ICS ELECTRONICS
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APPLICATION BULLETIN

Replacing the Watlow Controllers in an Axcelis/Fusion Gemini Asher with ICS's 2399 ANSI to Modbus RTU Interface

INTRODUCTION

The Axcelis/Fusion Gemini series Ashers are plasma ashers that were designed to remove the photoresist layer from an etched wafer. Axcelis/Fusion Gemini series Ashers used Watlow 988 Temperature Controllers to monitor and control the temperature during the stripping or plasma ashing process. These Watlow Temperature Controllers are now obsolete and are very difficult to repair since replacement units or parts are very hard to find. Maintenance is difficult and Asher downtime disrupts your production. This Application Note describes how an ICS 2399 ANSI X3.28 to Modbus RTU Interface can be used to update an Axcelis/Fusion Gemini Asher with a modern Watlow Temperature Controller without having to rewrite the process software.

BACKGROUND

In semiconductor manufacturing, plasma ashing is the process of removing the photoresist (light sensitive coating) from an etched wafer. Using a plasma source, a monatomic (single atom) substance known as a reactive species is generated. The reactive species combines with the photoresist to form ash which is removed with a vacuum pump.

The Fusion Company developed a series of ashing machines and strippers for the semiconductor industry. They were designed using Watlow 988 series Controllers to monitor and control the chamber temperature. These units are still giving good service and are used in hundreds of locations in the semiconductor industry. The key to keeping production equipment running profitably is good and swift maintenance when something fails.

WATLOW 988 SERIES TEMPERATURE CONTROLLERS

The Watlow 988 Series of Temperature Controllers were designed in the mid-1990s and includes the 981, 982, 986 to 986 and 996 to 999 Models. They are controlled serially using an ANSI Commands sent over an RS-232 or RS-422/RS-485 communication link.

The Watlow 988 series Controllers are obsolete and spare units are not available without cannibalizing another machine. Cannibalization defeats the idea of keeping all of your semiconductor lines running and is an expensive solution since these machines are still worth well over $50,000. Spare parts for the Watlow Controllers are now virtually impossible to find.

UPDATE SOLUTION

The obvious solution to fixing the Axcelis/Fusion Gemini Ashers is to replace the obsolete 988 series Watlow Controllers with a modern Temperature Controller that will be available for the next 10-15 years. The problem is that none of the newer Temperature Controllers on the market recognize the ANSI Commands used in the Fusion Gemini Ashers. All of the new Watlow Temperature Controllers, and those from most other manufacturers, are register-based and accept Modbus RTU protocol packets. Redoing the software in the Fusion Gemini Ashers to change the protocol would be almost prohibitive[1].

2399 ANSI X3.28 TO MODBUS RTU CONVERTER

ICS Electronics, in conjunction with Texas Instruments, developed the 2399 ANSI X2.28 to Modbus RTU Converter that converts ANSI commands into Modbus RTU packets. The 2399 accepts ANSI commands on serial port #1, does a table lookup conversion and sends Modbus RTU packets to a Modbus Temperature Controller from serial port #2. Data from the Modbus Temperature Controller is converted back into the expected response format and outputted to the host on port #1.

The 2399 makes the new Watlow EZ-ZONE Temperature Controller with its modbus RTU interface look like the old Watlow 988 series Temperature Controller to the Fusion Gemini Asher. This inexpensive upgrade does not require any software change to the Fusion Gemini Asher.

CONTROLLER REPLACEMENT STEPS

There are three basic steps to replacing the 988 controllers. First select a new Temperature Controller. While any manufacturer's Temperature Controller that has a serial Modbus RTU interface can be used in the Ashers, the Watlow EZ-ZONE Controller seems favored due to its case size and low cost. The PM series EZ-ZONE controllers are available in several case sizes so they can physically replace the existing Watlow 988 series controllers. They are also compatible with the temperature sensors used in the Fusion Gemini Ashers. The Gemini series Ashers have two Watlow Controllers while earlier Ashers may have only one controller.

Second, prepare an Excel cvs spreadsheet with the commands used by the Asher so you can load the 2399's ANSI Command Conversion Table. You start by recording the serial communication to the 988 Controller during the power turn-on/initialization period and when running the production process. This will give you a list of the ANSI commands used by the Asher. While examining the recorded communication log, determine if the Asher is using the X3.28 or Xon-Xoff protocol.

You can look up the ANSI command functions by downloading a copy of the Watlow 988 COM Manual and looking in the Temperature/Process Controller Prompt Table. Watlow also supplies a Excel table that lists all of the PM EZ-ZONE registers and their functions. You can get the PM register number for each ANSI command by cross referencing the command functions between the two tables. Watlow's support people provide excellent help in deciphering the PM Table. The 2399's Instruction Manual has detailed step-by-step directions for filling out the Excel cvs spreadsheet and for uploading and saving it in the 2399. Copies of the 2399 manual can be downloaded from ICS's website.

The third step is the physical replacement of the obsolete 988 series Controllers with the new EZ-ZONE PM Controller and the 2399. Remove the 988 enclosure to access the 988 Controllers. Remove the wires and note the pins numbers and signal names the wires were going to. The wires will have to be connected to the same signals (same functions but different pin numbers) on the new EZ-ZONE Controller. Do not connect the existing serial lines to the new EZ-ZONE Controller.

There is typically space for the 2399s above the chambers and just below the gas box. Fashion a sheet metal bracket to mount rgw 2399s. The 2399's have a separate 5-pin, plug-in screw terminal strip on each serial port. Run new wires from the 2399's Port #2 terminal strip to the RS-232 pins on the new EZ-ZONE Controller. Connect the existing serial wires to the Port #1 terminal strip.

There are many details to be considered in each step that were not covered here but the change is worth it especially if you have a number of Fusion Gemini Ashers to maintain or are familiar with working on them.

SUMMARY

This Application Note has described the problem trying to maintain Axcelis/Fusion Gemini series Ashers when dealing with the obsolescence of its Watlow 988 series Temperature Controllers. This note has described a way to replace the obsolete Watlow 988 Temperature Controllers with modern Watlow EZ-ZONE PM Temperature Controllers using an ICS 2399 ANSI X3.28 to Modbus Interface module.

The material cost of the proposed 2399-Watlow PM Controller solution is less than $1,500 for a Fusion Gemini Asher. Pro actively replacing the obsolete Watlow 988 series Controllers will reduce future maintenance time and go a long way toward keeping your Axcelis/Fusion Gemini Ashers productive.

Notes:
1. The cost of making software changes is prohibitive because the original software was done 20 years ago by Fusion. The product line has been sold twice and access to the original source code is uncertain. If you found the source code, are the compiler's still available and is the code commented well enough for new programmers to make the changes? No matter how well the code is commented, it will take the programmers time to come up to speed on how it and Ashers are supposed to work. Making changes to 20 year old code or doing a complete rewrite is possible if you have the resources and background in designing the earlier Fusion Ashers but it would take a long time and lots of money.

2. Axcelis/Fusion Gemini Asher use RS-232 signals for communicating with the Watlow Controllers.

3. EZ-ZONE is trademark of Watlow Electric Manufacturing, Company, Winona, MI 55087.

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