

# **Operations and testing Manual**

## **Chip Scale Seedling Growth Chamber Laboratory**

A decorative graphic at the bottom of the page consisting of several overlapping, semi-transparent geometric shapes in shades of blue and grey, creating a layered, architectural effect.

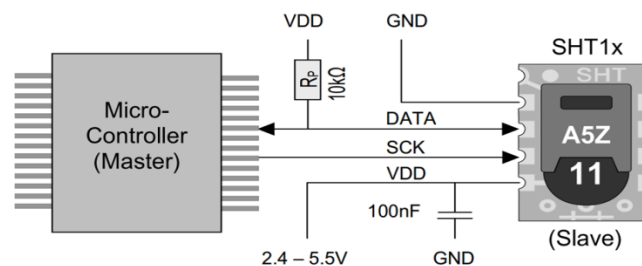
**Dec 1212**

## System Overview:

The Chip Scale Laboratory consists of three main parts; a solenoid manifold, a sensor array, and a 2-layer silicon channel system. The sensor provides information about humidity in a seedling chamber to the solenoid manifold via an Altera Cyclone II FPGA. When humidity needs to be corrected, the solenoids will lock an address in to the silicon chambers and use peristaltic pumping action to increase the humidity of the chamber by adding small amounts of water to the environment. Once the sensor detects the correct humidity, the next chamber is addressed.

## Setup of Individual Components:

### Sensor Array:

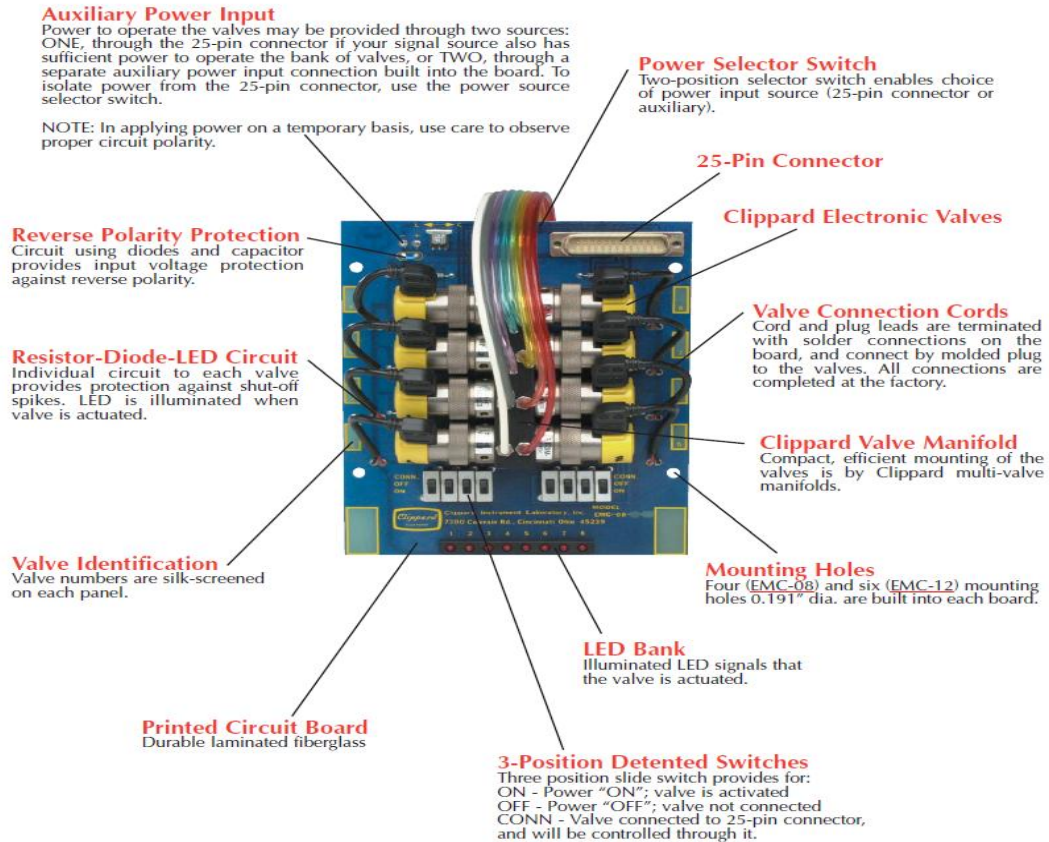


The SHT1x has 4 pins; Ground, Data, SCK, and VDD. The sensor input is interpreted via an Arduino microcontroller.

1. Place the SHT1x into a bread board and wire its GND and VDD pins according to the figure above
2. Wire DATA and SCK into the Arduino into pins that you have assigned in the Arduino interface

3.

## Solenoid Array:



The EMC-12-06-20 has places for 12 Solenoids that can be switched on by grounding the corresponding pin in the 25 pin connector on the PCB board. EMC-12-06-20 is controlled through an Altera Cyclone II FPGA

1. Connect the manifold pins 1-10 to the output pins assigned on the Altera Cyclone II FPGA then connect the power pins to a +6 Volt power supply and make sure the dipswitches on the board is set to "comm" and the power switch is set to "p"
2. Upload your Verilog code to the Altera Cyclone II and start the system

## 2-Layer Silicon:

The 2-Layer Silicon is created by using a mask system that has the layouts of two different channels; one for air delivery and the other for water.

