Snowflake WiFi Specification

29Apr2016

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- Write flake test pattern table
- Write logon Information
- Check Run Table
- Run Time Display

Browser

- Write run table
- Run Time Display

Version History

1. 29Apr2016 Dean Garton
    1.1. Tweek information about Web logon
    1.2. Tweek information about Web Download
    1.3. Tweek information about Web Run Time Display
2. 22Apr2016 Dean Garton
    2.1. Add information about Web Logon
    2.2. Add information about Web Download
    2.3. Add information about Web Run Time Display
    2.4. Add information about installing the FTDI driver
3. 20Mar2016 Dean Garton
    3.1. Add information about switching between patterns
    3.2. Illegal profile number will generate an error
4. 24Feb2016 Dean Garton
    4.1. allow profiles to be redefined for each new pattern
    4.2. remove scale factor
    4.3. make all times 16 bits
    4.4. make all times 10ms resolution
    4.5. add Blink Delay Time
    4.6. do not turn all displays off with start of new pattern
    4.7. show record number in decimal, not alpha
5. 19Feb2016 Dean Garton
    5.1. Remove GitHub credentials
6. 18Feb2016 Dean Garton
    6.1. Collect and update handwritten notes
    6.2. Add additional information to create a complete document
    6.3. Needs information about the browser interface

Features

1. Private WiFi Network
    1.1. Each Snowflake Node can control 1-16 snowflake displays
2. 10ms control of each snowflake display
    2.1. on
    2.2. off
    2.3. dim
    2.4. blink
    2.5. ramp up
    2.6. ramp down
    2.7. reps
3. Start up sequence
    3.1. Start web server
    3.2. Display test pattern
    3.3. Display version number
    3.4. Check run table
    3.5. Execute run table
4. Browser control
    4.1. Download new run table
    4.2. Display run time information
5. Run time information
    5.1. Pattern name
    5.2. Reps Remaining
    5.3. Record #
    5.4. Record Contents
6. GitHub for software updates
    6.1. Arduino IDE to compile software

Hardware

1. Private network with 2 or more nodes
2. Each node is connected via WiFi
3. The PC Node is required

Assemblies

PC Node

1. Function
    1.1. Create Run File
    1.2. Download Run File to Snowflake Node(s)
    1.3. Start/Stop Run File Execution
2. Parts List
    2.1. PC
        2.1.1. Run File
        2.1.2. Browser
    2.2. Router
        2.2.1. WiF

Snowflake LED Node

1. Function
    1.1. Control 1-16 displays
2. Parts List
    2.1. Enclosure
        2.1.1. Mother Board
        2.1.2. PWM Board
        2.1.3. LED Board
    2.2. Bolts, Nuts, Standoffs
    2.3. 3.3v Wall Wart

Snowflake AC Node

1. Function
    1.1. Control 1-16 displays
2. Parts List
    2.1. Enclosure (2x8 & Masonite)
        2.1.1. Mother Board
        2.1.2. PWM Board
        2.1.3. AC Board
    2.2. Bolts, Nuts, Standoffs
    2.3. 3.3v Wall Wart
    2.4. 110v power cord
    2.5. 110v Outlets
    2.6. Wire

Update Box

1. Function
    1.1. Connect to PC for Software Updates
2. Parts List
    2.1. Enclosure
        2.1.1. Update Board
    2.2. Bolts, Nuts, Standoffs
    2.3. Ribbon Cable
    2.4. USB Cable

PCBs, Make

Mother Board

1. Function
    1.1. Download the Run File
    1.2. Execute the Run File
2. Inputs
    2.1. Update
        2.1.1. Reset, GPIO 0, Rx, Tx
    2.2. Power
        2.2.1. 3.3v, GND
3. Outputs
    3.1. Update
        3.1.1. 3.3v, GND
    3.2. I2C
        3.2.1. SDA, SCL, 3.3v, GND
4. Parts List
    4.1. ESP-01 Board
    4.2. EEPROM
        4.2.1. 128K x 8 bits
    4.3. Resistors
    4.4. Capacitors
    4.5. Connectors
    4.6. PCB

LED Board

1. Function
    1.1. 16 LED display
2. Inputs
    2.1. PWM signals for LEDs
    2.2. Power
        2.2.1. 3.3v
3. Outputs
    3.1. LEDs
4. Parts List
    4.1. LEDs
    4.2. Connectors
    4.3. PCB

