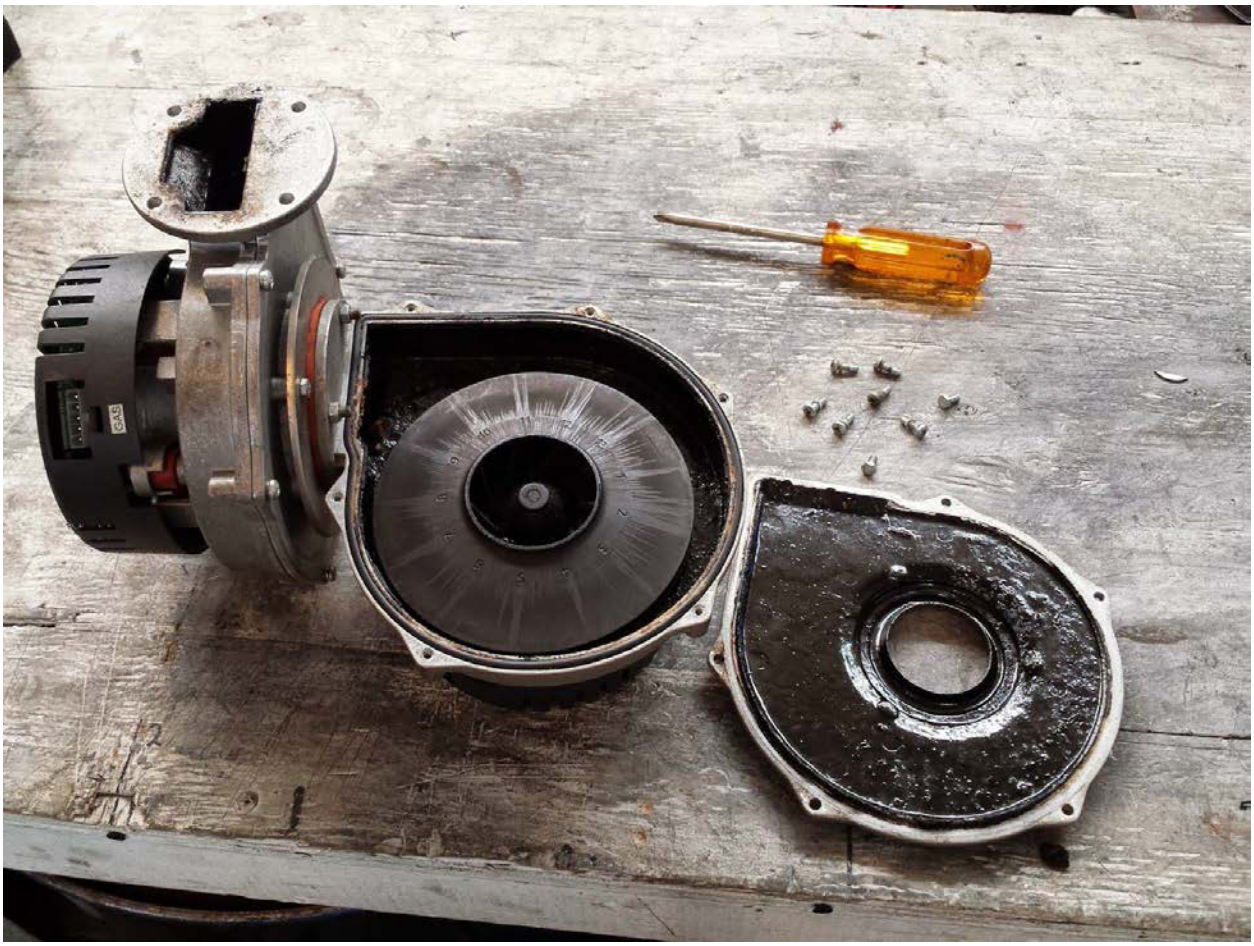
ALL Power Labs
personal scale power

Chapter 9
Troubleshooting



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1. Most Common Problems

The most common problems that cause failures to start are:

- **Starter not turning over: Insufficient battery charge**— during the flaring process, the air and gas blowers, igniter, grate shaker, and all of the electronics are being powered by the battery. If the battery is insufficiently charged, the flaring period can deplete the battery to the point of being insufficiently charged to start the engine. Charging the battery or replacing it with a fresh battery should fix this problem
- **Engine governor and ignition not working: blown fuse**— if the hour meter does not come on and the engine governor does not produce a soft electronic whine when you turn on the Power Pallet, the circuit they share may not be receiving electricity. Check fuse F6 on the relay board to see if this fuse was blown. See Chapter 4 of the Technician's Handbook for an annotated image of the relay board identifying fuse F6.
- **Engine turns over but won't start: gas path obstruction**— if the engine starter is clearly operational, but the engine still won't start, the gas path may be obstructed. Make sure the the valve leading to the engine is open and the valve leading to the flare is closed; also check the throttle valve to make sure it is not obstructed with tar residues.

2. Gasifier Troubleshooting

2.1 Testing the fuel level switch

2.1.1 Paddle Switch

To test the fuel level switch, access the testing mode screen on the PCU. In the fuel level switch test mode, it should give the following values:

- Numbers less than 600 means the switch is depressed by feedstock.
- Numbers near 900 means the switch is untouched, and feedstock level is low .
- 0 means there's no signal and the circuit should be checked for loose connections.

2.1.2 Flex Reed Switch Troubleshooting

1. The switch remains closed at the limit of the the paddles' travel. (Auger remains on when paddle is depressed)
    a. Loosen jam nut and back off the reed switch assembly 1/8 turn. Retighten jam nut and repeat test.
2. The switch remains open in the rest position. (Auger stays off when reactor is empty)
    a. Check to make sure the Switch Rod is concentric with switch body. If not, complete Flex Switch Calibration procedure.
    b. If the Switch Rod is concentric, loosen jam nut and screw in the reed switch assembly 1/8 turn. Be sure there is enough clearance between the switch rod and the reed switch by moving the paddle by hand. Retighten jam nut and repeat test.
3. If scenarios 1 and 2 cannot be resolved, remove the reed switch assembly and test by checking continuity through the switch. The reed switch should show no continuity in the absence of a magnet, and SHOULD show continuity when a magnet is held against the distal end of the threaded stud. The switch should NOT have continuity through any one of the leads and the body of the switch.

