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Actuator and Electronics Card Troubleshooting

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The single axis units (one cylinder) provide force parallel to the optical axis of the mirror. The dual axis units have two cylinders, one providing force parallel to the optical axis of the mirror and one providing force at a 45° angle. The forces achieved by the dual actuators are combined.

There are two voltage controlled pressure regulators that provide pressure to each side of the cylinder allowing for compression and tension forces (push/pull for each cylinder). To provide a zero force command, an equal bias pressure is applied by both pressure regulators. All regulators have a pressure relief valve (pop off) to prevent excessive force being applied to the mirror.

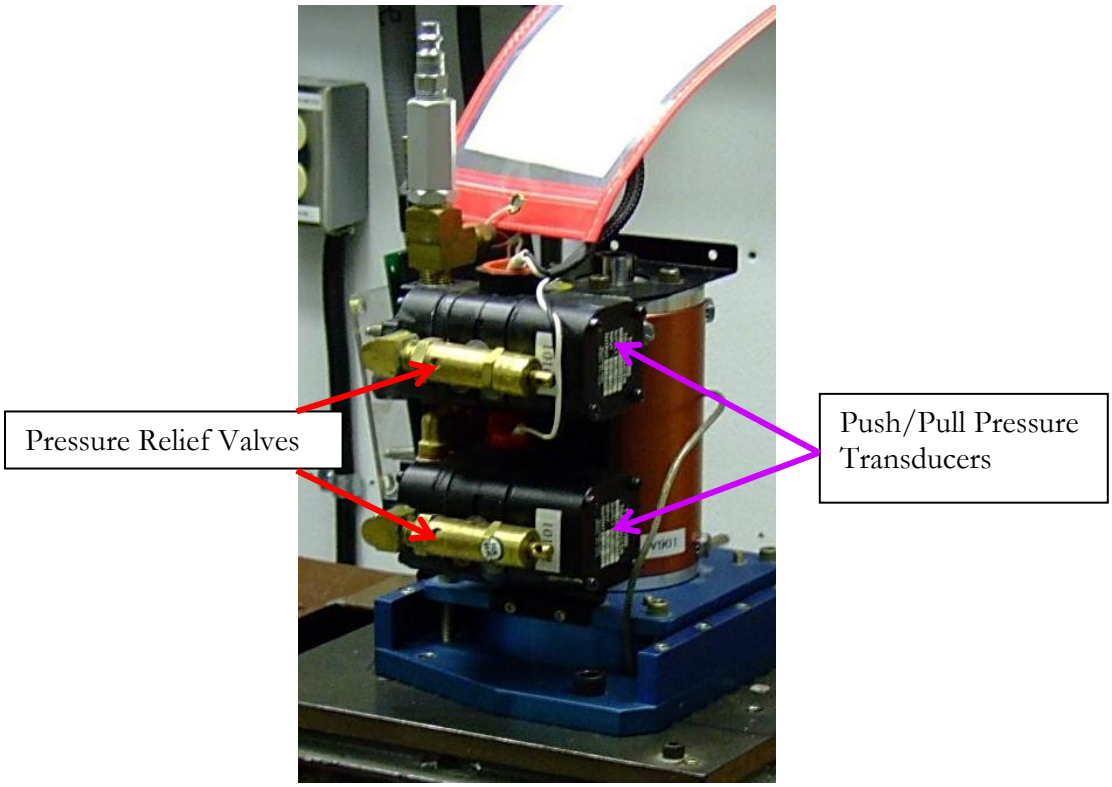


Figure 1

A problem that may arise concerns the pressure relief valves. The relief valves are rated at 100 psi for the regular single actuators and 60 psi for the special (those positioned near the outer diameter of the mirror) single actuators. The actuators being tested have to go through a series of force tests to ensure the actuator is reliable up to its rated pressure level. If an individual relief valve opens to release the air at a pressure below its rated pressure, further assessment is required to ensure the valve is still in good working order.

