh grease. Note: this is the only step when the grease is used, all other parts are lubricated with the Tri-Flow oil.

- Next remove the new "long tension cord" from the kit.
- Orient the Injection unit, so the clear plastic cover is facing up.
- Fit one end of the cord into the slit (long tension cord mount), at the end of the black "syringe slider" assembly. Now draw the cord's knot into the slit

area where it locks in place (you may remember removing the old cord). It should snap into place and be fully seated into the grooved area.

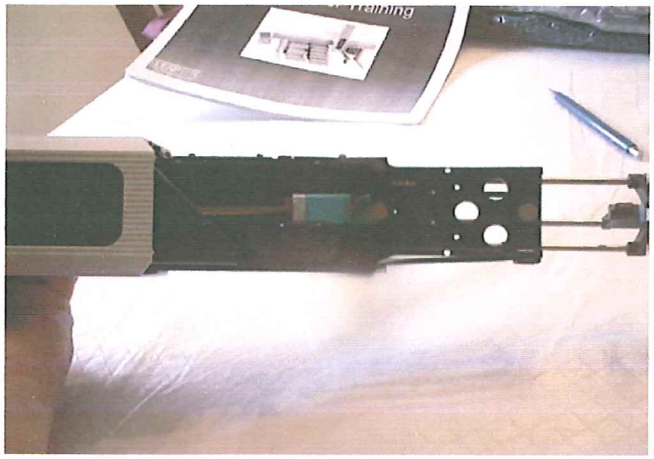


- Now stretch the cord straight across the "syringe slider" body. The end knot will fit into a special small notched area between the black sheet metal cover and the black "syringe slider" body end. The picture shows this spot by the blue arrow below.
- This is temporary position for the cord, securing it here while the assembly is being slid back together Later, you need to "fish out" this cord knot through the end of the "Z tube" and finally securing the knot into the "end cap's" slit grove.



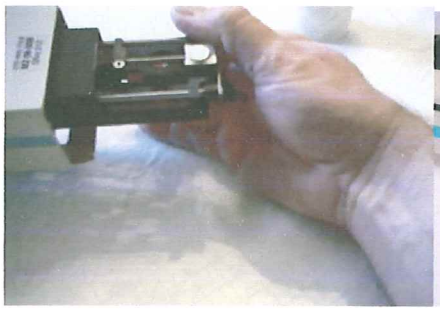
Step 12 *(Sliding the two assemblies into each other)*

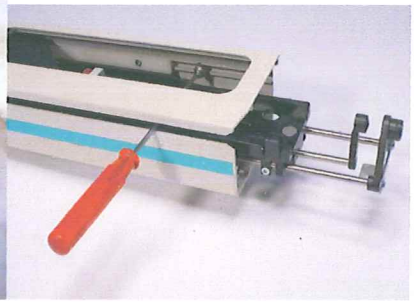
- With the long tension cord in it's temporary held position, gently lift the black "syringe slider" assembly slightly off the table. Line up the two upper "bearing rollers" with the two steel "rail rods" in the "Z tube". When they mate together, start to slide the black "syringe slider" assembly into the "Z tube", 4 inches down from the first set of rollers are the second set.



- Make sure the second set align and roll into the "Z tube" as well. As you slide the "syringe slider" assembly completely in, watch that the flat cable and gas tube (if equipped) move without jamming you can look through the end cap opening and verify the cable and tube (if equipped) are ok.

- If everything went well, you should be able to move the slider up and down inside the "Z tube" freely and without hesitation. If not, slide it out and investigate the problem.





- When you are moving it up and down you should hear the "Z" motor whirring quietly, this is normal.
- Retrieve the "slider stop" from where you have it sitting from a previous step. Orient it so the nut fits into a grove in the "Z tube". Slide the "slider stop" up to the previously marked (Sharpie) position. Remove from the kit the 2.5mm hex head wrench and tighten the stop into place. If you have lost the "Sharpie" mark, the correct position of the stop is when it halts the slider from going any further then the first round roller hanging halfway out (exposed) from the steel rail rods (see the Addendum "Injection Unit Front Zoomed View" for a view of the bearing rollers hanging half way out).

- Now with the "slider stop" tight and the "syringe slider" assembly fully pushed in, and looking at it through the "end cap" opening, locate the "long tension cord" end knot, from the temporary position. Using a hemostat or small forceps, clamp onto the knot and draw it out of the end opening of the "Z tube" (you may need to use a small flashlight). With your other hand grasp this knot and release the forceps.

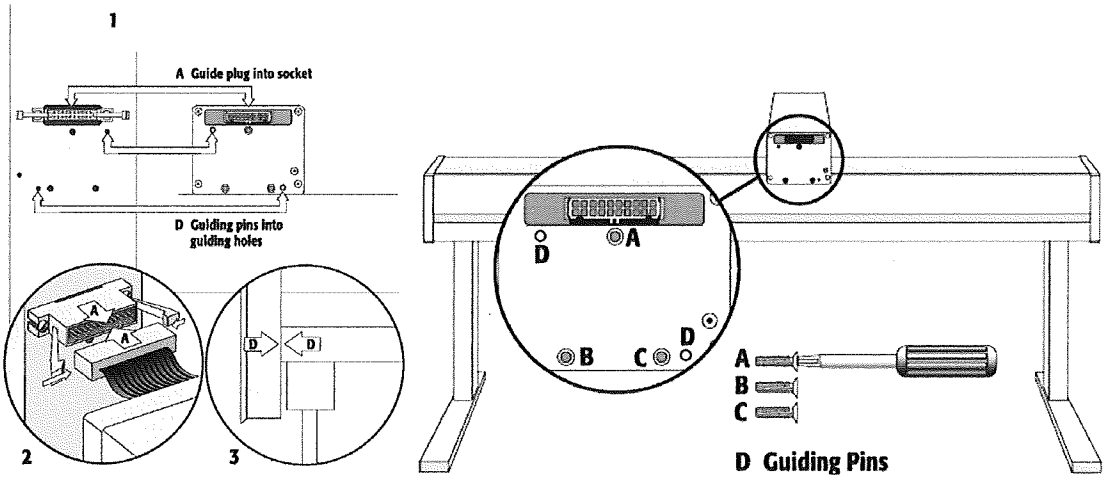
- Fit this knot into the "end cap's" slit. Then fit the end cap onto the end of the "Z tube", and insert the T-10 screw in and tighten.