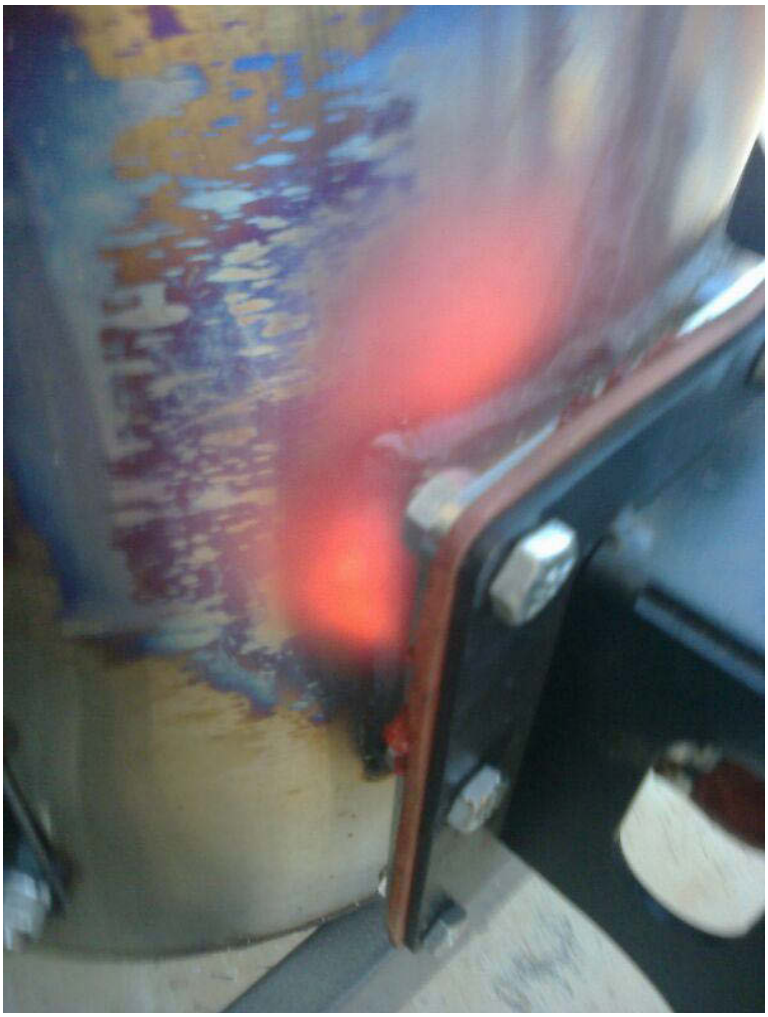
2.2 Testing the Thermocouples

The thermocouples may need to be tested to check to see if they are giving correct readings. To test a thermocouple on the Power Pallet, turn on the Power Pallet, unscrew and extract the thermocouple while leaving it plugged in, then apply a small flame such as a flame from a lighter to the tip of the thermocouple and watch for the temperature reading on the PCU to rise. If the thermocouple reading does not rise when heat is applied to the thermocouple, the thermocouple itself is probably damaged, and should be replaced.

2.3 Testing for leaks

Air leaks constitute an entire class of problems that can arise anywhere there is a joint or interface or even a faulty hose. Because the entire gas circuit is under vacuum pressure when the machine is operating if there is a leak, air will leak into the gas circuit rather gas leaking out. Because of this, testing for leaks is not always easy. The most common ways to detect a leak are:

- **Observing the emission of smoke when the machine is shut down—**
  Immediately after the Power Pallet is shut down, the system will no longer be under vacuum pressure. There will be enough residual heat in the system to continue pyrolysis, so the biomass in the pyrolysis column will continue to smoke. The smoke will eventually migrate throughout the system. If you observe smoke leaking from any point, the location where the smoke is exiting the gas circuit is usually the location of the leak.
- **Observing excessive heat anywhere on the gas circuit during operation—**
  if there is a leak, and air is being introduced into the gas circuit while the machine is operating, it is not unusual for internal fires to ignite around the leak. Rapid heating surrounding a likely leak point indicates that an internal fire is burning near an air leak. Undetected air leaks can cause a jet of flame to burn right through whatever structure is in front of the leak. The machine should be stopped as soon as possible if this is the case to avoid irreversible damage.



An example of localized overheating due to an internal fire caused by an air leak from a poorly re-sealed interface.

- **Scanning for leaks with a mechanic's stethoscope, or other detection methods—** The most reliable way to detect leaks is to use one of the detection methods listed below to detect air rushing out of a leak as a little bit of positive pressure is applied to the gas circuit while the machine is fully cooled down. To apply positive pressure, shut both of the valves leading out of the gas filter and to apply a low level of positive pressure to the gas circuit (as little as ½ psi, no more than 2 psi) using an adapter and a restricting valve with a pressure dial connected to a source of compressed air. Alternatively, you can connect some other source of blown air, such as shop vacuum cleaner's air outlet. To detect leaks, the following methods all work quite well: (**WARNING**: Be sure to totally purge the gas circuit with the gas blowers before you attempt any positive pressure leak tests; if there is a leak, carbon monoxide left in the gas circuit can leak out and asphyxiate the technician testing the machine.)
    - **Spray soapy water over likely leak points.** If there is a leak, you will see bubbles form around the leak. Be sure to wipe away the soapy water when you finish testing for leaks.
    - **Slowly move a smoking incense stick past potential leak points** while the machine is under positive pressure. If there is a leak, you will see the stream of air disturb the smoke from the incense. **WARNING**: the All residual gases must be purged before this test. If combustible gases leak out, the smoldering tip of the incense stick may ignite the gases and cause a fire.
    - **Slowly move a downy feather past potential leak points.** The principle of this test is the same as above; you should be able to see any leak disturb the feather as you move it by.