A valve tester should be set up to manually check the pressure at which the valves will open. To get started on building a tester, gather a pressure transducer, a power supply, black / red leads, an air tank with the proper air fitting, a pressure gauge, and a voltmeter.

- Set up a stand that holds a good spare transducer (vice stand).

- Have a power supply close by with red and black leads connected and set up to reach 10V. Attach the voltmeter to the power supply in parallel to adjust the voltage accurately.

- The air supply nozzle must be connected to the IN port on the transducer.

- Affix the air to an air hose and the IN port of the transducer.

- Attach a pressure gauge to the port labeled OUTPUT (Note: It is important to have a very accurate pressure gauge).

- There are two auxiliary output ports. One port should be blocked off with a plug and the other port is where the pressure relief valve will be attached and checked.

- Keep the power supply at 0V, and off. Connect the positive red lead to the BLACK WIRE of the transducer and the negative black lead to the WHITE WIRE on the transducer.

- Make sure the air on the source tank is off and attach the nozzle to the transducer.

- Remove the seemingly faulty relief valve from the actuator.

- Attach the relief valve to your test setup.

- Turn the air on.

- Turn the power supply on.

- Slowly increase the voltage on the supply. As the voltage increases the pressure will also increase and can be seen on the gauge (the transducers are rated 0V-10V for 5psi – 120psi). Record the voltage at which the valve releases and the pressure the valve reaches.

- If the release of pressure is either well below or well above the rated pressure, the valve needs to be replaced. If the valve is working but still releases air before the actuator gets to its rated force, write down the maximum air pressure achieved before the pressure releases from the valves.

Transducer Check

- Leave the transducer on the actuator on the teststand for this process. To check the transducers and ensure they are in proper working order, begin by detaching the valve connector (JP2 for single only, JP2 and JP3 for Dual) on the electronics card while the actuator is still on the teststand.

- Identify the side of the cylinder you are checking: the push transducer or the pull transducer. Remove the pressure relief valve from the transducer.

- Put a precision pressure gauge in place of the pressure relief valve on the transducer.

- **FOR PULL TRANSDUCER**: Attach the red (positive lead) to pin 1 on JP2, and the black (negative lead) to pin 2 on JP2 connector.

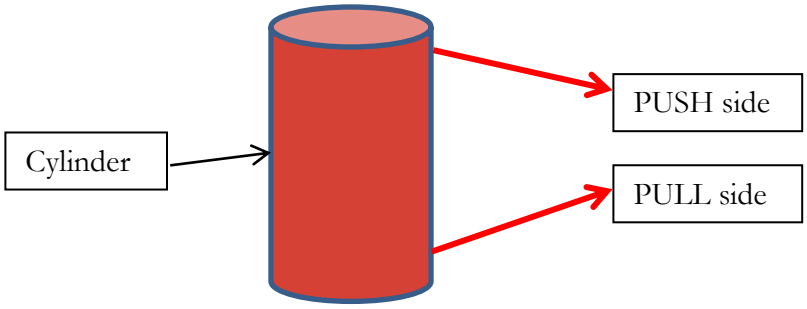
- **FOR PUSH TRANSDUCER:** Attach the red (positive lead) to pin 3 on JP2 and the black (negative lead) to pin 4 on JP2 connector.

- **FOR DUAL ACTUATOR:** On JP3 connector, pull transducer pins, pin 1 (+) & pin 2 (-) and push transducer, pin 3 (+) & pin 4 (-)

- Connect the air to the actuator.

- Have the power supply switched on and ready at 0V.

  Adjust the power supply very slowly to reach max 10V and record the pressure on the gauge attached to the transducer. If the gauge reads nearly 120 psi, the transducer is working fine. The transducer may read lower than 120 psi. If lower than 90 psi, the transducer needs to be replaced and then checked or re-calibrated.



While the actuator is still on the teststand, assess if problems other than pressure relief valve issues are occurring with the actuator.

If there is a problem with an actuator in the cell, the actuator should be removed and mounted on the teststand.

