# Greenhouse Climate Control

**Dale Nelsen**
**Preliminary Project Description**
**Etec 471, Professor Todd Morton**
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*Western Washington University*
*EET*

# Introduction

Have you ever had chores that needed to be done and needed to be done at the same time everyday? If so then you may want to get an automated system to take care of those chores for you. The Automated Greenhouse Climate Control is a system that will take care of the daily chores of a greenhouse. It will take input from a temperature sensor, a relative humidity sensor and a clock to take care of a heater, a fan, and a water valve to keep the climate inside the greenhouse to the optimum level.

The user of the system will just have to enter in a couple of variables to the system and then just sit back a watch the system work. The variables enter will be the time or times the watering is desired, the temperature that is required, and also the humidity that best works for the plants inside the greenhouse. If the greenhouse gets too hot the fan will come on to cool it off. Also if the humidity gets low or high the heater or fan will go on or off accordingly. The system will control these variables in this way.

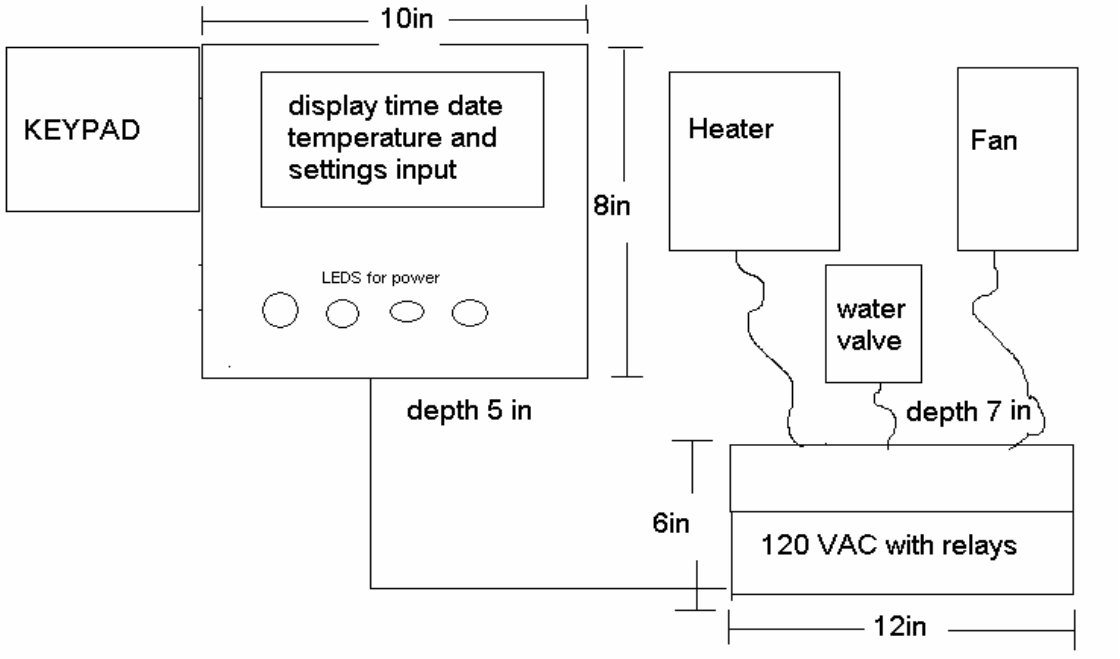

*Figure One*

# HARDWARE DESCRIPTION

## Micro controller

The automated greenhouse climate control system is controlled by the Motorola's MC9S12DP256B and from the schematic it is labeled U1. This is a 16 bit micro controller and it has 256Kb ytes of flash EEPROM, 12 K bytes of RAM, and 4 K bytes of byte-erasable EEPROM. The 9S12 receives data from the two sensors for humidity and temperature. The Humidity input is input into the PortT pin 7 of the 9S12 and the temperature is input into PAD00. It also receives input from the four buttons up, down, menu and enter located on the prototype. These buttons are input to Port B(0-4). Port A and K on the controller are used to control the output on the LCD module. Input from the RTC is input to the SPI and is used to keep track of the real time. Port T (0-2) controls the relays for the heater, fan, and water valve. Last the four LED that indicated what is running are connected to the port t (3-6). The figure for this is located below. Figure two below shows all the ports that are used on the 9S12 and what they are used for.