If you find a leak, the appropriate remedy depends on what is leaking. Any seals you can tighten should be tightened; if a leak is occurring on a hose or other component, it may be patched as a temporary fix while a replacement is ordered. Often times, leaks near gaskets between imperfect mating surfaces can be remedied by the application of RTV silicone sealant.

2.4 Tables of Symptoms

2.4.1 Hopper

Symptom	Possible root cause	Solution
Air leaks around hopper	1) Damaged lid gasket	Align or replace lid gasket
	2) Misaligned bolts or flange gasket	Align or replace drying bucket flange gasket. If leaking seen through bolt holes, apply silicone RTV around bolt hole and reinsert bolt.

2.4.2 Auger

Symptom	Possible root cause	Solution
Auger jamming	1) Feedstock is too difficult for auger	Remove any material that is over 1.5" in length. Avoid feedstock that has a natural tendency to entangle or other natural transport difficulties.
	2) Auger is bent.	Disconnect the auger assembly from the drying bucket. Gently bend the auger spiral to be straight in alignment with the auger motor shaft.
	3) Auger is catching on inner wall of drying bucket.	portion of the drying bucket right above the base of the auger may need to be trimmed or bent forward.
	4) Fuel level switch needs adjustment.	The fuel level switch may not be actuating properly to turn the auger off in time allowing the auger to compact the fuel into the reactor. Double check that the switch works and adjust the tension spring on the fuel level switch.
	5) Tar build-up around fuel switch obstructs motion	Unscrew the entire fuel switch fixture and clean out all tar with solvents.
Auger not turning on	1) Fuse needs replacement.	Check the two forward and reverse fuses for the auger on the relay board.
	2) Relay needs replacement.	Replace relay on the relay board.

	3) Fuel level switch is damaged.	Replace.
	4) Tar build-up holds switch in off-position.	Unscrew the entire fuel switch fixture and clean out all tar with solvents.
Low current state for auger	1) Bridging in the hopper or drying bucket.	Check the two forward and reverse fuses for the auger on the relay board.
	2) Low/No feedstock	Fill the hopper up with feedstock.
PCU is not indicating the correct auger state.	1) Current sensing not working properly	Make sure current sensor is wired correctly or current sensor may need replacing.

2.4.3 Cyclone

Symptom	Possible root cause	Solution
Ignition of gas inside the cyclone indicated by excessive heat, blistering paint, etc.	Cyclone ash can does not have an air tight seal	Take the can off of the cyclone and clean the components. Make sure the gasket is seated properly; replace gasket if damaged.
No condensate or ash accumulates in the cyclone ash can after running for a while.	Blockage in the inside the cyclone	Use a wire brush and a stick to check for and clear out blockages in the cyclone.

2.4.4 Gas filter

Symptom	Possible root cause	Solution
Pfilt is less than **Preactor** by a difference greater than 30 (3 inches WC)	Filter media is saturated with tar, or was packed with too many fines.	Change the filter media.