- Now the assemblies are all fitted together and the new tension cords are in place. <u>The syringe slider should be able to slide out and back in freely. The lower needle guide assemblies should be able to nest into each other and snap back</u>.
- Orient the Injection Unit so the clear plastic cover points up. Slid open the cover, apply several drops of Tri-Flow oil to the narrow swab. Apply/dab the oil onto the plunger's large lead screw (it may have the plunger's red or blue adapter attached) See the Diagram or Addendum for a closer picture of the Plunger Lead Screw area. Move the plunger screw up and down and keep applying the oil until it moves freely. If you have black buildup on the threads, try to clean them with a narrow brush (like a toothbrush). When you have finished applying oil with the swab, wipe residual oil and buildup with a Kimwipe, making sure no oil drips below.

Step 13 *(Re-attaching the Injection unit to the PAL)*

- Depending on your model follow in reverse the Step 2 or 2A to re-attach the injection head to the "Y axis".

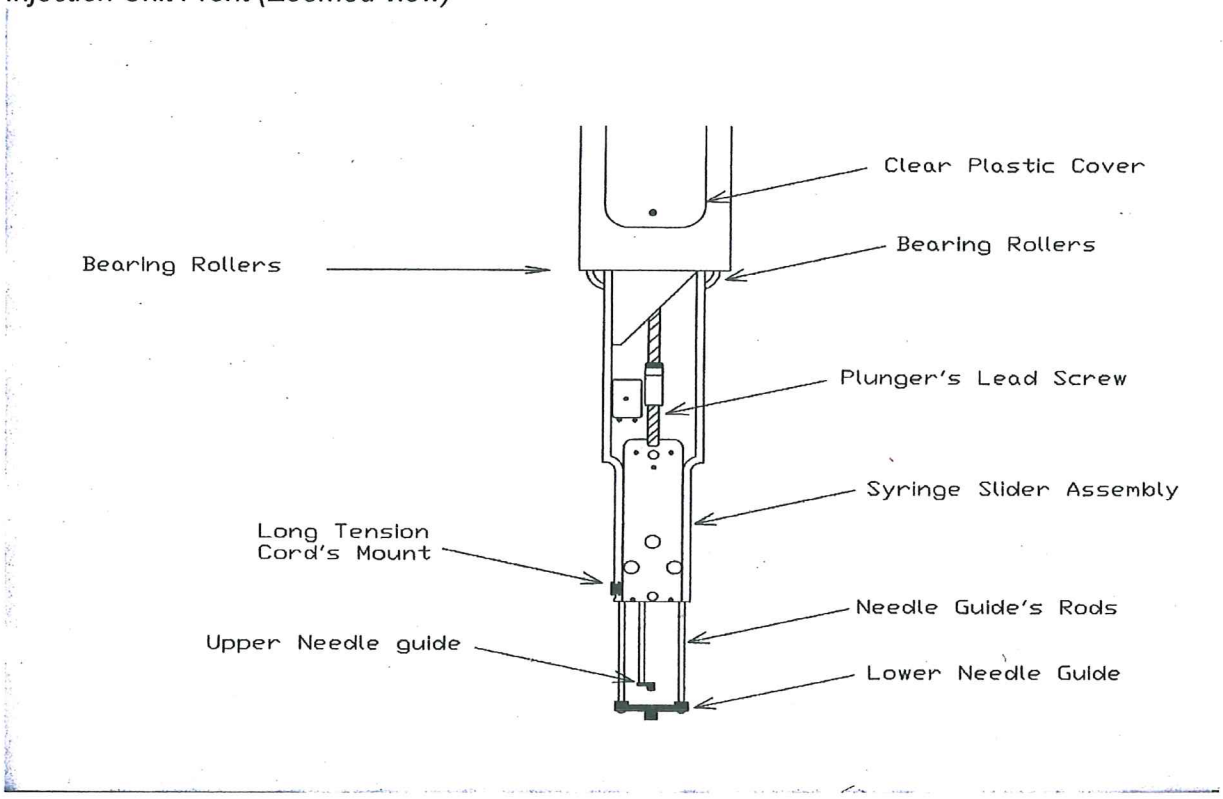
- After the Injection Unit is attached, verify the flat cable behind it gently rolls up and down as you pull the "Injection Unit" forward and backwards. Failure to get it to move evenly with the "injection unit' will cause a permanent bend in the flat cable that may cause other problems later on.



- Power up the PAL, and watch the "Initialization" process of the PAL. There should not be any errors. If you get a "Y axis" end switch error, it could be the cable has bunched up, not allowing the Injection unit to travel full backwards. Remove the Injection unit and re-attach, watching the flat cable's position.
- Re-teach all locations, objects and injection ports, wash stations, as a PM can cause the Injection Unit to be slightly in a different alignment.
- Dispose of the used parts in an appropriate manner.
- Clean up any grease smudges on the PAL.
- Backup the firmware memory again.
- Fill out any documentation/stickers your lab requires.
- End of procedure.

Addendum

Injection Unit Front (Zoomed view)



Injection Unit Back (Zoomed view)