Mass Flow Controller Troubleshooting Suggestions
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Scribner Associates, Inc.

This document describes troubleshooting steps for the 890 and 850 families of fuel cell test systems. Much of this is applicable to older 890 and 890B models. This document assumes that MKS type 1179A or M100B mass flow controllers are used with standard straight-through cables from the interface board. If another type of mass flow controller is used, there will be a custom cable assembly and the voltage measurements described below need to be made from the interface board by unplugging the cable from that end. If MKS controllers are used, the cable should be unplugged from the mass flow controller end as described so the cable is also tested.

CAUTION:
The 890 interface box and the 850 chassis both contain hazardous voltages. These operations should only be performed by qualified service personnel.

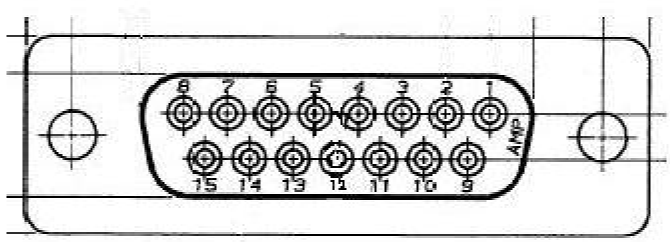
1. Remove the 15-pin connectors from the anode and cathode mass flow controllers. Ensure that the gas supplies to the test station are turned off.

2. Turn on the instrument and fuel system power. Start the FuelCell software. Enter the 'File>Instrument Configuration' menu. Enter the instrument's serial number when prompted. Click the 'Fuel Configuration' tab. Ensure that the settings are as follows for Anode and Cathode: Fuel Flow Control Type - Gas/Mass Flow Controller. Full Flow of Controller (Liters/Minute) - these should be set to the flow ratings of the anode and cathode mass flow controllers, respectively. Purge Gas flows through Mass Flow Controller - checked. If any of these settings are not as described, change them and click 'OK', 'Yes, save the new settings', and 'OK'. Close the FuelCell software. Otherwise, click 'cancel' to exit the menu.

3. Enter the 'Setup Fuel' menu. Select the 'Fixed' buttons for the Anode and Cathode Flow Control Method. For the 'Flow (l/min)' boxes, enter 50% of the full scale rating of the anode and cathode mass flow controllers, respectively. Click 'OK'.

4. Using a voltmeter, make the following measurement on the plug that normally attaches to the Anode mass flow controller connector:

Pin 8 to pin 12: 2.490 to 2.510 volts



15-pin Connector Used for Mass Flow Controllers

If this voltage is not present, remove the J105 connector from the back of the instrument. Probe the contacts for pin 4 (+) and pin 5 (-) with a voltmeter (890C/890CL). Probe pin 3 (+) and 20 (-) of J105 for 890e/890ZV. If the voltage is present between 2.490 to 2.510 volts, the problem is within the fuel system wiring, so troubleshooting can be performed between J105 and the mass flow controller connector with an ohmmeter and visual inspection. If the voltage is not in the range of 2.490 to 2.510 volts, perform the following test to see if the FuelCell software is the problem:

Close the FuelCell software and cycle the instrument power. Start the National Instruments NI-488.2 GPIB Explorer window from the Start menu. Select the GPIB0 board symbol and right-click to Scan for Instruments. When the instrument appears in the right-hand window, click on it and right-click to select Communicate with Instrument. The Communicator window should appear. Enter 'SF A 2.500 000' in the command field and click 'Write' (substitute 'C' for 'A' when testing cathode). Ensure that no red text appears in this window.

Measure the voltage from pin 8 to pin 12 again. If it is not between 2.490 to 2.510 volts, then the instrument requires factory servicing.

4. Using a voltmeter, make the following measurements on the plug that normally attaches to the Anode mass flow controller connector:

Pin 7 to pin 5: 14.5 to 15.5 volts
Pin 6 to pin 5: -14.5 to -15.5 volts

If either of these voltage levels are not present, there is a problem with the mass flow controller wiring or power supply within the fuel system. This can be diagnosed by measuring the voltage produced by the fuel system's power supply and by visual inspection of the connections.

5. Repeat step 4 for the Cathode mass flow controller.

6. If all electrical measurements look good at this point, either the mass flow controller is defective or there is not a pressure differential required for proper operation on the gas inlet and outlet.

7. If the response of the MFC appears too slow, too fast, or irregular, the control and readback signals can be monitored with an oscilloscope. Figure 2 below shows typical response for a 0 to 25% full scale step control input (0V to 1.25V) for a new 5 SLPM rated MKS M100B. For this model, MKS specifies settling time to be no more than 2 seconds for a change from 0 to anything from 25% to 100% of full scale settled within 2% of final value. The control signal should cycle between 0 and 1.25V for 3-5 seconds at each value and the reading should be taken after a few cycles. As seen in Figure 2, the MFC required about 1.2-1.6 seconds to reach 98% of the final value, so it is performing according to MKS specifications. Note that for a step change from 0 to less than 25% of full scale, the response time of the MFC increases significantly as flow is reduced and is strongly dependent on

previous settings. Also, note that the control range for the M100B is only specified down to 2% of full scale, so attempting to set flows below this value may have unpredictable results.

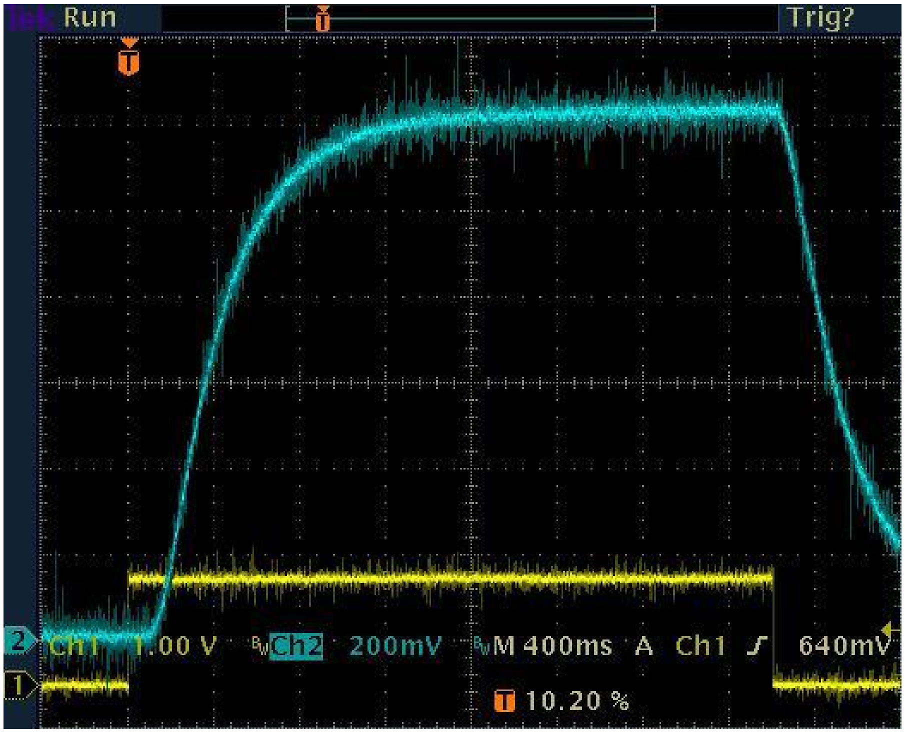


Figure 2 – Typical MFC Response (control signal in yellow, flow read in blue)