Hazer XS: Circuit Description & Service Procedure

The stainless steel tube is heated by a low voltage high current source.
Its temperature is monitored by a thermocouple attached at a specific position.
A cycling heat/ cool/ pump routine establishes the desired conversion of fluid to vapour.
A self-cleaning routine is introduced at specific time counts, and changes temperature switching levels, in order to achieve the desired results.
Using CPU control allows for line level power adjustment, controlled switching of circuit elements and analogue reading of sensors.

Sensor Reading -
NTC device mounted in din socket. This is a zero temp compensation for the thermocouple device. The monitored temperature is added to the thermocouple temperature.

Thermocouple -
A precision op-amp differentially amplifies the output from this device, in such a way as to maximise the accuracy when applied to the 8-bit aid converter in the CPU. Input and static protection is via reverse connected zener diodes.
The reading is taken at exactly the same point during the mains cycle to minimise fluctuating readings.

Line Monitor –
At reset and cleaning cycles, this reading determines the burst fire cycle count current delivered to the tube in order to provide some level of control over a range of line voltages.

Zero cross –
This input detects the zero voltage crossing point of the ac waveform in order to provide a software loop cycle start point. It allows zero voltage control of power switching, and consistent aid reading points.

Haze on/off –
Monitors the haze switch and external 0-1Ov inputs.

Element Control -

Air/Relay -this line controls a low power triac, which will activate the main current path relay and the air pump.

Heater –
This line drives the monitor LED and, via an opto-coupler, triggers the current controlling triac. This is a zero voltage burst fire output, and the LED will mimic the burst cycle pattern.
In a 'fail' condition the main relay will be switched off, allowing the LED to indicate which fail mode has occurred.

Fan –
This line drives an optocoupler triac connected in series with the main fan. It allows the fan to be pulse controlled, in order to reduce the cooling effect when the cleaning mode is in effect.

Pump –
This line allows phase-controlled pulses to be delivered to the pump in order to control the amount of fluid delivered per cycle.
Note: The 250mA fuse in the pump line is intended to blow if continuous voltage due to a triac failure is supplied to it. When testing the pump or intentionally powering the pump by bypassing the triac, this point should be considered.
Note: The pump can be made to produce a series of pulses in order to prime quickly. This is achieved by having the mains switch and haze switch initially in the off position. Switch the power on, and within five seconds of doing so, switch the haze switch on and off for at least five times, with its final position as on.
The pump may be switched off instantly by turning the haze switch off.

The circuit consists of ancillary components to provide the required element control, i.e. driver transistors etc. A voltage doubler provides an isolated gate drive level for the mosfet current switch. An adjustable voltage regulator provides an exact 5V supply to the CPU to maintain aid integrity. A current limiting FET is used for the external12v DMX supply line. This prevents a short circuit from disturbing the CPU supply.

Circuit Action -
At switch on, initial readings will be taken and the circuit allowed to settle.
A cleaning phase will always be entered. This involves the air pump, the fan, and current control to the tube. The tube will be taken to a much higher temperature than the normal running temperature.
The air fan will pulse, and a reduced current flow will be issued to the tubing. At around 300C the main fan will stop, whilst current flow will continue. At a higher temperature level, current flow will cease, and the tube allowed to cool. Again at around 300C the fan will start pulsing, to cool the tube. The current will be re-applied at a lower temperature, and the process repeated several times until, finally, the fan will be switched to full flow, the temperature switch points changed to normal operation and the main routine entered.
This is a simple heat up -cool down -fluid pump -heat up -cool down etc.
Software fail sensing is continuous and is present in both cleaning and operational modes.
For safe operation, several conditions must be monitored.
Any Fail will lead to the main power relay being switched off, and hence no air pump.
A fault code will be flashed on the LED.
A single or series of flashes, followed by a few seconds pause, will indicate the nature of the failure.
It is advisable to monitor tube current via a current clamp sensor connected to an oscilloscope so that the correct zero crossing and burst fire control can be inspected.
The output of the thermocouple op-amp is approximately 10m/volts per degree C, which can give at least an idea of working temperatures.
The CPU is set for low voltage detection in order to provide correct operation at the clock rate of 8Mhz. An incorrectly set CPU voltage could cause reset problems.

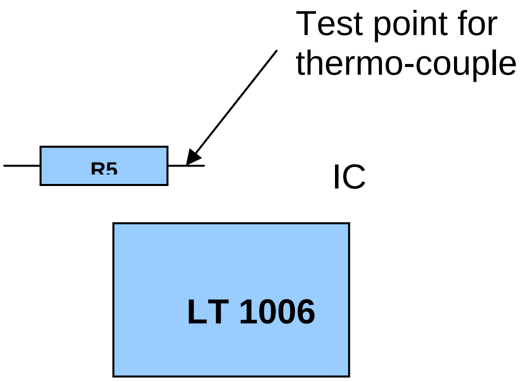
In order to start and continue the software flow, a zero voltage signal must be present at all times.
Because of the high level of current being applied to the tube (region of 30amps), it is essential that all connections in this path are made correctly, and that all crimps and mechanical fittings are tight.
A 'floating' FET gate due to faulty crimping will lead to unusual conditions, and failures, so this should be checked.
An excessive 'ripple' produced by the high current passing through a badly connected thermocouple, will lead to rapid cycling and spurious performance.
Most problems with new Hazers when going through the test stages are associated with thermocouple connection to the tube. It is possible that degradation has occurred after the test stage, or the test stage has completed with a borderline tube that has got worse. Working tubes will normally remain perfectly functional for its performing life.

