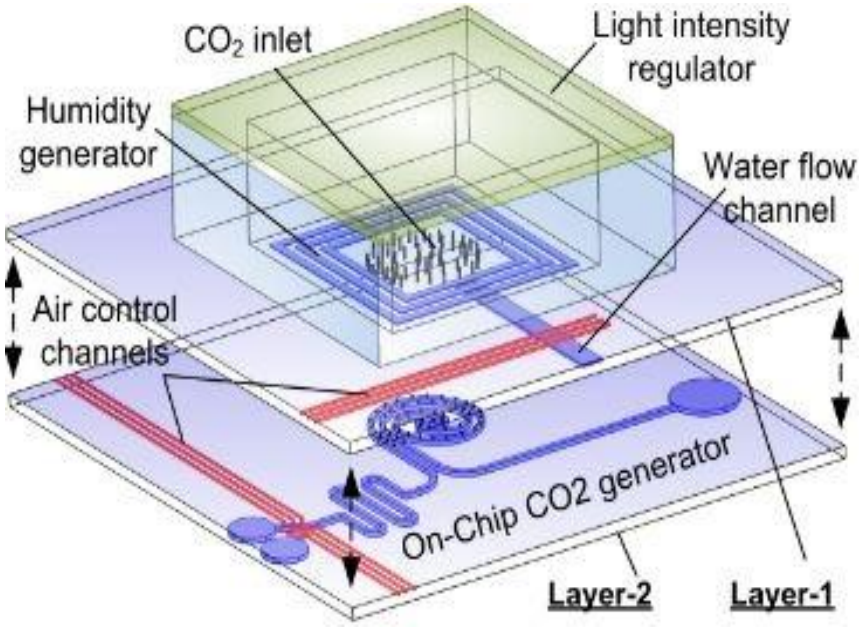
Environmental Control for a Chip Scale Laboratory

Abstract

The purpose of the chip-scale laboratory is to offer numerous individual seedling chambers that each house a single seed. The advantage is that each chamber can have a uniquely specified set of environmental conditions such as temperature, humidity and CO2 levels.



Problem Statement

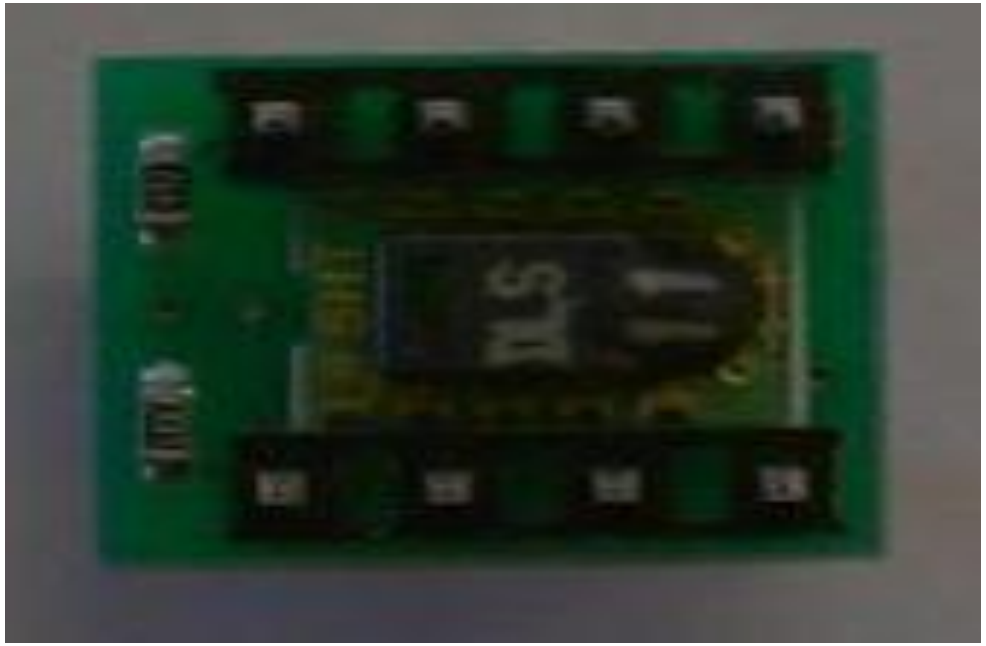
Develop a system capable of controlling humidity in multiple seedling chambers by detecting deviant humidity levels and pumping amounts of water to correct the humidity level.

