ANGRY ELECTRONS

WordClock-5 User Guide

A WiFi Based Colorful WordClock

Contents

Introduction

WordClock 5 is a clock that displays the time in words, from what appears at first glance to be a random matrix of letters eight rows deep, by either sixteen, thirty-two or forty-eight (!) columns wide, using one, two or three sixteen column boards connected together. The sixteen column version displays time in five minute increments, the thirty-two column version displays time, to the minute and the forty-eight column version additionally displays seconds.[1] Several languages are available, with more[2] on the way. It does all this in glorious technicolor with a host of different color animations and transitions, all selectable via a web setup and through two buttons on the clock.

WordClock 5 connects to Internet NTP servers as a time source, and seasonal adjustments for daylight savings time are accomplished automatically.

An open source format file is used for each version and each language, so users may adjust and customize settings as they please. You can even make your own faceplate for any other type of 'clock' if you're feeling adventurous.[3]

Several time change automations are built in and available to run at varying time changes during the day.

Additional features of WordClock 5 include:

- Initial setup and configuration are accomplished using a web browser on a PC or mobile device.
- UTC offsets with 30 and 45 minute time differences are supported, for use anywhere in the world.
- Daylight Saving Time (DST) start and end times are supported.
- Connects to Wi-Fi networks (open or WPS password protected).

[1] Currently in development…
[2] We shall see….
[3] Laser required….

Quick Start

- Connect a 5V DC power supply, 5.5/2.1mm diameter, center positive. The clock is reverse voltage protected, BUT IT IS NOT PROTECTED AGAINST HIGHER VOLTAGES! More common 12V supplies will most likely destroy all 128, or 256 LEDS! Minimum 2A for single board clocks and 4A for double board clocks.

- AP will blink on the display, indicating access point mode.

- From a mobile device or PC, connect to the Wi-Fi network named *WordClock-5*.

- Enter 192.168.4.1 into the URL field of any web browser (on the same WiFi network)

- Select the WiFi network that you wish to connect the clock to and enter the password.

- Change other settings as appropriate, referencing this manual.

- Press the *Save* button below the last field, to save selections and start WordClock 5.

- If successful, the clock display will show 'WC5', then 'WiFi', then 'NTP' and then the correct time.

A note on NTP servers. If you have a *lot* of clocks that regularly poll the same NTP server (such as *us.pool.ntp.org*) then that *can* lead to problems as the request times per the user agreement for the NTP Pool Project ask that';

"4. End-User agrees that he or she will not:
(a) Change default settings to make more frequent request of the Services, if using an ntp daemon ("NTP Protocol");
(b) **Request time from the Services more than once every thirty (30) minutes (ideally at even longer intervals), if using SNTP**."[4]

Modern routers usually offer an inbuilt NTP server that all home devices can be pointed to so as to avoid any issues. For example, 198.162.1.1 may be a valid address for a local NTP time server.

This may be different for other publicly available time servers. A web search will identify many that are freely available.

[4] https://www.ntppool.org/tos.html

Operation

Button functions

SW1 – Hold and apply power to cycle LEDs through RGB colors. Useful to test soldering skills as assembly progresses.

SW1 – Press while the time is displayed, to change the color effects. Effects will cycle in the order displayed in the setup function.

SW1 – Press during override to restore original settings for the time specified in Cancel Override Timer (see Configuration Settings below).

SW2 – The initial WC5 display should show colors in Red->Green->Blue order. W should be red, C should be green, and 5 should be blue. If any other order is displayed, hold SW2 and apply power then release when WC5 appears. If the color order is still not correct, repeat the process. This only needs to be done once to account for different display types.

SW2 – Press SW2 while time is displayed, to change brightness. Brightness will cycle through ten levels.

SW2 – Hold for five or more seconds while time is displayed, to put WordClock 5 into Access Point mode. The original options will be saved so they can be edited.

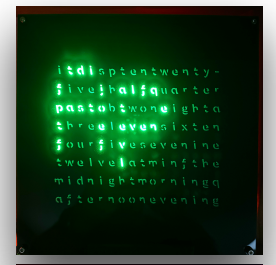
Pressing SW1 and SW2 when power is applied, resets WordClock 5 to factory defaults, and puts it in access point mode. Release the buttons when WC5 is displayed.

