COMPONENT SPECIFICATION

TITLE

Hybrid OSEM Assembly Specification

APPROVALS:	DATE	REV	DCN NO	BY	CHK	DCC	DATE
DRAWN: J. Romie	2-20-03						
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1.0 Scope

This specification covers the assembly of the **Mode Cleaner Coil Assembly, D020225** and the **Recycling Mirror Coil Assembly, D030073**, used in the Advanced LIGO suspensions. Sensor/actuator head assemblies are commonly called osems, which is an abbreviation for Optical Shadow sensor and Magnetic actuator. The assembly is broken up into two main sections: the assembly of the sensor/actuator and coil, detailed in D030105, Hybrid OSEM Assembly, and then the assembly of the accompanying brackets and screws around the former assembly, detailed on the top assembly, D020225, Mode Cleaner Coil Assembly and D030073, Recycling Mirror Coil Assembly

2.0 Parts Lists

See parts lists of the following top assemblies:
D020225: Mode Cleaner Coil Assembly
D030073: Recycling Mirror Coil Assembly
under both of which is the assembly of the sensor/actuator and the coil:
D030105, Hybrid OSEM Assembly
E030094, Hybrid OSEM Testing Specification

3.0 Fabrication of Coil Former

The head/former drawing details the dimensional requirements for the head along with the radii requirements.

3.1 Part Number
D020188: Coil Former

3.2 Fabrication Specifications
The formers need to be fabricated in a clean environment. Raw material or work-in-progress must be protected from the shop atmosphere when not being handled or worked on by plastic sheets or similar protective covers. Polyethylene plastic sheet is acceptable. All machining fluids (if applicable) shall be water soluble and free of sulfur, chlorine and silicone.

The radiused inside and outside corners are important for the reliability of the final assembly. These radii requirements will require extra machining/processing steps and potential vendors should be made aware of these requirements during the RFQ process.

The parts will be cleaned in an ultrasonic tank with hot detergent and then rinsed thoroughly with DI water. This step should remove any oil, wax, dye and general handling marks. An inspection of the parts after cleaning will be performed to assure the cleanliness of the parts.

3.3 Head Fabrication Inspection
When the formers come back from the vendor, inspect the parts for dimensional acceptance. Check that the corner radii comply with the callouts on the drawing. Make sure that all burrs and sharp edges have been removed. Check the integrity of the #4-40 threads. Reject parts if these requirements are not met.

3.4 Part Identification
Part and serial number identification will be accomplished by laser marking or etching the parts. Part identification requirements are detailed in note 4 of the drawing. As an alternative, parts may be marked with a Dremel-like tool. Marking will not add any contamination to the parts.

3.5 Laser Marking Inspection
Inspect the part number identification. Be sure that the identification is legible and that the parts are clean.

4.0 Assembly of Magnet Coil

This part of the specification covers the coil winding and the first cleaning and baking procedure for the sensor/actuator assemblies, called the “hot bake.”

4.1 Sensor/Actuator Assembly Part Number
D030105: Hybrid OSEM Assembly

4.1 Coil Winding
Using the Kapton wire called out on the drawings, push the end of the wire into the groove in the former, going from the back of the former (where the three 4-40 threads are) to the coil groove. Wind the wire clockwise on the head 400 turns, looking from the back of the head (with the threaded holes) while wiping down the wire with an isopropynol-dampened clean wipe. Thread the end of the coil into the same groove in the former to the back of the head. Leave approx. 6” at the beginning of the coil and 6” at the end of the coil, measured from the back of the head, to allow for dressing of the wires. For identification purposes, tie a knot at the end of the “finish” coil wire (not the “start” wire.) Double check that the coil was wound clockwise, looking from the back. If, for some reason, the wire was wound counterclockwise, tie the knot in the start of the wire instead. This step is important as the knot will be used to identify which wire gets soldered to which pin in a later step. Secure the wires to the head with a rubber band or equivalent so that the coils will not unwind during inspection and shipment.

4.2 Coil Winding Inspection
Inspect the coils. Check that the wires are uniform. Perform a short test and document on the Test Data form, attached. Using a digital multimeter (DVM), measure the coil resistance and inductance. The inductance should be measured at 1 kHz. Measure the coil-body resistance by attaching one probe to the end of the coil wire while

putting the other probe up against the body of the former. Check the coil-body resistance again using the start of the coil. Note resistance and inductance levels. Note data on form in Appendix. Perform a visual inspection to make sure coil wire is not cut, abraded or in a position to be cut or abraded.