Servicing the Hazer XS

The very first thing to do is a thorough visual examination of the machine, paying particular attention to:-

1. The low voltage wiring and connections associated with the element, as any resistance will seriously impair the operation or even cause the machine to display a fault condition.
2. Ensuring the air pump, reservoir bottle and the tubing are all free of fluid.
3. Ensuring the integrity of the thermo-couple, as the machine will *not* operate correctly if this is faulty.

When first switched on, the machine will automatically go through a cleaning phase, which should last for about one minute. During this time, check that the thermo-couple on the element is working correctly. With a DC voltmeter, test between earth and R5,(see picture). When first switched on, the voltage here will rise at approximately 0.1v/second until it reaches a little over 4 volts. If this does not occur, then there is something wrong, either with the thermo-couple, or the voltage applied to the element and should be investigated immediately, as the machine will only go into fault condition at the end of the cleaning phase.



At the end of the cleaning phase, there should be a slight delay of a few seconds before the fluid pump operates. The voltage at R5 at this time should be between 2.4 and 2.8 volts.
Once the haze has started issuing, it is prudent to check the efficiency of the air pump, as the quality of haze will be poor if this is not to standard. Stop the main fan from running and observe that the haze is being blown out to at least 8-10 cms. If this is not the case, it is recommended that the air pump be stripped and cleaned thoroughly before going any further. The effect of an inefficient air pump is “spitting” of fluid and an inconsistent flow of haze.
Details of cleaning the air pump will be found in “Service Procedures”

The Next Step.

It is now assumed that all on the previous page checks out, but it still refuses to produce haze.
What is being displayed by the monitor LED on the rear panel? If it should be 1,2,3, or 4 flashes every three seconds, then this indicates a fault:-

Single Flash;
Din plug not connected or NTC failure. This is monitored via the NTC ambient temperature sensor input.

Double Flash;
Loose or bad thermocouple fitting onto tube. Higher than desired resistance in the tube current path (loose connections etc) This will be monitored by a time test during the heat up phase. If an excessive time is taken to reach the top temperature, then a failure of this nature will be assumed. A condition which could mimic this fault is a drop in line voltage, immediately on commencement of a cleaning phase, where a burst fire cycle count has been established, then a reduced voltage is applied. (High line resistance due to mains cabling etc.) This may cause too little power applied to the tube, and hence an excessive heat up time.

Triple Flash;
Open circuit thermocouple leads. This is monitored as an over-temperature condition, since an open circuit in this path will lead to a high voltage on the op-amp output.

Quadruple Flash;
Current control to the tube. A method of detecting continuous current supply to the tube is required in order to prevent thermal runaway. This is achieved by recording the peak temperature at the point where current should be switched off and cooling commenced. Should the temperature be recorded as going above this level, then it is assumed that power is still being applied. This will lead to a failure condition.

If a very rapid flash occurs, but the pump is not operating, this is an indication that the pump pulses are being sent but the pump circuit is not responding. The pump can be easily checked; at the top right corner of the PCB there is a connector that is not used. To the left of this is the blue lead connecting to the pump. *VERY BRIEFLY* short these two connections. If the pump is operational it will be heard to pump, (always assuming that the supply to it is OK). If this operation is not done briefly, the 250 m/A fuse will blow; if it has already blown it is most likely that the pump is faulty and will require replacement.

Service Procedures.

Servicing the air pump.

It has been found that the air pump requires cleaning after a period of use. The most obvious indication that this is needed is if the haze output is erratic or there is “spitting”.

Remove the four screws that hold the pump and remove the tubing. Take off the black rubber backing and remove the round black diaphragm/magnet. Using a piece of cable, loop it around the green pump unit and carefully pull it from the main body. On the underside will be found a small, round, black plug, remove this. Now give the assembly a thorough wash in clean water and dry off with an airline, making sure that it is properly dried. Replace the plug and re-assemble.

The machine should now work satisfactorily.

Fitting a replacement element

1) Loosen the two Allen screws on the power connectors at both ends of the element.
2) Unplug the DIN plug.
3) Withdraw the element complete with the red sleeving.
4) Remove the red sleeving and the power connector block, observing their positions.
5) Re-assembly is the reverse of the above, ensuring that the screws are reasonably tight without being over-tightened. Also, make sure that the red sleeving sits just inside the silicon sleeving and is <u>not</u> pushed back into the tee piece, as this will block the fluid from entering the element.

Typical Voltages for XSHP1 chip

Pin	Haze Off Voltage	Haze On Voltage
1	5.02	5.02
2	0.009	0.023
3	2.29	2.28
4	2.505	2.5
5	0	0
6	0	0
7	5.02	5.01
8	0.029	0.03
9	2.411	2.406
10	4.97	4.96
11	1.567	1.544
12	-0.005	2.00(variable)
13	0	5.4
14	3.68	3.3
15	2.531	2.533
16	0.003	0.003
17	0.002	4.95
18	0.002	3.4(variable)
19	0.001	3.6
20	0	0

Typical Voltages For LT1006

Pin	Voltage
1	11.07
2	1.228
3	0.285
4	-8
5	0
6	-6.13
7	11.03
8	10.93