Pressing SW1 when WC5 is displayed, puts WordClock 5 in a special debug mode where the clock displays time quickly, to check for errors in format files. Release the button after WC5 is cleared from the screen. More on this later.

Messages

SD Card – The SD Card cannot be mounted. It may not be present, or it may be formatted incorrectly (only for single board clocks with different languages or the double/triple board clock)

AP – This message is displayed while WordClock is in Access Point mode, waiting for *Settings* to be saved.



WiFi – While connecting to a Wi-Fi network, this message will be displayed. If the message does not clear after a few seconds, the WiFi password is probably not correct.

NTP – This message indicates that the clock is connecting to an NTP time server, after establishing a Wi-Fi connection. It is displayed quickly or sometimes not at all.

Override Modes 1-3

Three override modes can be set based on hourly on/off times. Several options are configurable within each time range. For example, WordClock 5 can be set to dim the display between 11:00PM and 7:00AM on weekdays etc.

If override mode time ranges overlap, the range with the lowest number has the highest priority.

Configuration settings

Access Point

A new WordClock will start in **AP** mode the first time it is powered on. To start in **AP** mode after WordClock has been running, hold SW2 for more than 5 seconds. To start in **AP** mode and reset all settings to factory defaults, hold SW1 and SW2 and then apply power.

When **AP** is displayed, select the Wi-Fi network, *WordClock-5*, from a PC or mobile device. After a connection is indicated, enter 192.168.4.1 into the URL line of a web browser. The

Settings options detailed below will be displayed. Press the Save button after settings are updated.

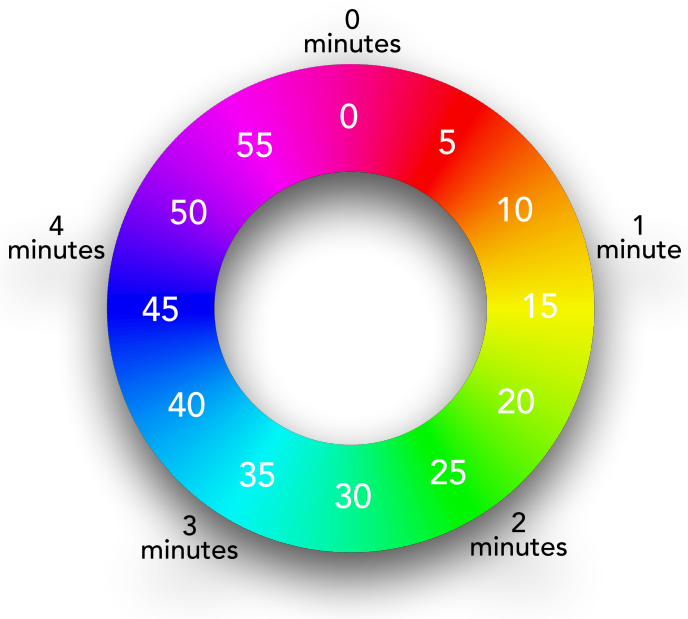
All hourly settings use 24 hour time.

- **Access Point Name** – The name of the access point that appears as the Wi-Fi network when connecting from a pc or mobile phone's browser. The default is WordClock.
- **Network SSID** – Available networks are displayed in a dropdown. Select the network to connect to if using NTP as the time source. Although SSIDs with spaces may be displayed, WordClock may fail to connect. No more than 25 characters are recognized.
- **Password** – Enter the password for the Wi-Fi network. Spaces within passwords, and trailing spaces, are not allowed. Maximum length is 25 characters.
- **NTP Server** – Enter the name of the NTP server. This field defaults to pool.us.ntp.org.
- **Animation** – Select the desired animation from the list.
- **Animation Time** – Select the frequency of the animation, or off.
- **LED Effect** – Select the desired effect, or off.
- **LED Brightness** – Select the brightness level, or off.
- **Override Start Time 1-3** – Starts the override at the selected hour.
- **Override End Time 1-3** – Ends the override at the selected hour.
- **Override Days 1-3** – Activates override mode for All, Weekdays, or Weekends.
- **Animation 1-3** – Same as above, but for the current override mode.
- **LED Effect 1-3** – Same as above, but for the current override mode.
- **LED Brightness 1-3** – Same as above, but for the current override mode.
- **Override Brightness 1-3** – Sets the brightness of the display when in override mode.
- **UTC Offset Hours** – Sets the number of hours offset from UTC time.
- **UTC Offset Minutes** – Used for a few time zones worldwide.
- **UTC Offset Direction** – Sets the offset specified to + or -.
- **DST Start Month** – Sets the month that daylight savings time starts.
- **DST Start Week** – Sets the week of the month that daylight savings time starts.