If the teststand calibration trials fail, the electronics card can be checked for a few obvious problems while still mounted on the teststand. Here are steps to take in the event that the **actuator does not respond at all**:

- At the electronics card, verify 48VDC is present (Connector *JP1: pin1 = +48V, pin2 = -48V*). If not, check the fuse at the sector distribution box and replace if open. **If voltage IS present, proceed with next set of instructions. If no voltage is present, REMOVE card.**

- Verify the DC-DC converter is outputting +/-15VDC (*U14 pin 3 = +15V, pin 5 = -15V*). If the voltage is not present, the converter has failed (or output has been shorted - check to make sure the output has not been shorted). **If voltage IS present, proceed with next set of instructions. If no voltage is present, REMOVE card.**

- At the electronics card, verify that a DAC command is present. The DAC signal (analog voltage) into the card is on *JP1 at pins 5 & 6* for single actuators and *Pins 5 & 6 and 11 & 12* for dual actuators. Verify the voltage on JP1 to see DAC information. **If voltage IS present, proceed with next set of instructions. If no voltage is present, REMOVE card.**

- If there is no signal to the card, there may be an issue with the output at the DAC card in the cell crate, or a continuity issue in the cabling. This will be of primary concern when the actuator is still in the cell. If there is no DAC command while actuator is in place, if possible switch cable connections with the next closest actuator and run a bump test to see if that actuator now has the same issues. If so, the problems exist at the cell crate. The next step would be to inspect the DAC by troubleshooting the computer.

- At the electronics card, verify the load cell feedback is present (*#1 FMON (pin 10) and #0 FMON (pin 7) on connector JP1*) while the system is on and a force command is given. If no feedback is present, check load cell cables and connections. **If voltage IS present, proceed with next set of instructions. If no voltage is present, REMOVE card.**

- If there is a problem with the load cell cable (i.e. it is cut or shorted) the output of U17 *(Pin 6 of U17)* will be railed to maximum voltage (approx. 11V). **If the voltage is railed, remove card and begin to inspect and/or remove load cell.**

NEXT STEP: If none of these obvious conditions are the problem, the next step is to **remove the electronics card** from the actuator and perform the following checks and inspections at a bench:

- Have a power supply and leads ready, set up to +48V. If you have a standard power supply, set it to its max +/- output (not exceeding 48V). (Note: dc-dc converters are wide-input range, so 18-72V will work if a 48V supply is unavailable.)

- Attach shorting plugs where shown in Figures 2 & 3 (if card is from a dual actuator you will need the extra shorting plug). NOTE: Shorts at connectors JP4 and JP5 need to be grounded.