AC Board

1. Function
    1.1. Drive 16 AC Snowflake Displays
2. Inputs
    2.1. PWM DC Signals for displays
    2.2. Power
        2.2.1. 110v AC
        2.2.2. 3.3v
3. Outputs
    3.1. PWM AC signals for displays
4. Parts List
    4.1. Bridge Rectifier
    4.2. Opto Isolators
    4.3. IGBT Transistors
    4.4. Diode
    4.5. Resistors
    4.6. Capacitors
    4.7. Connectors
    4.8. PCB

Update Board

1. Function
    1.1. Connect to PC for Software Updates
2. Inputs
    2.1. USB connector
        2.1.1. Rx, Tx, 5v, GND
    2.2. Update
        2.2.1. 3.3v, GND
    2.3. Switches
        2.3.1. Reset, GPIO 0
3. Outputs
    3.1. Update
        3.1.1. Reset, GPIO 0, Rx, Tx
4. Parts List
    4.1. FTDI Board
    4.2. Level Shifters
        4.2.1. MOSFETs
        4.2.2. Resistors
    4.3. Switches
    4.4. Connectors
    4.5. PCB

PCBs, Buy

ESP-01 Board

1. Function
    1.1. Microprocessor
        1.1.1. Embedded code to manage WiFi communications
        1.1.2. API for customized code to manage snowflakes
    1.2. Radio
        1.2.1. WiFi
2. Inputs
    2.1. Reset
    2.2. GPIO 0
        2.2.1. Low + Reset
            2.2.1.1. Enter update customized code mode
        2.2.2. High + Reset
            2.2.2.1. Execute customized code
    2.3. Serial Interface
        2.3.1. Rx, Tx
            2.3.1.1. Update customized code mode
                2.3.1.1.1. Update customized code
            2.3.1.2. Execute customized code
                2.3.1.2.1. Communicate with another device
                    2.3.1.2.1.1. Feature not used
    2.4. Power
        2.4.1. 3.3v, GND
3. Outputs
    3.1. GPIO
        3.1.1. Execute customized code
            3.1.1.1. I2C Interface
                3.1.1.1.1. SDA, SCL
4. Parts List
    4.1. ESP-8266
    4.2. Connectors

PWM Board

1. Function
    1.1. On/Off/Dim Control of displays
2. Inputs
    2.1. I2C
        2.1.1. SDA, SCL, 3.3v, GND
3. Outputs
    3.1. 16 Pulse Width Modulation (PWM) Signals
    3.2. Power
        3.2.1. 3.3v
4. Parts List
    4.1. PCA9685
    4.2. Resistors
    4.3. Connectors

FTDI Board

1. Function
    1.1. Convert USB signals to Serial Interface
    1.2. Level shifters to optionally convert signals from 5v to 3.3v
2. Inputs
    2.1. USB signals
    2.2. 5v/3.3v Switch
        2.2.1. Must be in the 5v position
3. Outputs
    3.1. Serial Interface
        3.1.1. Tx, Rx, 5v, GND
4. Parts List
    4.1. FTDI Chip
    4.2. Switch
    4.3. Connectors

Software

Start Up Sequence

1. Start web server
    1.1. Web LogOn credentials are retrieved from EEPROM
    1.2. An IP address is output to the serial port
        1.2.1. Paste this address into a web browser to communicate with snowflake node
2. Display test pattern
    2.1. Each snowflake display is turned on one at a time
        2.1.1. snowflake #1 to snowflake #16
3. Display version number
    3.1. The version number is displayed in binary
        3.1.1. snowflake #1 = bit 0, and snowflake #16 = bit 15.
4. Check run table
    4.1. The run table is validated before attempting to execute it
5. Execute run table
    5.1. Snowflake displays are changed per the run table

Logon Information

1. Logon information is stored in non-volatile EEPROM memory
    1.1. Logon information starts at address 0 in the EEPROM
2. Logon information consists of 2 records
3. The first record contains the SSID name of the router
4. The second record contains the password of the router
5. Logon information is entered by the user
    5.1. See User Interface section for details
6. Once Logon information has been entered, it is stored in non-volatile EEPROM memory and does not have to be entered again
7. The layout of the Logon information in EEPROM is illustrated below

0x82	SSID - variable length, space reserved for up to 50 characters maximum
0x83	Password - variable length, space reserved for up to 50 characters maximum
Record ID	First Run Table Record (See Run Table section below)