4.3 Coil Wire Strain Relief
Mix Ceramabond per instructions on containers. Apply a small dab of Ceramabond to wires in the coil groove. This will secure the coil wires and assure that they do not move or unwind during handling and shipment. Then position the wires such that they fall inside the groove on the back surface of the former. Twist the wires 3-4 times. Apply a small dab of adhesive to secure these wires in the groove. Take care to make sure the Ceramabond is flush to the back surface so as not to bother the mounting of the brackets. Secure the wires to the OD of the heads. Air dry Ceramabond at room temperature for 24 hours or air bake at 200 deg. F for 3 hours. Perform tests as detailed in section 4.2

4.4 Test and Strip Wires
Strip the ends of the coil wire using the magnet wire stripper made by The Eraser Company, model no. DCF1/ Item # AR4501. Put a loose knot in the “finish” end, to replace the one cut off. Using a multimeter, clamp a probe to each wire and check the resistance and inductance. Check coil-body resistance as detailed in section 4.2. Document this data using the head serial numbers, on the attached form.

4.5 Coil Hot Bake
Per LIGO-E960022, LIGO Vacuum Compatibility, Cleaning Methods and Qualification Procedures. Ultrasonic clean in methanol for 10 minutes. Soak in isopropyl alcohol for 10 minutes, agitating regularly. Bake in vacuum at 200 degrees C for 48 hours if the head is stainless and bake in vacuum at 120 degrees C for 48 hours if the head is aluminum.

5.0 Circuit Board Assembly

This part of the specification covers the fabrication and assembly of the circuit boards that are mounted in the sensor/actuator heads. There are two part numbers, one for board with the LED and one for the board with the photodiode. This part of the specification also covers the scribing of the air vent for the photodiode optical filter, fabrication of the filter spring clip, mounting of the clip and installation of the optical filter.

5.1 Circuit Board Part Numbers
D030107 Circuit Board Assembly, Hybrid, LED
which uses **D020146, Alumina Circuit Board for Controls OSEMS, LED**
D030106 Circuit Board Assembly, Hybrid, Photodiode
which uses **D020147, Alumina Circuit Board for Controls OSEMS, Photodiode**

5.2 Circuit Board Cleaning and Soldering
Clean boards by soaking in isopropyl alcohol for 10 minutes. Use latex gloves while handling these parts from this point in the process onward. Scrub the boards with an acid brush. Do the same with the LED and

photodiode. The photodiode boards are identified by “P” near the hole. That will be the only way that assembly personnel will be able to identify the boards after soldering as the components look alike.

Clamp a board into a PC vice. Position a device on the solder pads. Take care to center the lens of the device in the center of the hole in the board. Apply pressure to the back of the device, in the form of a tweezers, for example, to reduce the amount of solder under the pads. Or, use clips to secure the device to the board for soldering. Solder the device to the board. Solder under the pads will distort the perpendicularity of the device relative to the board and therefore distort its performance. Use the pressure on the device during the soldering operation to maintain perpendicularity of the device relative to the edges of the board.

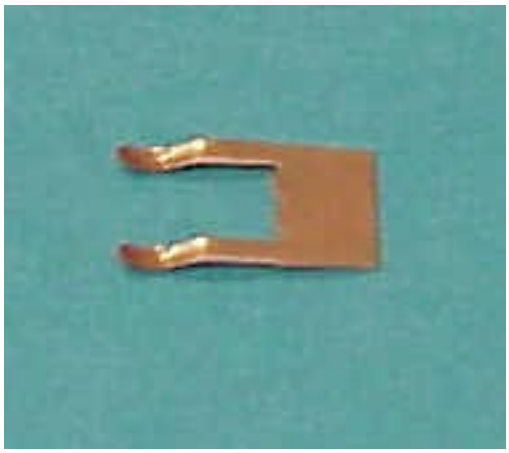
Strip one end of two pieces of 3.00” +/- .25” long Kapton wire using The Eraser Company’s magnet wire stripper. Solder the wires to the board. Strip only enough of the Kapton so that after soldering it to the board, no copper wire is exposed. This is critical as shorting may occur if wire is exposed. Use a minimal amount of solder on this joint as the parts won’t fit together with a large lump of solder.
Soak the assembled boards in isopropyl alcohol for 10 minutes. Carefully brush the boards clean. This step should remove most of the flux. Use another beaker of clean isopropyl alcohol for a final cleaning.