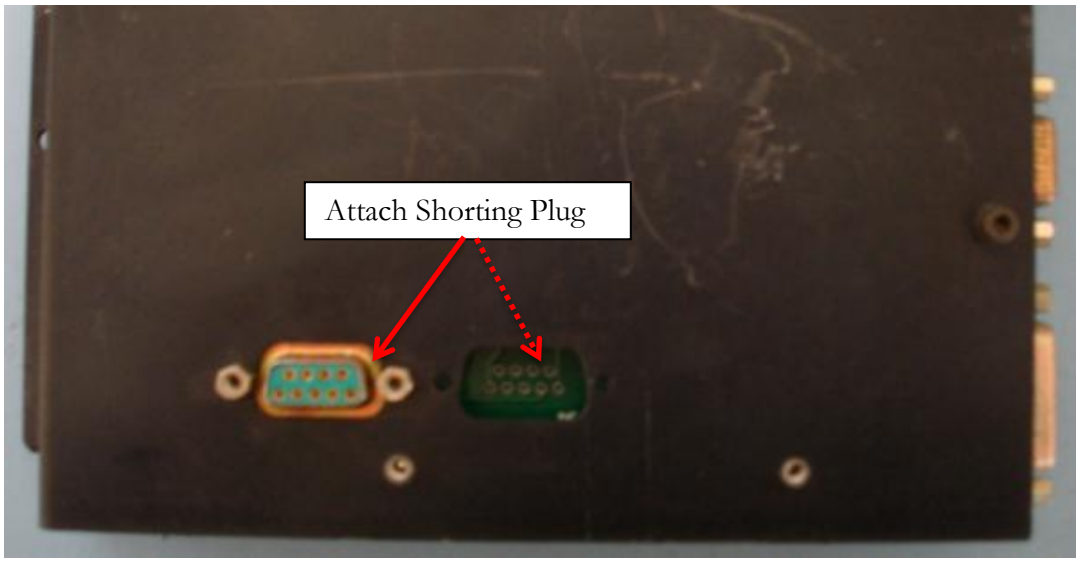


Figure 2: Shorting Plug Attachments for JP4 (dual) and JP5 (single)

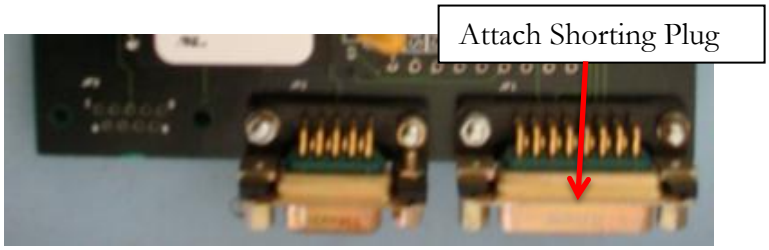


Figure 3: Shorting Plug Attachment for JP1

- Attach JP1 shorting plug to power supply (+V) and connect the ground *(Pin 1 on JP6 for both cards)* as shown in Figure 4. This ground may be used wherever a ground is needed.

- Have the load cell duplicate ready (used only for single actuator electronics cards)