Run Table

1. The Run Table is stored in non-volatile EEPROM memory
    1.1. The Run Table immediately follows the LogOn recprds
    1.2. All values in the Run Table are stored in binary format
2. The Run Table contains one or more Pattern Tables
3. Each Pattern Table consists of two tables
    3.1. Profile Table
        3.1.1. Defines the behavior of an individual snowflake display
        3.1.2. A Profile definition persists until that profile is redefined
    3.2. Pattern Table
        3.2.1. Assign each snowflake display to a profile for a specific period of time
4. There is overhead when switching to a new pattern
    4.1. Profile redefinition requires 10ms/12 profiles

profiles	time
0-12	10ms
13-24	20ms
25-36	30ms

    4.2. Display Outputs will be frozen during profile redefinition
5. The Run Table contains four types of records
    5.1. Start of Pattern Record
    5.2. Profile Record
    5.3. Pattern Record
    5.4. End of Table Record
6. Each record type is defined in the following paragraphs
7. A minimal Run Table is illustrated below:

Record ID	Start of Pattern 1 Record
Record ID	Profile Record
Record ID	Profile Record
Record ID	Pattern 1 Record 1
Record ID	Pattern 1 Record 2
Record ID	Pattern 1 Record 3
Record ID	Start of Pattern 2 Record
Record ID	Profile Record
Record ID	Profile Record
Record ID	Pattern 2 Record 1
Record ID	Pattern 2 Record 2
Record ID	Pattern 2 Record 3
Record ID	End of Table Record

Run Table Records

Start of Pattern Record

1. Defines the start of a new pattern table
2. Represented as hexadecimal numbers, but stored in binary format
3. When this record is encountered:
    3.1. If(more reps of the previous pattern are needed)
      wrap to first pattern record in previous pattern
      decrement rep count
    else
      continue to next record
    endif

		Start of Pattern Record
Byte #	Value	Description
0	0x90	Record ID
1	0x00 0x01 - 0xFF	Number of Reps same as 0x01 Reps
2	0x00 - 0x7F	Character 1 in Pattern Name (ASCII)
3	0x00 - 0x7F	Character 2 in Pattern Name (ASCII)
4	0x00 - 0x7F	Character 3 in Pattern Name (ASCII)
5	0x00 - 0x7F	Character 4 in Pattern Name (ASCII)
6	0x00 - 0x7F	Character 5 in Pattern Name (ASCII)
7	0x00 - 0x7F	Character 6 in Pattern Name (ASCII)
8	0x00 - 0x7F	Character 7 in Pattern Name (ASCII)
9	0x00 - 0x7F	Character 8 in Pattern Name (ASCII)

Profile Record

1. Defines the behavior of an individual snowflake display
2. Represented as hexadecimal numbers, but stored in binary format

		Profile Record
Byte #	Value	Description
0	0x80	Record ID
1	0-0x23 0x24-0xFF	Profile Number Profile Record will generate an error
2	0 0x01-0xFE 0xFF	Start intensity Off Dim On
3	0 0x01-0xFE 0xFF	End intensity (only used when ramp time is not 0) Off Dim On
4/5	0 0x0001-0xFFFF	Ramp Time Hi/Lo No Ramp 10ms - 655.35 seconds (Each Tick = 10ms)
6/7	0 0x0001-0xFFFF	Blink Delay Time Hi/Lo (only used if Blink On Time is not 0) No Blink Delay 10ms - 655.35 seconds (Each Tick = 10ms)
8/9	0 0x0001-0xFFFF	Blink On Time Hi/Lo No Blink On 10ms - 655.35 seconds (Each Tick = 10ms)
10/11	0 0x0001-0xFFFF	Blink Off Time Hi/Lo No Blink Off 10ms - 655.35 seconds (Each Tick = 10ms)

			Snowflake display behavior per profile record
Ramp Time	Blink On Time	Blink Off Time	Description

not 0	any	any	If(Start Intensity) < (End Intensity)
			  Ramp Up
			Else
			  Ramp Down
			Endif

0	not 0	not 0	Blink per Blink On and Blink Off times
			  On Intensity = Start Intensity
			  if(Blink Delay Time not 0)
			  Off for Blink Delay Time before On
			  endif

0	not 0	0	On Once per Blink On Time
			  On Intensity = Start Intensity
			  if(Blink Delay Time not 0)
			  Off for Blink Delay Time before On
			  endif