Objectives

- Fabricate a 2-layer channel system capable of delivering small amounts of water
- Integrate sensor, solenoid and chamber systems into system capable of controlling humidity
- Implement a sensor array that can be expanded to facilitate up to 128 sensors.
- Using Verilog, develop a solenoid control program capable of 7-bit addressing and peristaltic pump action

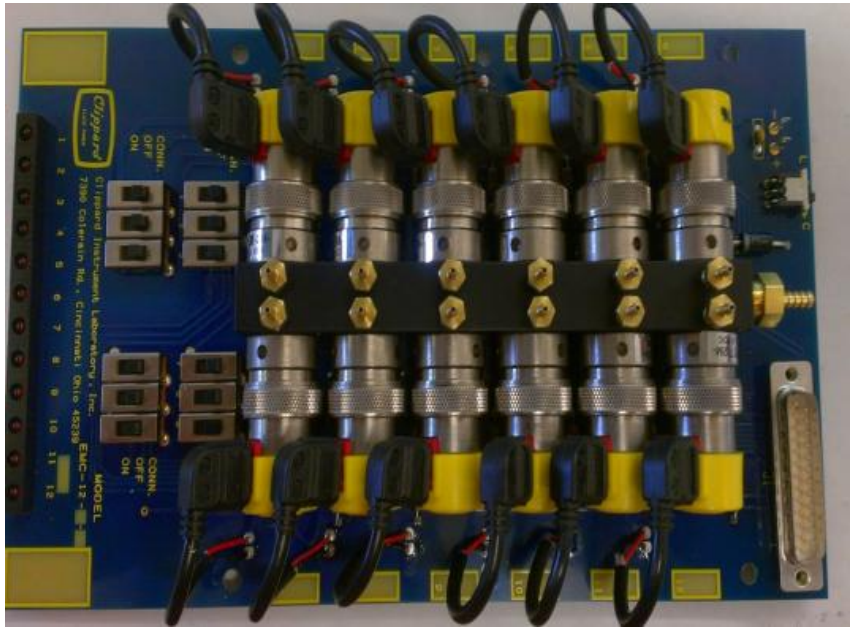
COMPONENT OVERVIEW

SHT11X Humidity/Temperature Sensor:



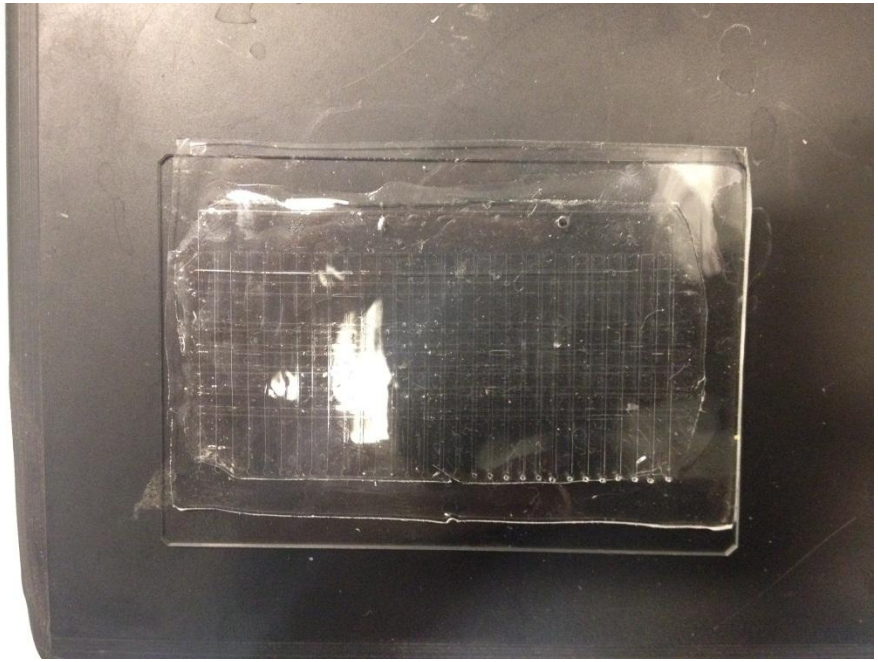
Range from -40 to 115 C and 0-100% RH
Analog and Digital out configurable
Very compact design

EMC-12-06-20 Solenoid Manifold:



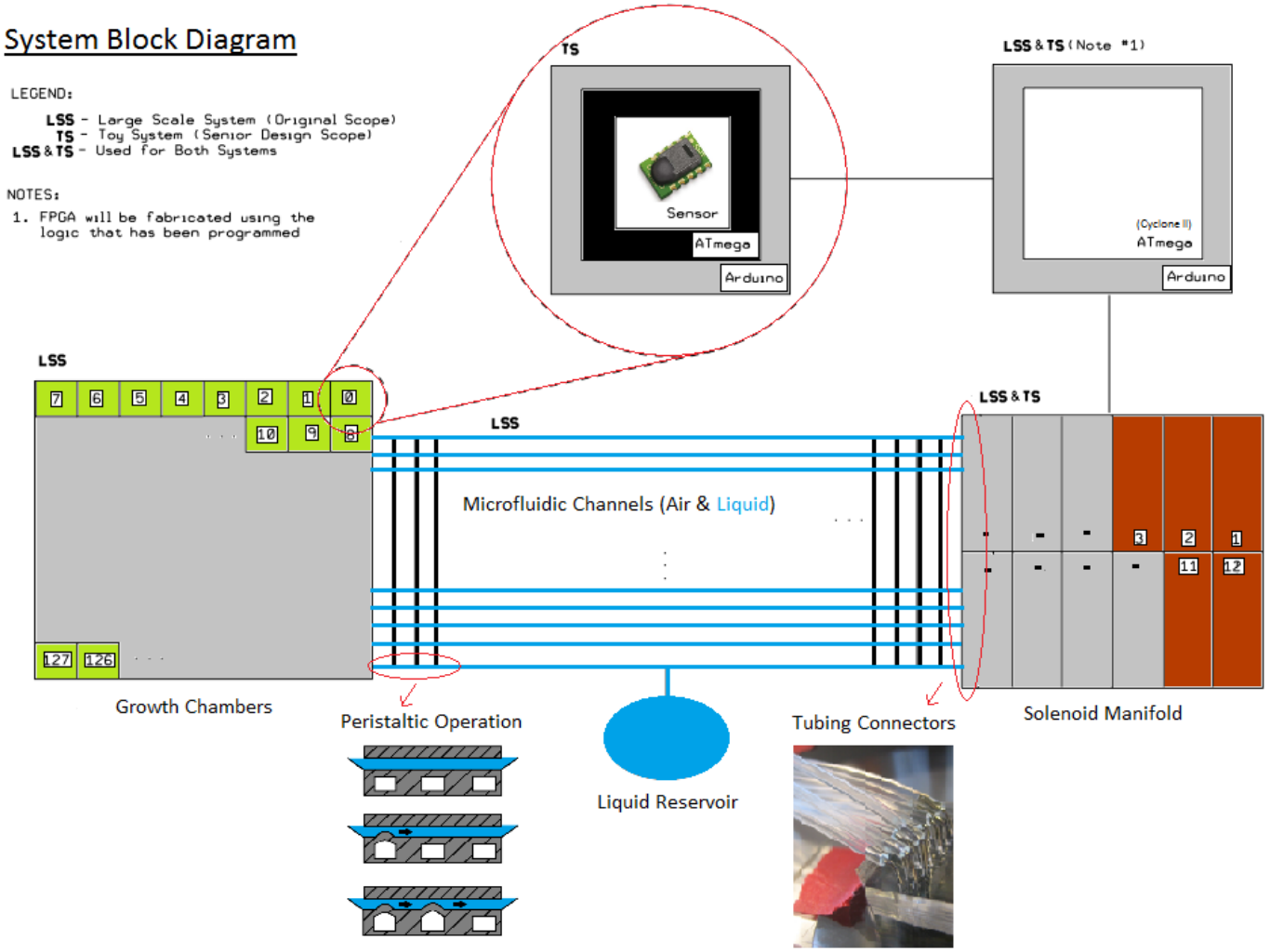
12 Mounted Solenoids
Can deliver up to 100PSI
5-10ms response time
Low power consumption(6V 0.4mA Normally off)

Channel Overlay System:



Allows for individual chambers to be selected for humidity control
Facilitates peristaltic pumping through compression/decompression of three air chambers