If shipping of the boards is required at any point, wrap them carefully in UHV foil, then wrap in a CP Stat bag. Mark the bags to indicate the board assembly part number.

5.3 Circuit Board Groove
Using a Dremel tool or diamond tip scribe, mark a line or groove .25” long from the hole in the photodiode boards towards the soldered wires. This groove is scribed into the side opposite the device. It is only needed on the photodiode board, D020147 (with the “P” marked on the opposite side.) This line may be very narrow and shallow as it is only used to allow air to escape from underneath the optical filter that is soldered on later. This operation may be performed prior to the processes described in 5.2 above.

5.4 Fabrication of Filter Spring Clip
The filter spring clip is a U shaped spring that holds the photodiode optical filter, D000209, onto the photodiode circuit board assembly, D030106. It is made from beryllium copper spring stock. The manufacturer is Tech-Etch Inc., 45 Aldrin Road, Plymouth, MA 02360, (508) 747-0300. Their web page is http://www.techetch.com. The spring stock part number is 60R-16-02 and comes 16” long. Clean the spring stock in a warm Liquinox solution and then rinse with DI water. Take care to rinse thoroughly with DI water. Ultrasonic clean in acetone for 5 minutes and then ultrasonic clean in methanol for 5 minutes.

Procure Photo-Etch Shears from MicroMark, 340 Snyder Avenue, Berkeley Heights, NJ 07922, (800) 225-1066. Their web page is http://www.micromark.com. The Photo-Etch Shears part number is 81308. Also procure their Smooth Jaw Clips, part number 14532, which will be used later. Use the shears to cut off 4 “fingers” at a time from the spring stock. Then, for each 4 finger section, use your fingers to bend the 2 middle fingers over at a 90 deg angle. Snap off the two middle fingers. See figure below.



5.5 Assembly of the Spring Clip to the Board
Mount a circuit board in a PC vice. Use clean tweezers to pick up the spring clip. Line up the spring clip with the solder pad. Position the spring clip so the “spoon” pressure on the fingers will apply pressure to and support the photodiode optical filter. Solder the clip to the board. Use the Smooth Jaw Clips to hold the spring clips to the board. Spray board with Deflux solution. Ultrasonic clean in Liquinox for 10 minutes. Rinse in DI water at least 3 times, changing rinse water every time. Ultrasonic clean in methanol for 10 minutes.

5.6 Cut Wires to Length
Cut the wires soldered to the boards to 1.00” +.25”/-.00”. Strip ends of the wires back by .1” using the magnet wire stripper listed above.

5.7 Screen LEDs
Screen the LED boards, D030107, using a fixture and a test photodiode board. Use an IR camera to view the LED output relative to the hole in the circuit board. Set aside the boards that have an obvious offset between the LED output and the hole and the ones whose LED axis is obviously skewed from the hole axis.

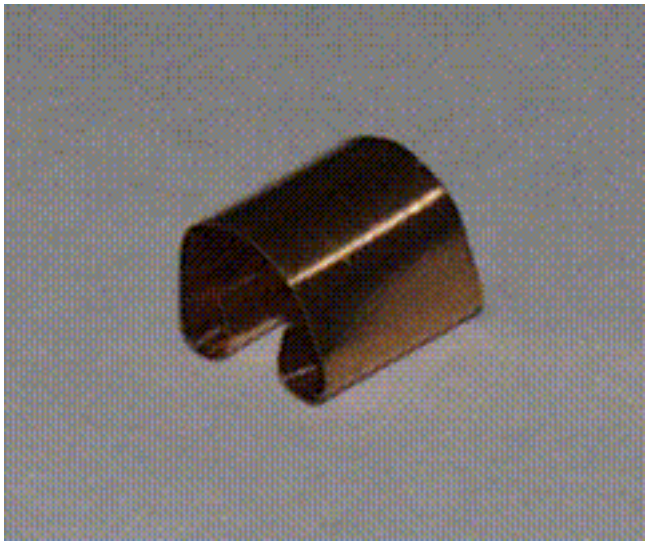
6.0 Sensor/Actuator Assembly

This part of the specification covers the fabrication of the retaining clip and the assembly of the circuit boards into the sensor/actuator head. It covers the testing of the assemblies. It also covers the fabrication of the pin plates and the photodiode optical filters. Sensor/actuator pigtails follow in Section 7.0.
From this point in the specification onward, all assembly steps must take place in a clean room, with personnel dressed in clean room garb and wearing approved gloves for handling UHV components.