2.4.5 Flare

Symptom	Possible root cause	Solution
Too much air allowed into flare stack at low flows	Air blower gasket stuck in housing.	Adjust the gasket so that it seats properly in the gasket housing.
Flame seen above the flare stack	Flare does not have enough air; flame starved of oxygen.	Increase air blower output using the knob on the control panel.
Flare is not lighting.	1) White smoke seen as steam actually seen during start up of the reactor.	Reactor is not lit yet. White smoke is actually steam coming off of moisture in the system.
	2) Improper air to fuel ratio in flare stack.	Try increasing or decreasing the air blower to achieve the right air to fuel mixture in the flare stack.
	3) Igniter not working properly.	Test igniter using testing screen on the PCU. Check fuse on the relay board. Replace igniter tip if damaged.
Gas blowers are not able to achieve over 5 WC.	1) Charcoal is packing densely the grate basket	Clean out the reactor and char basket, then use correctly sized charcoal and feedstock for the second start.
	2) Gas blower malfunctioning.	Check to see if both fans are operational and the fan blades are intact or fouled with tar; clean with alcohol if fouled.
	3) Low battery	Recharge the 12V DC battery.

2.4.6 Air inlet

Symptom	Possible root cause	Solution
Smoke seen passing through air inlet check valve when machine is off.	1) Gasifier is on an incline, causing check valve flap to fail to seal.	Level the Power Pallet.
	2) Check valve flap physically obstructed or stuck open by tar.	Tap on the flap and it should fall back into place. Remove check valve and remove tar residue with alcohol.

2.4.7 Difficulty starting and operational problems

Symptom	Possible root cause	Solution
Ignition port melted from heat	Torch being applied to ignition port for too long by operator trying to light the reactor.	Lighting the reactor should take no longer than 10 minutes. If feedstock does not seem to light, see the row below.
Reactor temperatures not increasing after extended application of torch to the ignition port	Bridging, non-combustible debris, or other problems may be hindering ignition.	Open the PyroReactor viewport and break the bridging with a stick. If bridging is a common occurrence, feedstock might need to be sifted or processed differently.
Melted or damaged components, or discoloration from local over-heating	Air leak in somewhere in the gas circuit causing a fire in the wrong place	Find and replace the part with the air leak. If it is a welded piece of the pyroreactor, the whole pyroreactor will need to be replaced. Ensure that there are no leaks in the reactor around the bungs, flanges, gaskets, and joints before running the system.
Difficulty starting reactor	Clinker formation around the air nozzles; high temperatures around nozzles may be causing ash fusion	Clean out the reactor, chip away clinkers. Perhaps use a lower mineral feedstock.

2.4.8 P_{ratio} problems

Symptom	Possible root cause	Solution
Pratio too low	1) **Pratio** reads lower than 10 during start up and does not increase due to leaking upstream of the reactor.	Make sure there is no leaking in the reactor lid, reactor port cover, hopper and drying bucket connection, or hopper lid.
.	2) **Pratio** is 15-20 due to packing in the reduction bell	This can happen when using feedstocks that produce very fine particles of charcoal, such as pelletized feedstocks.
	3) Charcoal used for starting gasifier has too many small pieces or made from pelletized charcoal dust.	Turn up the gas blower or increase the load on the engine or repack the reactor with coarser charcoal, sifted to remove dust.
	4) Grate basket may be	Clean out grate basket, perhaps blend

	fouled with clinkers	clinker-prone feedstock with lower-mineral feedstock.
	5) **Pratio** is below 15 for most all of the run	If the gasifier operates well in spite of the low **Pratio**, this is not a problem, and alarm threshold needs to be adjusted.
Pratio too high	1) Reactor is out of feedstock.	If the hopper, drying bucket and the reactor are completely empty of feedstock the system should turn off. If it does not shut down automatically, turn the system off immediately and wait until the system cools before filling with feedstock. Operating without sufficient feedstock is an explosion hazard.
	2) Bridging in the hopper, reactor or the drying bucket.	Open the reactor lid port, and check to see if there is bridging; use a rod to break apart any bridges. Be careful as air allowed through the port may cause flame to rise.
	3) Jammed auger.	Check auger to see if it is working properly; a broken auger may fail to push material into the reactor, leading to **Pratio** problems.