1. Select the bottom layer mask and apply material to create first layer
2. Select top layer mask and apply material to create second layer
3. When the 2 layers have solidified, bond them together creating a two layer system

## Testing of Individual Components:

### Sensor Array:

The output of the Sensor/Arduino can be observed from a PC

1. Place the sensor in room temperature/humidity and check for output
2. Place the sensor in different humidity by placing the sensor near a glass of water and check to see the humidity changes
3. Place the sensor near a heating element to see if the temperature changes

### Solenoid Array:

Verilog provides a way to write test benches to provide a way to test the Solenoid Array

1. Create a test bench that will provide the system with false inputs that can be used to simulate a working environment

2. Observe the LED system on the manifold to check and see if the appropriate sequence of pumping and addressing is selected based on your test bench

## 2-Layer Silicon:

To test the 2-layer system, air pressure must be added to the input of the system.

1. Attach air cylinder to the inputs of the 2-Layer system
2. Observe channels to check for proper inflation of thin areas
3. Seal the system and check for leaks or layer ruptures

## Setup of Integrated System:

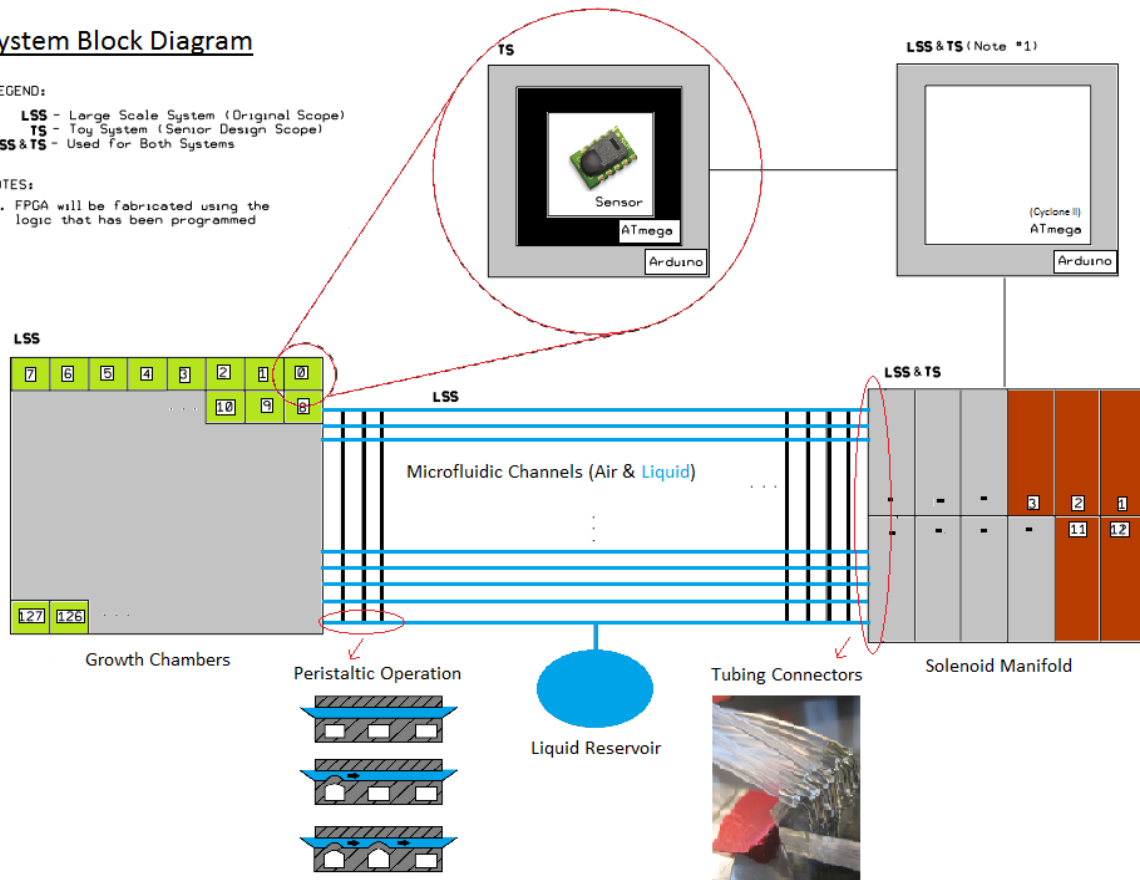
### System Block Diagram

**LEGEND:**

- LSS** - Large Scale System (Original Scope)
- TS** - Toy System (Senior Design Scope)
- LSS & TS** - Used for Both Systems

**NOTES:**

1. FPGA will be fabricated using the logic that has been programmed



All three parts can be integrated together very simply after the individual parts have been tested.

1. Begin by taking an output pin from the Arduino that contains information about the humidity coming from the sensor and place it on the assigned input pin of the Altera Cyclone II
2. Take a 1/8" Tube from an air supply and attach it to the main input on the ECM-20-06-12. Be sure the air supply is off until all hoses are attached
3. From the top of the ECM-20-06-12 output manifold, attach 1/16" hose from each active solenoid to the 2-layer systems input adapters.
4. Power on the Arduino and the Cyclone II and turn on the air supply
5. Check for proper system operation

## Testing of Integrated System:

After setup of the Integrated System, by adding fluid to the channel system the operation of the system is easily checked.

1. Add water to the supply reservoir in the 2-layer silicon system
2. Place the sensor in a high humidity environment
3. Power on the system
4. Watch for the address of the high humidity sensor appear and the pumping action begin
5. Make sure the water is being delivered along the channels
6. Once satisfied with the pumping action, remove the sensor from the high humidity environment and check to see that pumping action stops and addressing action resumes