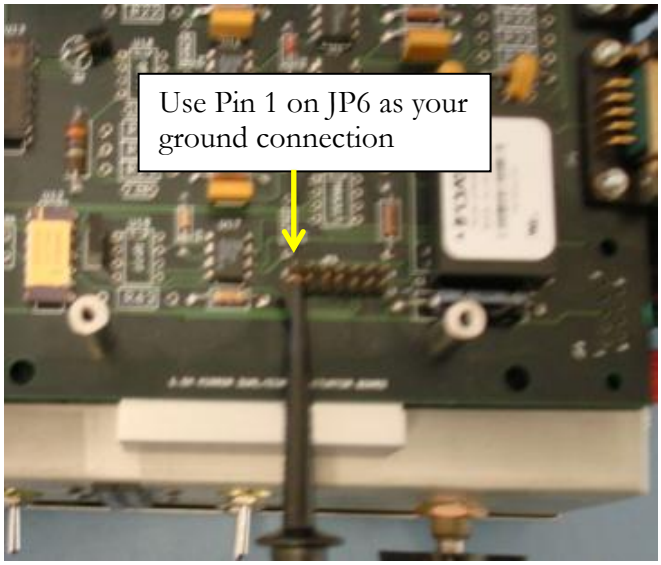


Figure 4: Ground Connection

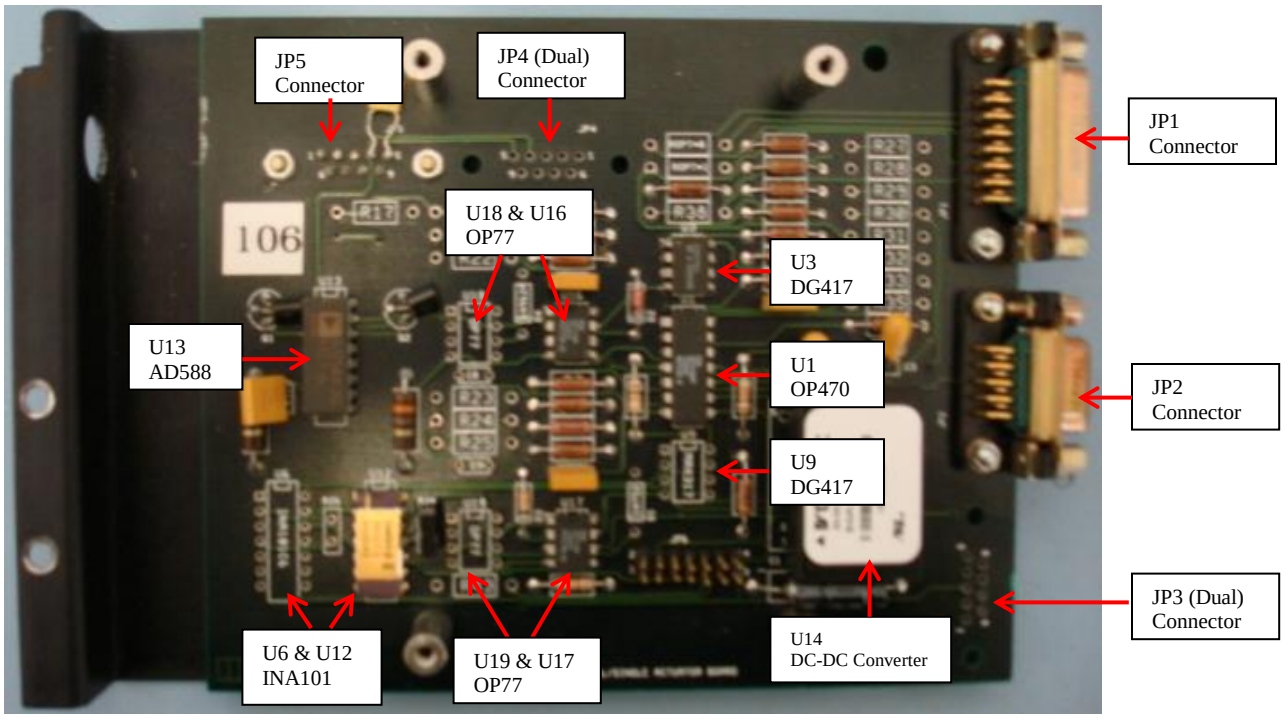


Figure 5: Single Actuator Electronics Card

- Verify the power supply voltage is present (Connector *JP1: pin1 = +48V, pin2 = GND*).

- Verify the DC-DC converter is outputting +/-15VDC (*U14 pin 3 = +15V, pin 5 = -15V*). If the voltage is not present the converter has failed (or the output has been shorted - check to make sure it isn't shorted). Check capacitors C1, C2 and C3. Remove the capacitor and put on a tester; if one fails, replace capacitor.

- **INA101** Verify U6 (single) and U12 (Dual) are functioning properly. *Check pin #1 on U6 and U12* to verify the output voltage and record it (it should be approximately zero). If the voltage is obviously erroneous, replace the INA101.

- **NOTE: U6 and U12 are instrumentation amplifiers that have a gain determined by the value of a resistor. The equation G=1+ 40k/R_g will assign the op amp gain, therefore, the output voltage pre-gain can be determined by dividing the recorded output voltage by the gain calculated. The gain value for U6 and U12 is approximately 500. The calculated voltage should be very close to zero.**

- **DG417** is the precision analog switch used to enable and disable the integrator. Verify the integrator lockout signals are present. The signal will be *Pin 1 & Pin 8 of U3 (single) and U9 (dual)*. The voltage at this output is very important for a proper working electronics card. If the chip is bad (shorted or open), the integrator will never function properly. With the system powered and the chip in place the outputs should be open. The voltage on the output should be the same on pin 1 and pin 8. If the output reads more than 3V, this is a strong indication the chip is internally shorted; replace the DG417.

- Jump *Pin 5 and Pin 6* to each other to power up the DG417. Once the chip receives 5V to the input (*Pin 6*) the switch will then close and the outputs change. Pin 1 should then read zero and Pin 8 should read "voltage changing" as the integrator ramps up. If this does not happen, replace the DG417.

- **OP77** provides the output voltage to the valves which control the pressure on the double acting cylinders, increasing or decreasing the force on the actuator. The proper function of these IC's is very important. Check and record the input / output voltages at *Pins 2, 3 (in) & 6 (out)* under the conditions required.