6.1 Fabrication of Retaining Clip
The retaining clip is used to separate the two circuit boards in the sensor/actuator head. It is made from phosphor bronze spring stock. The stock material is .004” thick x 1” wide and 85’ long. It can be bought from

McMaster Carr, p/n 90545K11, spring tempered phosphor bronze coil.

Cut a strip of material, .25” x 3/4”. Using smooth nose (not knurled) needle nose pliers, curl the ends of the strip inward. Curl the ends inward so that the outside dimension is .25”



6.2 Mount Circuit Boards

Insert circuit boards into the sensor/actuator heads using a Teflon positioning device. Insert retaining clip to separate and support the boards. The retaining clip may be positioned so that it sits on top of the flat part of the filter spring clip. Try to align the boards well such that the boards are parallel to each other. Be sure the boards are positioned relative to the sensor/actuator head correctly, per the drawing. Use the #4-40 threads in the back for alignment. Put the head on a clean table, and push the boards so as to be flush to the back surface (with the threaded holes.)

6.3 Positioning the circuit boards with the test box
Use an IR video camera or equivalent to check that the LED works and that its light is pointed towards the photodiode. Twist knob on the test box to provide #3 readout. Test box instructions are detailed in LIGO-E030094. Adjust position of boards relative to each other to give a maximum value for the photodiode current. Only adjusts the boards fore and aft in the former, do not tilt relative to each other. If boards cannot be positioned to keep the photodiode current above 90 μA, switch out boards and try again. Follow the tests outlined in LIGO-E030094, section 3.1

6.4 Apply Ceramabond to boards
Procure Aremco Ceramabond. Follow the directions and prepare some Ceramabond. Using a dental tool apply Ceramabond to edges of circuit boards as shown on the top assembly drawings. While applying adhesive, keep wires attached to test box, showing the photodiode current, switch position #3, to make sure the circuit boards do not rotate relative to each other. Ceramabond will harden quickly so work quickly. Unhook wires from test box. Air dry at room temperature for 1 - 4 hours and then air bake at 200 deg. F for 2 hours.

6.5 Perform Pre-bake Testing
After the heads are cooled, perform a pre-bake test per E030094, section 3.2.

6.6 Pin Plate Assembly
The pins for the Sensor/Actuator Pin Plates, D970073, come from another connector, an Augat DIP socket, p/n 508-AG10D. They may be bought separately but generally have a substantial lead time (i.e. 21 weeks) and cost more. If they are bought with the DIP socket, they must be removed from the connector. It is best to carefully heat up the connector with a heat gun and pop out the pins. They may also be manually removed with pliers. Soak the pins with methylene chloride and then ultrasonically clean with methylene chloride to remove the particles of the plastic connector. Look under a microscope to make sure that any black residue from the connector is gone. Load up 6 pins into one pin plate with hand pressure. Use this pin plate as a stamper. Load up 6 more pins onto the ends of the stamper's pins. Use an arbor press to press the pins (with the stamper) into another pin plate.

6.7 Fabrication of the Photodiode Optical Filter
As the Photodiode Optical Filters, D000209, are fragile care must be taken while fabricating them. Procure the substrate material and then have it coated, per the information on the drawing. The coated glass then needs to be cut or diced. A silicon wafer fabrication facility can do this best. They should also be able to clean the parts afterward. The parts should be cleaned with Opticlean to remove any wax used to hold them down during cutting. They should then be ultrasonically cleaned with acetone to remove the Opticlean. Then, they should be ultrasonically cleaned in warm isopropyl alcohol. The cleaning operations should utilize stainless mesh catch basins to protect the filters from damage. Pack the filters for shipping in a single layer, separated by Kodak paper, with foam on either side, in a plastic box.

6.8 Solder Pin Plate to Wires
Insert the three Teflon OSEM Spacers, D030108, between the end of the head and the pin plate. Dummy metal

spacers may be used for this soldering operation and then replaced with the Teflon spacers, if desired. Attach the pin plates to the head with one #4-40 screw. Solder wires to pins on the pin plates per the top assembly drawings. On the drawing, the phrase “coil end” is used. The wire with the knot in it, whether it is the end (for a coil wound clockwise from the back) or the beginning (coil wound counterclockwise from the back) is the proper one to solder to the “coil end” pin. The wire without the knot is always soldered to the “coil start.”Use flux remover on the joints to clean the solder joints. Use care to keep the flux remover away from the rest of the sensor/actuator head assembly.