2.4.9 Temperature related problems

Symptom	Possible root cause	Solution
Trst too low or not increasing	1) Wet feedstock or charcoal.	Replace with appropriate feedstock and charcoal.
	2) **Pratio** values are too low/resistance is too high in the reactor to support proper reaction rates	Feedstock particles are too fine in reactor, pelletized feedstocks may have fallen apart and caused packing in the reactor.
.	3) Gas flows too low in reactor	Increase flows by turning up the gas blower or increase the load on the engine/ generator.
	4) Thermocouples installed incorrectly	Make sure thermocouples are properly connected and installed to the right depth.
	5) Faulty thermocouple or grounded thermocouple	Test the thermocouple, replace if needed.

	6) Fault connection on the PCU board.	Switch **Trst** and **Tred** to see if each connector gives the same reading, replace if needed.
Temperatures are too high (above 1020˚C)	1) Insufficient feedstock in pyrolysis zone (pyrolysis and tar cracking are endothermic, and help regulate top temperatures.)	Turn off the system by closing the gas or engine valve. Fill the hopper up with feed stock when the system is cool.
	2) Fuel burns too hot; coal, and some nut shells burn extremely hot	Do not use coal in gasifier; if nut shells are giving excessive temperatures, blend with some wood chips, or use some fuel with higher moisture content.
	3) Localized combustion due to leaks inside the system	Shut down the system, locate leak and repair.
Thermocouple reading does not exceed 2	Faulty extension cable.	Replace extension cable.

3. Engine Troubleshooting

3.1.1 Engine

Symptom	Possible Cause	Corrections/Solutions
Engine cranks but does not start.	1) If first starting the system up, there will be air in the gas filter and the lines leading to the engine.	Cranking the engine will purge the air until wood gas and the correct air mixture reaches the engine. This can normally take longer than a typical engine start approx 20 sec). **Do not operate the starter continuously for more than 30 seconds.** Be sure to allow the starter motor to rest for 30 seconds between start attempts. If the engine does not start after 3 attempts allow the starter to cool for 10 minutes before attempting to start again.
	2) Gas quality may be poor.	Switch over to the flare and make sure that the reactor is producing good gas and the reactor temperatures are ideal. If the flare will not ignite please refer to the troubleshooting section in Chapter 3.
	3) Gas filter may be clogged.	Check the filter media to see if it needs to be changed. Tars may cool from previous run and typically condense around the bottom grate. Reactor vacuum (`Preact`) should be less than 3 inches of water (30 units) above reactor vacuum. Change the filter media if needed. Refer to the gas filter documentation for further information.
	4) Throttle valve may need maintenance	Check throttle valve operation, clean if necessary.

	5) Air mixture servo not opening properly	Check lambda meter for error code. Use air servo adjustment menu to verify operation of the air servo.
	6) Grid Tie Systems: “Engine On” signal from DeepSea to PCU disconnected.	Mixture on grid-tie systems is controlled by the PCU. A single wire from the DeepSea controller to the tells the PCU to enable mixture control. If this connection has been severed, the PCU will not control mixture and the engine will not start.
Engine starts then abruptly shuts off after a few seconds.	1) This can be due to the governor automatic shutdown thresholds.	Refer to the governor and throttle documentation.
	2) Air mixture servo not opening properly.	Possibly due to oxygen sensor malfunction. See oxygen sensor documentation.
Engine shuts down. PCU display shows oil pressure alarm.	1) Engine oil level low	Check oil level with dipstick. Add oil if necessary.
	2) Configuration wrong in the configuration screen of the PCU	Check the configuration screen on the PCU and make sure it matches the configuration of the Power Pallet.
	3) Jumper configuration wrong on the relay board	Check relay board documentation and make sure that the jumper is configured properly.
Engine backfires	1) Air/Fuel mixing in the line before engine.	Check for air leaks upstream of the engine. Check the gas lines and gas filter and other components upstream for air

		leaks.
	2) Poor gas quality	Switch to flare. See troubleshooting section in Chapter 3.
	3) Wrong spark timing	Confirm spark plugs are wired for correct engine firing order.
Engine pre-ignition when starting	Poor spark plug wire seating	Confirm wires are well seated.
Engine speed unstable	Sticky valve on engine governor	Open up throttle and clean valve using alcohol or other solvent.