0	0	not 0	Off Once per Blink Off Time On Intensity = Start Intensity
0	0	0	Fixed Intensity Intensity = Start Intensity

Pattern Record

1. Assign each snowflake display to a profile for a specific period of time
2. Represented as hexadecimal numbers, but stored in binary format

		Pattern Record
Byte #	Value	Description
0	0x81	Record ID
1	0x00 - 0xFE 0xFF	Profile Number for snowflake display #1 No Change
2	“	Profile Number for snowflake display #2
3	“	Profile Number for snowflake display #3
4	“	Profile Number for snowflake display #4
5	“	Profile Number for snowflake display #5
6	“	Profile Number for snowflake display #6
7	“	Profile Number for snowflake display #7
8	“	Profile Number for snowflake display #8
9	“	Profile Number for snowflake display #9
10	“	Profile Number for snowflake display #10
11	“	Profile Number for snowflake display #11
12	“	Profile Number for snowflake display #12
13	“	Profile Number for snowflake display #13
14	“	Profile Number for snowflake display #14
15	“	Profile Number for snowflake display #15
16	“	Profile Number for snowflake display #16
17/18	0x00 0x0001-0xFFFF	Wait Time Hi/Lo Time until next pattern record 10ms (minimum) 10ms - 655.35 seconds (Each Tick = 10ms)

End of Table Record

1. Marks the end of the run table
2. Represented as hexadecimal numbers, but stored in binary format
3. When this record is encountered:
    3.1. If(more reps of the previous pattern are needed)
      wrap to first pattern record in previous pattern
      decrement rep count
    else
      wrap to first record in the table
    endif

		End of Table Record
Byte #	Value	Description
0	0x91	Record ID

Software Tools

1. The user may perform these tasks
    1.1. Update the software
    1.2. Interact with the processor during program execution
2. Tools must be installed to perform these tasks
    2.1. This only needs to be done once
    2.2. Instructions are provided below

Installing Software tools

Installing Arduino IDE

1. Adapted from https://www.arduino.cc/en/Guide/Windows
    1.1. Go to https://www.arduino.cc/
    1.2. Click on the download tab
    1.3. Click on “Windows Installer” in the blue box
    1.4. Run the downloaded file and follow the directions
    1.5. Create the path: Documents\Arduino\SnowflakesWiFi
        1.5.1. The code from GitHub for updating the software will be placed in this subdirectory

Installing ESP-8266 Support on Arduino IDE

1. Adapted from http://neilkolban.com/tech/esp8266/
    1.1. Start the arduino IDE by clicking on the desktop icon
    1.2. File > Preferences
    1.3. Additional Boards Manager :
        1.3.1. http://arduino.esp8266.com/stable/package_esp8266com_index.json
    1.4. Tools > Board “...” > Board Manager
    1.5. Click Install Box in the “esp8266 by ESP8266 Community” section
        1.5.1. If no Install Box, click on Online help to get Install Box
    1.6. Click on Tools > Board “...” > Generic ESP8266 Module

Installing the FTDI driver

1. The FTDI driver is required to communicate with the update box
2. Recent versions of the Arduino IDE appear to no longer include this driver as part of the install
3. If installation of the driver is required, it may be found here:
    3.1. http://www.ftdichip.com/FTDrivers.htm

Using Software Tools

Serial Port

1. The serial port is available for the user to
    1.1. update the software
    1.2. Interact with the processor during program execution
2. The user must connect the update box to the snowflake node and invoke the arduino IDE to access this interface
    2.1. Instructions are provided below

Connecting the update box

1. Connect the snowflake node to the update box with a 6 conductor ribbon cable
    1.1. Place the red stripe of the ribbon cable on the side of the connector labeled with a 1 in white letters on the PCB in both units
2. Connect the update box to a PC with a USB cable.

Invoking the arduino IDE

1. Start the arduino IDE by clicking on the desktop icon
2. Select the COM port in the arduino IDE
    2.1. Tools > Port
        2.1.1. Hint: if more than one COM port appears in the menu, disconnect the USB cable from the update box and note which COM port disappears from the menu. Pick this COM port after reconnecting the USB cable.

Invoking the Arduino monitor

1. Invoke the arduino IDE
    1.1. See procedure above
2. Invoke the monitor by clicking on the small box with the magnifying glass in the upper right hand corner
3. A new window will open
4. Set the line ending in the lower right hand corner to “Newline”
5. Set the baud rate in the lower right hand corner to “115200 baud”
6. You may send characters by typing them in the box at the top of the window and pressing the Enter key on the keyboard or clicking on the Send Box in the upper right hand corner of the window.
7. Characters received from the Serial Port are displayed in the large box which occupies most of the window.