6.9 Assemble Hardware

Assemble the heads with Teflon washers. Use two more #4-40 vented screws to hold the assemblies together.

6.10 Final Cleaning and Bake

Per LIGO-E960022, LIGO Vacuum Compatibility, Cleaning Methods and Qualification Procedures. Ultrasonic clean in methanol for 10 minutes. Soak in isopropyl alcohol for 10 minutes, agitating regularly. Bake in vacuum at 80 deg. C for 48 hours.

6.11 Final Assembly

Slip the photodiode optical filter under the “spoons” of the filter spring clip. The filter’s front edge will not be flush with the front edge of the head. The front edge of the filter should extend about 1-2mm past the hole in the photodiode circuit board. Assemble the cleaned and baked pigtail, D990676, onto the head after the final bake of the head in the orientation shown on the top assembly drawings

6.12 Retest

Retest the assembled sensor/actuator assemblies, per E030094, section 3.2.

7.0 Pigtail Assembly Fabrication

This part of the specification covers the fabrication and assembly instructions for the pigtails.

7.1 Part Numbers

D990675 Sensor/Actuator Pigtail, Long

7.2 Pigtail Fabrication

Press the “D” pins into the Pigtail Rectangular Plate Detail, Item 2, D990675, such that the solder will face towards the angled holes, as shown. Cut 6 pieces of wire to length plus 2 inches. Insert 2 wires into each angled hole. Strip and tin each wire. Trim the tinned portion to about .03”. Neatly fill the “D” pin solder cups with solder. One by one, melt the solder and insert the correct wire into the solder at a right angle to the pin at the lowest point in the cup, as shown. Use a minimum amount of solder in all soldering operations. The wires should be pulled taut to remove any unwanted slack.

Twist each pair of wires about 5 twists per inch. Loosely braid the three pairs to the end. Don’t allow the pairs to untwist while braiding.

Remove the DIP pins from the connector as described in section 6.6. Press the pins into the Pigtail Pin Plate Detail, Item 1, D990675, per drawing using method described in section 6.6. Test the continuity of each pair to determine the origin in the rectangular plate. The pair that originates at pins 1&2 in the rectangular plate should be inserted into the strain relief hole that goes into pins 1&2 in the round plate, as shown. Repeat for the other pairs, as shown.

Cut each wire to the appropriate length for the pin to which it belongs. Strip each wire to about .12” and tin the bare wire. This tinned portion should encircle the appropriate pin and be soldered in place. Follow a neat wire dress procedure. Clean off solder flux.

8.0 Assembly of Brackets and Clamps

This part of the specification covers the assembly of the accompanying brackets, clamps and screws around the former assembly, detailed on the top assembly, D020225, Mode Cleaner Coil Assembly and D030073, Recycling Mirror Coil Assembly.