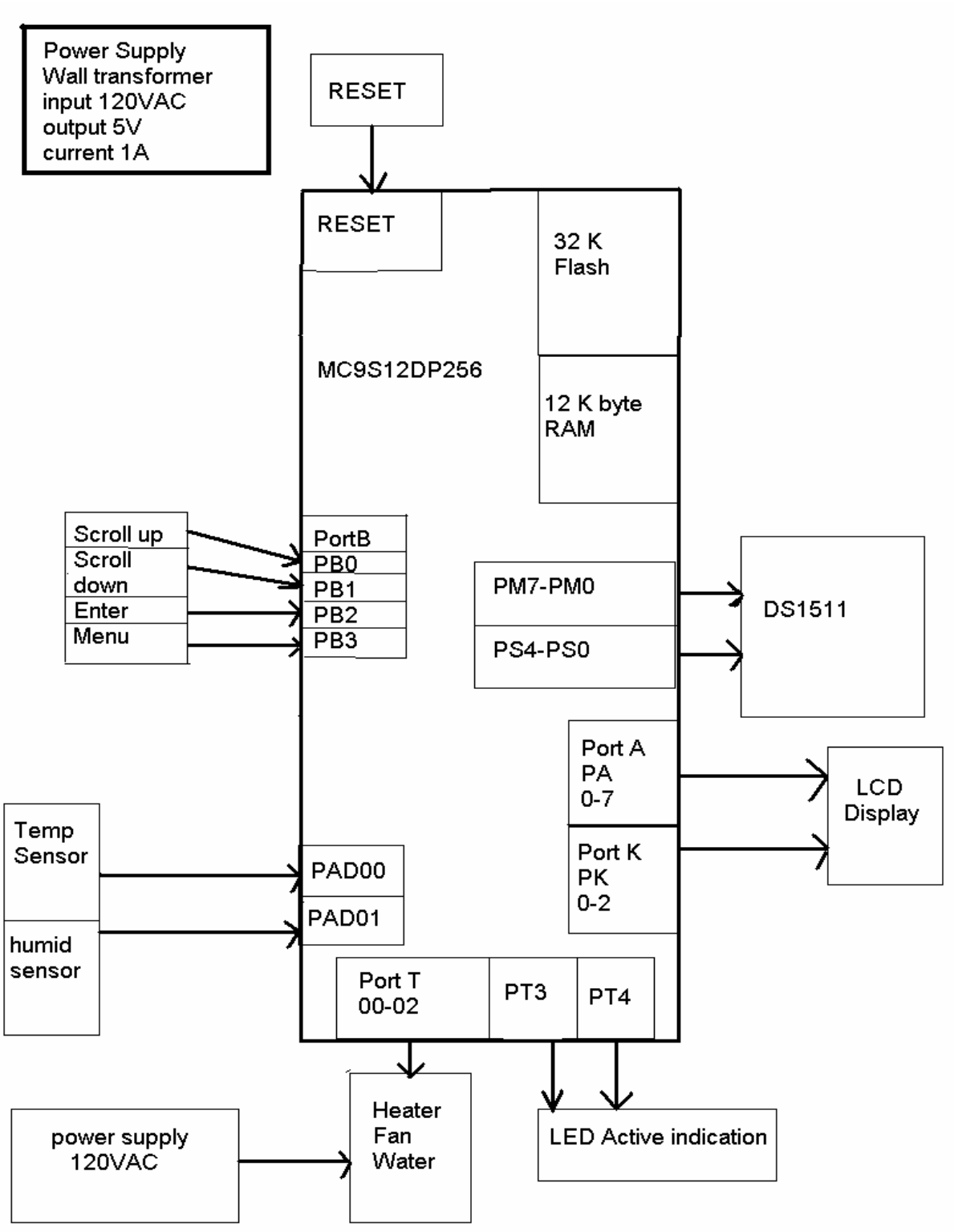
Power Supply
Wall transformer
input 120VAC
output 5V
current 1A
RESET
RESET
32 K
Flash
MC9S12DP256
12 K byte
RAM
Scroll up
Scroll
down
Enter
Menu
PortB
PB0
PB1
PB2
PB3
PM7-PM0
PS4-PS0
DS1511
Port A
PA
0-7
LCD
Display
Port K
PK
0-2
Temp
Sensor
humid
sensor
PAD00
PAD01
Port T
00-02
PT3
PT4
power supply
120VAC
Heater
Fan
Water
LED Active indication

*Figure Two*

## POWER SUPPLY

There is kind of three separate power supplies for this system. First off the heater and the fan use the 120VAC just from an outlet. The water valve uses the 24 VAC from a wall transformer. And the rest of the system uses a wall transformer that converts 120 VAC to 9V. Then is input to the LM2931T-5 regulator that gets a steady 5V DC output. This 5V is used on the 9S12 and also many of the peripherals.

## LCD MODULE

I used the HD44780U, which is a 2x16 character Lcd screen. It is just shown as LCD and U2 on the schematic. The LCD receives data from a total of 11 pins from the 9S12. It is connected to Port A (0-7) and also Port K (0-2). It is also connected to VCC of the micro controller. VSS is connected to ground and VEE is connected to the potentiometer, which is illustrated in the schematic as R11 10-20k.