System Description

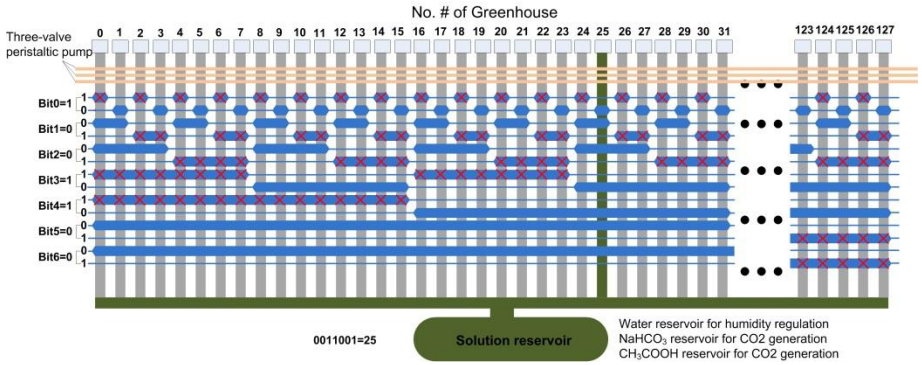


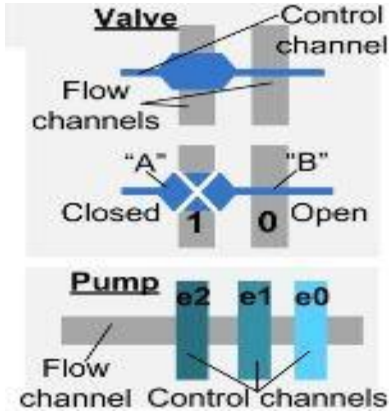
System Description

- Sensor detects humidity level.
- The output read is compared to preset conditions for chamber.
- The mismatch that’s found is corrected by pumping liquid into specific chamber.
- When output matches, next chamber is addressed.

System Description

- Addresses individual chambers by applying air pressure
- Air pressure inflates weakend areas of material causing them to balloon, pinching off the water lines





Setup and Testing Methods

Sensor Array

- Master slave operation – Arduino
- Place in different environment & observe output

Solenoid Manifold

- 25 pin connecter – Altera Cyclone II FPGA, Power Supply
- Testbench - Cadence

Setup and Testing Methods

Channel Overlay System

- First & Second layer are fabricated.
- Perform stress tests on material to verify proper layer bonding.

Small Scale System

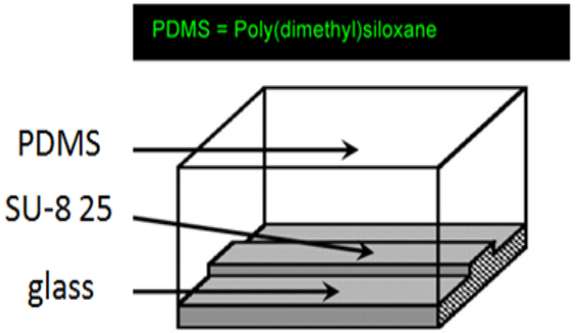
- “1/8” tubing & “1/16” tubing connections, Arduino and Altera connections.
- TS system testing do not use the channels.

Problems Encountered

Fluid Delivery Channels

a. Achieving correct thickness between layers of material

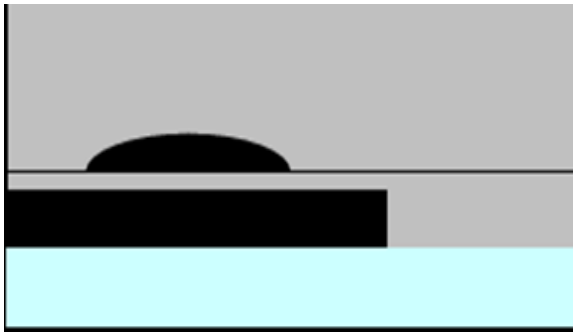
b. Maintaining the strength of bond between layers to prevent rupture of channels



Solenoid Manifold System

a. Interfacing sensor output with CycloneII in an easily readable way

b. Importing code to CycloneII can cause unexpected errors where there were none in simulation



Problems Encountered

Temperature/Humidity Sensors

a. Presenting sensor output in such a way that is both easily readable and can be expanded to 128 data paths easily
b. Creating a multiple sensor package when originally, one was required

Management/Project Scope

a. Scope of project changed multiple times
b. Last minute additions to project
c. Accepting changes as nature of project work/employment

Questions?