8.1 Coil Assembly Part Numbers:
D020225 Mode Cleaner Coil Assembly
D030073 Recycling Mirror Coil Assembly

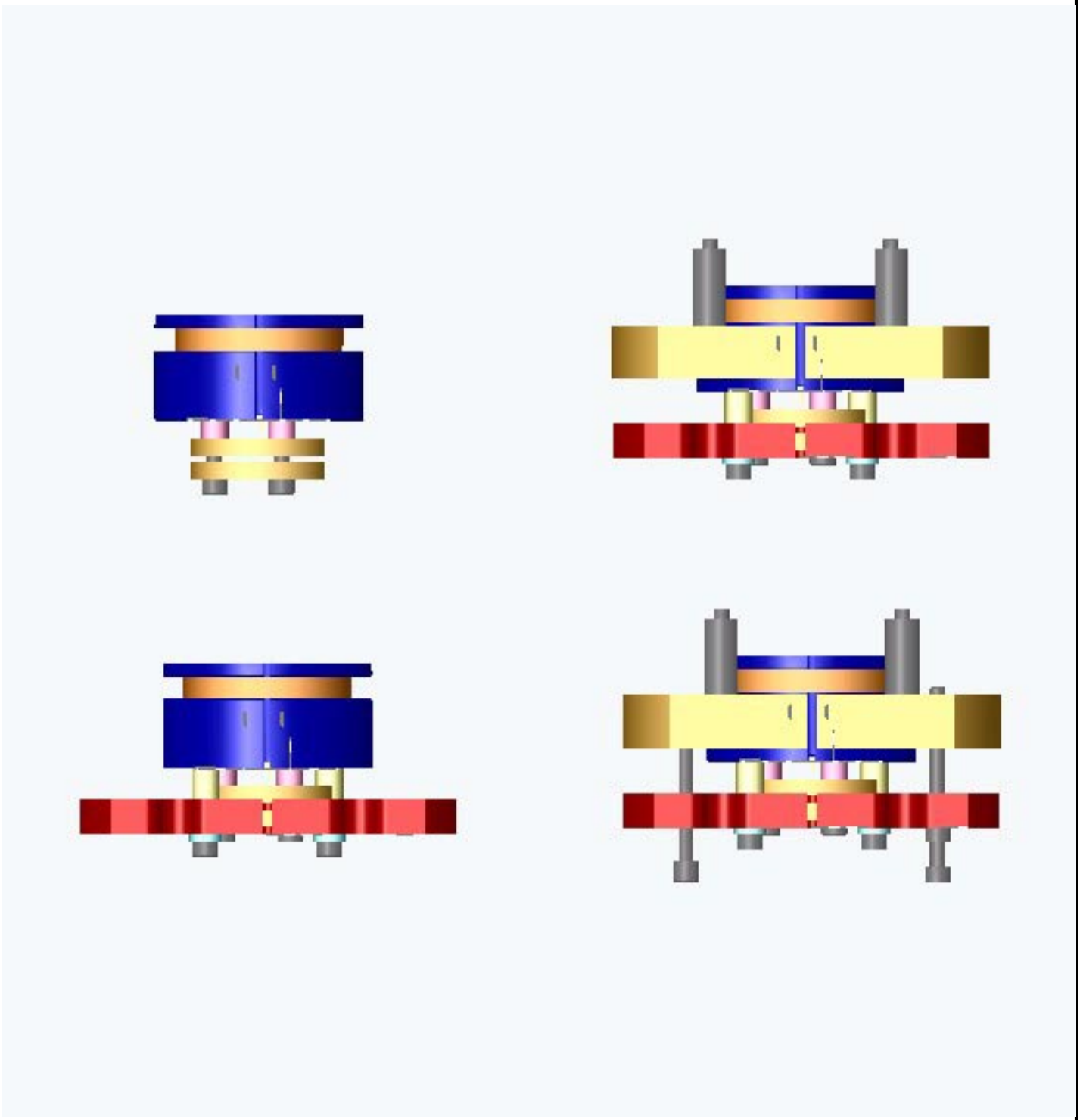
8.2 Assemble Brackets and Former
See Figure below. Each bracket and clamp has a slot. This slot may be opened with a large, levered, slotted screwdriver, if needed. The pigtail of the former assembly, D030105, must be moved through the slot of the Coil Former Bracket, D020282, before assembling the bracket onto the former assembly. Insert the Teflon Shoulders, D030122 and the Teflon Spacers, D030123, into and against the bracket and insert the proper silver plated 4-40 screws. Screw the bracket with its Teflon shoulders and spacers, into the former assembly, D030105. Make sure that all wires from the back of the former assembly are clear of the spacers. Using the screwdriver again, if needed, open the slot in one of the clamp and spacer assemblies. Move the assembly in place around the former assembly. Screw in the four silver plated 4-40 screws called out on the assembly to attach the bracket to the Coil Former Clamp, D030183. These screws allow for adjustment of the position of the former assembly during the suspension assembly process.

8.3 Perform Test
If these assemblies will not be used immediately, perform another suite of tests, as detailed in the test specification, E030094, and then wrap each assembly carefully in clean wipes and UV foil and then place them carefully in a CP Stat bag, or in a designated clean container.