- **DST Start Day** – Sets the day of the week that daylight savings time starts.
- **DST Start Hour** – Sets the hour of the day that daylight savings time starts.
- **DST Offset** – Sets the offset in hours for daylight savings time.
- **DST Offset Direction** – Sets the offset direction specified to + or -.
- **DST End Month** – Sets the month that daylight savings time ends.
- **DST End Week** – Sets the week that daylight savings time ends.
- **DST End Day** – Sets the day that daylight savings time ends.
- **DST End Hour** – Sets the hour that daylight savings time ends.
- **Announcement Color** - Sets the color of any announcements enabled from the SD Card
- **Cancel Override Timer** - When SW1 is pressed during an override, original settings are restored for the time period set here.

Color Wheel Timer is a special effect that cycles through a rainbow of colors based on a predetermined time period. For the single board clocks that display time in five minute increments, colors complete each cycle every five minutes. By familiarizing yourself with the color order, it is possible to determine the minute between each five minute cycle of the clock.

Similarly, the color wheel cycles each minute with two board clocks, so the seconds can be estimated. Three board clocks already display seconds, so the color wheel does not offer any additional information, although it does complete each cycle in one minute (and looks good too…).



Announcements

The announcement file is an optional feature that allows users to schedule and display custom messages based on calendar dates or weekday occurrences. This file should be saved on the SD card in the following location:

/Announce/Announce.txt

It is a plain text file that can be created or modified using any standard text editor, such as Notepad or TextEdit. The file can contain up to 75 individual announcements, each placed on a separate line. Every line in this file represents a unique message to be displayed at a specific day or recurring schedule.

Each announcement may be up to 62 characters in length. The order of the entries does not need to follow calendar sequence—announcements can be listed in any order that is convenient for the user. Note that this file is not included with the standard library distribution and must be created manually.

Date-Based Announcements

A standard announcement is triggered by a specific calendar day. The format for these announcements consists of two digits for the day, followed by a separator (either a dash - or forward slash /), and then two digits for the month. After this date component, the text of the announcement follows.

For example, an announcement that should appear on June 20th would be written as:

```
06-20Happy Birthday Melissa
```

To make an announcement appear every month on the same day, regardless of the month, the special code 00 should be used for the month. For instance:

```
00-12Pay Estimated Taxes
```

This line ensures the reminder is displayed on the 12th day of every month.

Weekday Occurrence-Based Announcements

In addition to fixed calendar dates, the system also supports announcements tied to specific weekdays and their occurrence within the month. This is useful for holidays or events that do not fall on a fixed date but instead recur on the same weekday each year (e.g., "last Monday of May”).

The structure of these entries includes the two-digit month, followed by either a dash or slash. This is followed by the weekday index (where Sunday is 1, Monday is 2, and so forth), a comma, and then the occurrence number. The occurrence is a numeric value from 1 to 5 for the first through fifth occurrence, or a greater-than symbol (>) to indicate the last occurrence of that weekday in the month.

Here are several examples:

```
05-01,>Memorial Day
```

This entry ensures the message "Memorial Day" appears on the last Monday of May each year.

```
03/02,2Second Tuesday
```

This message will display on the second Tuesday in March.

```
10,0,3Third Sunday
```

This line triggers the message on the third Sunday of October.

This flexible system allows for a wide variety of recurring announcements, managed through a simple text file. The format is deliberately straightforward so users can add or update announcements without specialized software or configuration tools.

Announcements are displayed at the 30 second mark of each minute.

Format Files

Please note that support is not provided for changing or developing new format files.

Format files are used to define the positions and actions of each LED within the matrix. Only the single board, eight by sixteen matrix clock has the format file built-in for the English language version. Other formats require an SD card, which will override the built-in format file. If changes to the built-in format are desired, *English5.fmt* can be installed on an SD card and modified. The SD card must contain a folder called *Language* and the file name must be no more than eight characters long, with the extension *.fmt*. Only one format file is allowed in the folder, but others can be stored elsewhere on the SD card.