## USER INPUT

The prototype of the system will have a entire 4x4 key pad but I will only be using four buttons which will be labeled menu, enter, up arrow, and down arrow. These buttons will be connected to Port B (0-4). These buttons are used to navigate through the user controls on the LCD. Menu will scroll through the menus, enter will select the menu option and the up and down arrows will scroll through number values for time, temperature, and humidity.

## Temperature Sensor

I am using the LM34 temperature sensor from national semiconductor. It is connected to PAD00, which is an Analog to digital converter on the 9S12. The LM34 output a temperature dependant voltage and this relationship is linear. It outputs 10 mV pet

degrees Fahrenheit. I amplify this signal by 4 and then I feed it into the Analog to digital converter for processing. I use the LF 411 in a non-inverting configuration with 3K and 1K resisters

## Humidity Sensor

The humidity sensor I am using is the HS1101 form Humirel sensors. This relative humidity sensor is essentially a varying capacitance that varies dew to the relative humidity. I have this interfaced with the TLC555, which is a 555 timer. The sensor is connected to the threshold pin and the trigger pin on the 555. Pin 7 on the 555 is used as a short circuit for resistor R14. So the HS1101 charges through R14 and R15 but it discharges through only R14 because of the connection to pin 7, which is the discharge pin. The output of the 555 timer is a square wave that has a humidity dependant frequency. This is fed into Port t pin 7 on the 9S12 and the micro controller will calculate the frequency.

## Relays

For the fan and the heater control I used solid-state relays connected to Port t (0-1). The part number is CC1027-ND and they are manufactured by Crydom. These relays are rated at 25A at 120 VAC input. They utilize the triac Output and they can be used as DC or AC control. Both the fan and the heater will draw about 12.5 amps the higher amperage was necessary. The micro controller will essentially be turning these relays on and off. The other relay has part number 20-1051-10 the manufacturer is Eac electronics and is rated at 5 amps and that is plenty for the water valve it will be connected to. This will be connected to Port T pin 2 on the 9S12 and will work exactly same as the other two.

These are designated as K 1-3 on the schematic.

## LEDS

I will be using LED to indicate whether or not the system or system peripherals are on. I will be using the 160-1496-ND LED and they will be connected to the 9S12 through Port t (3-6). So when the system is on the LED1 will light up, and if the heater is on LED2 will be on and so on.

## BDM

Since the system could need some changes down the road it is essential to have a means of updating the system. It is connected to the Eclk and Reset pins on the micro controller. It is used to communicate with the 9S12 and the BDM is designated as PL1.

## Real Time Clock

This is U4 and it is the DS1305 Real time clock. This chip counts seconds, minutes, hours, date of the month, month, day of the week, and has leap year compensation valid up to 2100. This is connected to the SPI pin on the 9S12 and also SDO pin is connected to master out slave in pin and the SD1 is connected to the master in slave out pin. The chip enable is connected to the SS0 pin on the 9S12 as well. To select the SPI mode on the chip the SERMODE is connected the VCC. This chip will only be used to give me the real time.

| ITEM | Quantity | Part | Designator |
|---|---|---|---|
| 1 | 1 | Resister 1% 3K | R1 |
| 2 | 2 | Resisters 1% 4K | R2,R17 |
| 3 | 4 | Resisters 1% 220 | R3,4,5,6 |
| 4 | 4 | Resisters 1% 10K | R7,8,9,10 |
| 5 | 2 | Resisters 1% 1K | R12,16 |
| 6 | 1 | Resister 1% 909K | R13 |
| 7 | 1 | Resister 1% 576K | R14 |
| 8 | 1 | Resister 1% 49.9K | R15 |
| 9 | 6 | Capacitor 10% 100nF | C1,3,4,7,11,13 |
| 10 | 4 | Capacitor 10% 10uF | C2,8,14,15 |
| 11 | 2 | Capacitor 10% 22pF | C5,6 |
| 12 | 1 | Capacitor 10% 330pF | C9 |
| 13 | 1 | MC9S12DP256 | U1 |
| 14 | 1 | LCD | U2 |
| 15 | 1 | LM34 | U3 |
| 16 | 1 | DS1305 | U4 |
| 17 | 1 | HS1101 | U5 |
| 18 | 1 | TLC555CN-ND | U6 |
| 19 | 1 | LF411 | U7 |
| 20 | 2 | CC1027-ND | K1,K3 |
| 21 | 1 | 20—1051-10 | K2 |
| 22 | 4 | 160-1496-ND | LED1,2,3,4 |
| 23 | 1 | 32kHz crystal | Q2 |
| 24 | 2 | 3 prong outlet female | |
| 25 | 1 | 3 prong outlet male | |
| 26 | 1 | TC7662A | U8 |
| 27 | 1 | Resister 1% 5.9k | R7 |
| 28 | 1 | Resister 1% 2k | R8 |
| 29 | 2 | Capacitor 10% 22uF | C16,C17 |
| 30 | 1 | KeyPad | K4 |