Performing a software update

1. Get latest code from GitHub
    1.1. Delete A0_ESP subdirectory in Documents\Arduino\SnowflakesWiFi path
    1.2. Go to GitHub.com
        1.2.1. In search box at top of page > SnowflakesWiFi
        1.2.2. Click on gartonrd/SnowflakesWiFi
        1.2.3. Click on Download Zip box on right hand side of page
        1.2.4. Extract files to Documents\Arduino\SnowflakesWiFi
            1.2.4.1. Right Click on SnowflakesWiFi-master.zip
            1.2.4.2. Click on Show in Folder
                1.2.4.2.1. Right Click on SnowflakesWiFi-master.zip
                1.2.4.2.2. Click on Extract All…
                    1.2.4.2.2.1. Browse to Documents\Arduino\SnowflakesWiFi
                        1.2.4.2.2.1.1. Click on OK box at bottom of window
                    1.2.4.2.2.2. Click on Extract box at bottom of window
        1.2.5. Rename SnowflakesWiFi-master subdirectory to A0_ESP
2. Connect the Update Box
    2.1. See procedure above
3. Invoke the Arduino IDE
    3.1. See procedure above
    3.2. File > Sketchbook > SnowflakesWiFi > A0_ESP > Click
    3.3. Put the ESP_8266 in program upload mode using the update box
        3.3.1. Press and hold the Reset button
        3.3.2. Press and hold the GPIO_0 button
        3.3.3. Release the Reset Button
        3.3.4. Release the GPIO_0 button
    3.4. Sketch > Upload
        3.4.1. Shortcut: second from left icon on icon bar just under menu bar
        3.4.2. Program compiles
            3.4.2.1. It takes a minute or two
        3.4.3. Program uploads
            3.4.3.1. It takes a minute or two
            3.4.3.2. LEDs blink on FTDI module in update box and on ESP-8266
        3.4.4. Program executes
            3.4.4.1. See User Interface below to interact with processor during execution

User Interface

Serial Port

1. To access this interface:
2. Connect the update box
    2.1. See procedure above
3. Invoke the arduino monitor
    3.1. See procedure above

Start/Stop

1. Send any character (except W or L) to toggle between executing the run table or not.

Write flake test pattern table

1. When execution is stopped, send a W to write a flake test pattern table into EEPROM.
2. Sending any character except W or L will begin execution of the flake test pattern table
3. The flake test pattern table is designed to test most of the features of the snowflake node

Write logon Information

1. When execution is stopped, send an L to write logon information into EEPROM.
2. Follow the prompts to enter SSID and password information
3. Once Logon information has been entered, it is stored in non-volatile EEPROM memory and does not have to be entered again
4. Space is reserved in the EEPROM for the ssid and password to be up to 50 characters each
    4.1. Entering a new ssid and password will not affect the run table

Check Run Table

1. The run table is scanned to verify that valid ID numbers appear at the proper spacing
    1.1. If(an error is encountered)
        1.1.1. An error message is printed
        1.1.2. The record with the invalid ID is printed
        1.1.3. Execution is terminated
2. Each record in the run table is transmitted out the serial port as the run table is scanned
3. The following information is provided:
    3.1. PatternName Record# : RecordContents

Run Time Display

1. Each record in the run table is transmitted out the serial port as the run table is executed
    1.1. The Start of Pattern Record is replaced by heading information
    1.2. The End of Table Record is replaced by a row of = characters
2. The following information is provided:
    2.1. PatternName Reps Record# : RecordContents

Browser

1. To access this interface:
    1.1. Record the IP address that is output to the serial port at startup
    1.2. Paste this address into a web browser

Write run table

1. Click the”Cchoose file” button
2. Navigate to the desired file
    2.1. The desired file should be in the .fl5 format
3. Highlight the desired file
4. Click the Open button
5. Click the “Upload pattern” button

Run Time Display

1. Records in the run table are displayed in the browser window as the run table is executed
2. The last 10 records are displayed
    2.1. The most recently executed record is on top of the list
3. The list is updated every 1 second
    3.1. The display of some records may be skipped if more than 10 records are executed in 1 second
4. The following information is provided:
    4.1. PatternName Reps Record# : RecordContents