Format files can be downloaded from the website.[5] Examining one will help to understand how they work.

Here is the *English1.fmt* file for reference;

```
//tag, row, column, length

Prefix:;
A,1,1,2;      //it
B,1,4,2;      //is

Minutes:;
1,2,7,3;      //one
2,2,10,3;     //two
3,2,13,5;     //three
4,2,18,4;     //four
5,2,22,4;     //five
6,4,1,3;      //six
7,4,8,5;      //seven
8,4,17,5;     //eight
9,4,24,4;     //nine
10,1,7,3;     //ten
11,2,25,6;    //eleven
12,3,1,6;     //twelve
13,3,7,8;     //thirteen
14,3,15,8;    //fourteen
15,3,23,7;    //fifteen
16,4,1,7;     //sixteen
17,4,8,9;     //seventeen
18,4,17,8;    //eighteen
19,4,24,8;    //nineteen
20,1,10,6;    //twenty
30,1,17,6;    //thirty
40,1,24,5;    //forty
50,2,1,5;     //fifty

A,1,16,1;     //dash for twenty
B,1,23,1;     //dash for thirty
C,1,29,1;     //dash for forty
D,2,6,1;      //dash for fifty

Separator:;
A,5,1,6;      //minute
B,5,7,1;      //"s" for minutes
C,5,9,4;      //past
```

[5] stocksclocks.com

```
Hours:;
1,5,14,3;     //one
2,5,17,3;     //two
3,5,20,5;     //three
4,5,25,4;     //four
5,5,29,4;     //five
6,6,1,3;      //six
7,6,4,5;      //seven
8,6,9,5;      //eight
9,6,14,4;     //nine
10,6,18,3;    //ten
11,6,21,6;    //eleven
12,6,27,6;    //twelve

Suffix:;
A,7,1,6;      //o'clock
B,7,8,2;      //in
C,7,11,3;     //the
D,7,15,7;     //morning
E,8,1,2;      //in
F,8,4,3;      //the
G,8,8,9;      //afternoon
H,8,18,2;     //in
I,8,21,3;     //the
J,8,25,7;     //evening
K,7,25,8;     //midnight

//(category, tag, time to reference(minute, minute10, minute5, minute1, hours, hours10,
hours1, time), >=, <=) - 1 means ignore

Format:;
prefix,A;                 //display prefix A & B "it is"
prefix,B;

minutes,,minutes,1,19;
minutes,,minutes10,20,59;  //display minute 10 msd
minutes,A,minutes,21,29;   //dashes for minutes
minutes,B,minutes,31,39;
minutes,C,minutes,41,49;
minutes,D,minutes,51,59;
minutes,,minutes1,20,59;   //display minute 1 lsd

separator,A,minutes,01,59; //"minute"
separator,B,minutes,02,59; //"s" at all times except  00 and 01
separator,C,minutes,01,59; //"past"

hours,,hours;              //display hours

suffix,A,minutes,00,00;    //display "o'clock" if minutes = 0

suffix,B,hours,00,11;      //in the morning 0000 to 1100
suffix,C,hours,00,11;
suffix,D,hours,00,11;

suffix,E,hours,12,17;      //in the afternoon 1200 to 1700
suffix,F,hours,12,17;
suffix,G,hours,12,17;

suffix,H,hours,18,23;      //in the evening 1800 to 2300
suffix,I,hours,18,23;
suffix,J,hours,18,23;

suffix,K,time,0000,0000;   //display "midnight" for the first minute at midnight
suffix,-A,time,0000,0000;  //remove "o'clock" at midnight
suffix,-B,time,0000,0000;  //remove "in" at midnight
suffix,-C,time,0000,0000;  //remove "the" at midnight
suffix,-D,time,0000,0000;  //remove "morning" at midnight
```

Comments must be proceeded by a double slash, and each command or definition must end with a semicolon.

The first five sections of the file include *Prefix, Minutes, Separator, Hours*, and *Suffix*. Each section definition must end with a colon, and a semicolon must terminate each line within each section.