3.1.2 Troubleshooting for the Air Servo

Symptom	Possible Cause	Solution
Servo does not move when adjusted	1) Servo not connected to PCU	Check all wiring connections from servo to PCU
	2) Adjustment outside of servo range	Make sure adjustment is between 0 and 180.
	3) Servo faulty	Replace servo
Servo having difficulty rotating all the way	Air filter could be obstructing the servo.	Pull air filter away from servo linkage. Check air servo for internal binding. This will be indicated by vibration felt on the plastic servo body
Min or max position outside of servo range		Remove servo from valve and adjust or flip the valve around. Set servo to lowest position using adjustment menu (See Air Servo section above), disassemble, and re-align with splines on butterfly shaft.

3.1.3 Troubleshooting for the Governor

Issue	Possible Cause	Solution
Service tool does not	1) Governor not powered on	Ensure PCU is in engine test

connect to governor		mode, listen for governor "whine"
	2) Serial cable not connected	Verify all cable connections, ensure use of correct port on automation assembly.
	3) Harness connections mis-wired	Verify governor and key switch harness RS-232 connections at relay board. Wire colors are marked on the board.
	4) Relay board serial buffer IC is faulty	Perform serial loop-back test. Replace buffer IC if necessary
	5) Governor is faulty	Replace governor
Engine shuts down abruptly after starting.	The engine may have exceeded the underspeed threshold of the governor and the governor may have gone into automatic shutdown mode.	Start the engine under a lighter load and ramp more slowly to the desired load.
Engine can crank for more than 90 seconds but fails to start.	Throttle sticking and unable to open or actuate properly.	Throttle valve in need of maintenance. Follow maintenance instructions above.

3.1.4 Troubleshooting for the Oxygen Sensor and Lambda Meter

Symptom	Possible Cause	Solution
"Please connect the device to a serial port and switch it on" when launching LM Programmer	1) Serial cable not connected	Verify serial cable connection
	2) Wrong communications port on lambda meter	Ensure cable is connected to "OUT" port on lambda meter
	3) Faulty lambda meter	Replace meter
"No serial port available" when launching LM Programmer	1) USB serial adapter not connected	Verify USB connections
	2) Required device drivers not installed	Install appropriate drivers

	3) No serial port	Obtain USB serial adapter or use computer with serial port
Lambda meter display unintelligible after programming		Power cycle lambda meter. Replace if issue continues.
"E2" error on lambda meter display	Oxygen sensor not connected	Check all oxygen sensor cable connections and ensure plugs are fully engaged to their sockets
E8 error shown on oxygen sensor dial, “No O2 sensor Signal” shown on PCU.*	Signal error caused by either low battery or poor connection to sensor	Check continuity between the oxygen sensor module and the sensor wire on the Relay Board.
E9 error shown on oxygen sensor dial. Or oxygen sensor resetting over and over. *	Low battery voltage	Charge the 12VDC battery.
Air mix servo not responding.	1) O_2 sensor issue.	Refer to O_2 sensor troubleshooting above.
	2) Air mix servo wire connection loose or misconnected.	The air mix servo connector should be securely connected to SRV0 on the PCU board
While running the flare, O_2 sensor reads very rich , starts at 1.5 then decreases while engine is not on.	Leak in the Pyrocoil	Replace Pyrocoil.