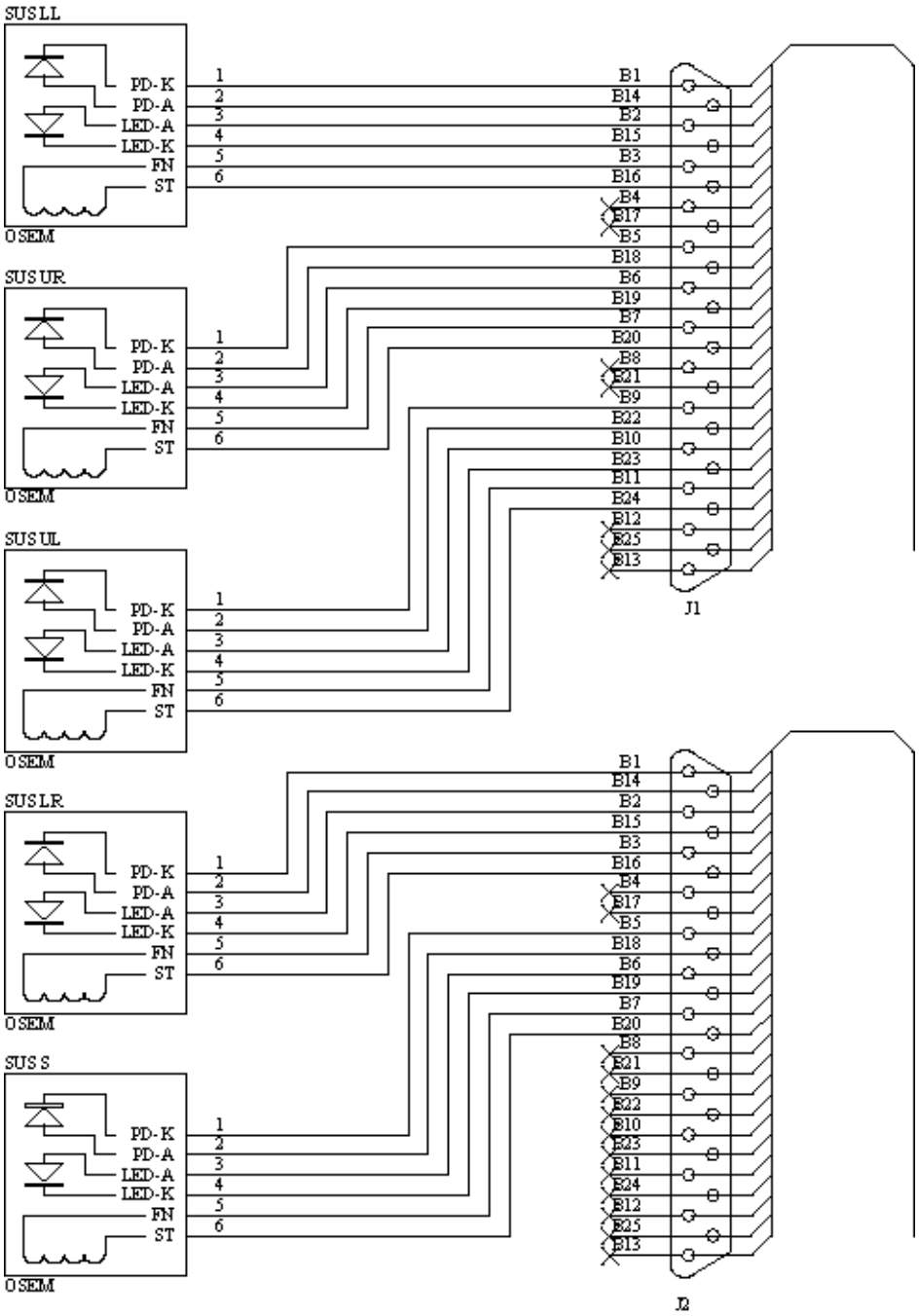
8.4 Installation Test
Prior to installation into a suspension assembly, retest the assemblies, per the tests detailed in the testing specification, E030094. Also perform the coil-body resistance tests detailed in section 4.2.

TITLE

Hybrid OSEM Assembly Specification



9.0 Appendix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Hybrid OSEM Test Data

Table 1:

Serial Number	doc. section	date	initials	LED current (ma)	PD current (μamp)	w/ filter	coil Ω	coil induct.	leakage current	coil end (#5)-body Ω[a]	coil start (#6)-body Ω[a]
	4.2			----------					-------		
	4.3			----------					-------		
	4.4			----------					-------		
	pre ship			----------					-------		
	post ship			----------					--------		
	pre 1st bake										
	post 1st bake										
	6.5										
	6.12										
	8.4										
	4.2			----------					--------		
	4.3			----------					--------		
	4.4			----------					--------		
	pre ship			----------					--------		
	post ship			----------					--------		
	pre 1st bake										
	post 1st bake										
	6.5										
	6.12										
	8.4										

a. there should be no continuity between coil (either wire) and the body