- **OP470** receives the voltage commands from the DAC through *Pins 2&3* (single) and Pins *11&12* (dual). The signal is then sent as a force command / error signal on *Pin 6 & 13* and is continuously being integrated. Output voltages are sent through *Pin 7 & 14* to the valve control circuits. With the shorting plug attached, there should be zero voltage at the inputs.

- **AD588** is a precision voltage reference set to provide a precise +/- 5V. Verify that *Pin 3 & 13* have +/- 5V. If not, check *Pin 1&15* (the base of the transistors) and the emitters to eliminate possible transistor failure. If the transistors are working fine, replace the AD588.

- Verify the operation of the air pressure regulators and make sure air is attached properly and air is on.

- If there is a problem with an actuator passing the bump test or if the actuator is very slow to respond when given a set force, check the regulator for insufficient air pass. There is a removable orifice on the transducer that should be taken out and checked for contamination and cleaned. If the condition is such that a new transducer is put in place and the actuator works fine, dispose of the old clogged transducer.

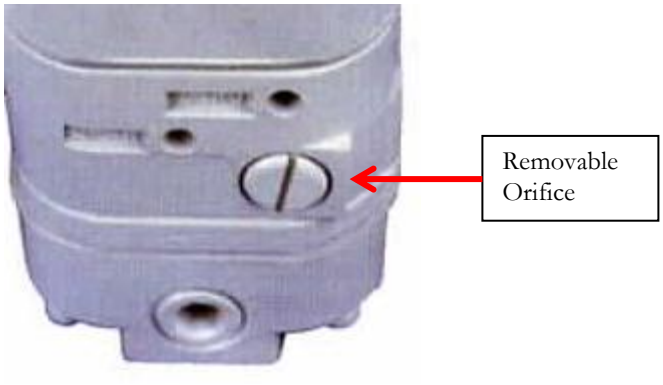


Figure 6: Transducer

- If the transducer is plugged in any way the actuator will try to compensate for air on the opposite end and may result in problems. It is imperative that a skilled or authorized person make any changes to the transducers. They are very sensitive and removing the orifice can also result in degraded operation.

Actuator is slow to respond

- Verify the integrator lockout signal is present on the electronics card. To do this, check the voltage at DG417 *Pin 1 and Pin 8 on U3 (single only) and U3 and U9 (dual)*. This is a switch that should be in the off position unless excited, in which case the switch opens and the output changes. If the switch is internally shorted, the chip will show the switch closed yet there is a voltage on the output of +5V – +8V. If you see this, replace the DG417.

- Verify the operation of the pressure regulators.

Actuator is out of control

- Verify the +/-15VDC (*U14 pin 3 = +15V, pin 5 = -15V*).

- Verify U6 and U12 are functioning properly (see above).

- Verify the excitation voltage on the load cell.

- Use a multimeter on the ohm setting and check the resistance at the load cell connectors.

- Verify the load cell connections at JP4 and JP5. Remove the back shells of the connectors and make sure the pins and wires are attached correctly and in place by giving them a little tug. If needed, remove the pins and visually inspect them or re-pin (or re-solder or re-crimp) them.

- Verify the DAC command is present at the electronics card. If not, check the DAC output in the computer chassis.

Teststand Trouble shooting

If any problems are deemed to be caused by the teststand, it will most likely be due to a hardware failure with the electronics or computer system. Here are a few inspections that can be done to investigate:

- If an actuator does not respond to a commanded force, check the 'Readback' field of the teststand interface. If it is reasonable for the force commanded, the commanded voltage may not be getting to the actuator. Check with a voltmeter on the teststand. If the expected voltage is present at the connector, then the actuator electronics card will need to be diagnosed.

- If a load cell seems to be reading abnormally low given the commanded force, check the voltage with a voltmeter at the output of the amplifier.

- Strange readings on the actuator may be the result of the stand itself being set for a dual actuator when it is testing a single actuator, or vice versa.

- Always first investigate and rule out the actuator; this will verify that it is absolutely an issue with the teststand.