4. Generator Troubleshooting

Symptom	Possible Root Cause	Solution
Heavy load step causes frequency drop	High instant torque on engine	Adjust STAB pot (this will cause voltages to dip, but allow larger loads to be placed on the engine with minimized frequency impact). See Meccalte “regulators.pdf” for tuning method.
Low frequency while engine throttle is wide open	The load is above what engine/gasifier can support under current conditions	Improve gas quality. Reduce load.
Voltage is greater than +/- 5% from expected voltage.	VOLT needs adjustment	Take off the front panel of the generator to access the VOLT adjustment pot. Adjust accordingly, measuring voltage on legs with a volt meter.

**Please see the Mecc Alte Installers Manual for more troubleshooting.*

5. Automation Assembly Troubleshooting

5.1 Troubleshooting FETs

To test operation of a FET output, use a voltmeter on the low-resistance or diode-check setting. The meter should read a low resistance to ground when the FET is switched, on and infinite resistance when it is switched off.

5.2 Firmware Upload Troubleshooting

Symptom	Possible Cause	Solution
PCU serial port does not appear in menu / “Serial port not found” error when uploading	FTDI USB serial driver not installed	Install USB serial driver on computer
Unable to find COM port	USB cable not connected	Verify USB connection at top of PCU, back of podium front door, and front of podium front door.
Unable to find COM port	No power to PCU	Turn on Power Pallet using power switch on podium front door
Error "avrdude: stk500_getsync(): not in sync: resp=0x00" when uploading	Programming jumper not set	Ensure programming jumper (ARD) is set.

5.3 Relay Board Troubleshooting

Symptom	Possible Cause	Solution
Subsystem not functioning	1) Fuse may have blown	Check fuse and replace if needed (wire connection in center of fuse is broken and plastic housing is discolored/darkened).
	2) Wires disconnected	Check all connections in screw terminals on harnesses (at bottom of relay board) and on FET screw terminals at relay board. Check that all connectors on the other

		ends of the harnesses are fully plugged into their mates. Use visual inspection and continuity test with volt-meter
	3) Circuit boards, harnesses, or subsystems incorrectly wired	Check all connections in terminals inside the enclosure and at subsystems against Wiring Harness Documents (found in appendices to Technician's Handbook). Use visual inspection and continuity test with volt-meter.
	4) Faulty connection to PCU	Check that PCU FET outputs and analog inputs have a solid electrical connection.
	5) Faulty relay	Replace relay with spare
	6) Faulty subsystem component	Check voltage at subsystem when PCU commands it on. Replace if necessary.
	7) Faulty component on PCU	Check voltages on PCU. Replace PCU f necessary. (see section on FET output troubleshooting)
Fuse blows more than once.	Shorted wiring connection	Check for shorted connections on relay board or swapped wires in harnesses and subsystem (refer to Wiring Harness Documents found in appendices).

5.4 Troubleshooting the PCU

Symptom	Possible Cause	Solution
Unable to read LCD screen/ nothing on LCD screen	1) Contrast non-ideal for lighting conditions.	Adjust the blue contrast knob or cover the LCD screen to shade from direct sun.
	2) Display connection not secure.	Check and secure connections.
	3) Display malfunction.	Replace display.
	4) ATX power supply may be faulty	Check that the green ATX LED on the right side of the relay board comes on. If not, replace ATX.
White blocks across the screen	1) Contrast not ideal	Adjust contrast knob
	2) Firmware corrupt	Re-upload firmware
LCD screen stuck on splash screen	Program timing glitch due to key switch being on when automation is turned on	Turn key switch to the OFF position and power cycle system.
Incorrectly proportioned pressure values	1) Pressure lines incorrectly connected	Connect pressure lines to correct ports on PCU
	2) Sensor offset calibration incorrect	Remove lines, calibrate sensors (see page 6 of this chapter for details)
Incorrect temperature readings	1) Thermocouple extension disconnected or connected to incorrect socket	Verify thermocouple extension connections at PCU and at connection to thermocouple
	2) Thermocouple faulty	See section on operational troubleshooting
PCU resets when USB cable connected or disconnected	ARD jumper set	Disable ARD jumper