Each definition within the first five sections follow the format, *tag, line, row, length*. *Tag* for minutes and hours must match the corresponding time. For example, using *English5.fmt*, “5,2,1,4” defines the five minute mark, line 2, row 1, 4 LEDs long, and this will light the letters, “f i v e.”

Constants such as “it is”, are represented similarly, except the tag can be any alphanumeric character, case independent.

The sixth section, *Format*, controls when each definition is displayed. Its format is *section, tag, time to reference(minutes, minute10, minute5, minute1, hours, hours10, hours1, time), greater than or equal*, and *less than or equal*.

To represent times that are “to” the next hour, enter + into the *tag* field, and the desired minute range. Here is an example from the *English5.fmt* file, “prefix,+,35,59;.” Enter “-” in the field to subtract an hour from the currently referenced time. This is only useful when a multi-board clock is designed with two different languages, and the second language needs to reset to the current time.

Leaving *tag* blank will force a search of the specified *section*, to match the current time. Adding *greater than or equal*, and *less than or equal*, limits the display to a specific range of times with a comparison to the actual time digits specified in *reference*.

Software Updates

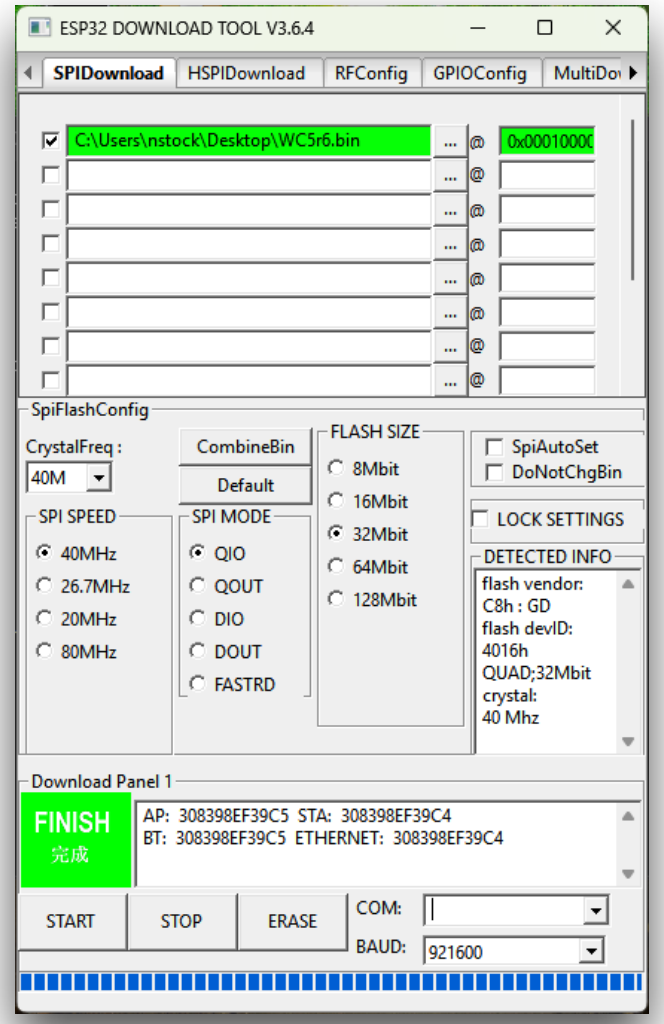
Occasional software updates may be provided to improve performance and/or add new features. Carefully follow these instructions to update the software if you wish to do so. Disconnect power from the clock. Connect the microcontroller board to a PC using a cable with a micro-USB connector. In Device Manager, note the COM port.

DO NOT connect the USB cable while the board is powered! The microcontroller board can be removed from the main board when updating the firmware.

Download and install the Flash Download Tools (ESP8266 & ESP32) from Espressif.[6] A link is also provided on www.stocksclocks.com.

Select *ESP32 Download Tool* from the menu.

Select *SPIDownload* tab and enter the following settings (see picture):



Download Path Config: Select the file provided by email or the web site by clicking on the box with three dots, on the first line. After "@", enter address 0x00010000 (four zeros after the one). Check the box to the left of the file name.

DO NOT CLICK ERASE or the microcontroller WILL have to be returned for reprogramming.

DO NOT CHECK ANY OTHER BOX IN THE LEFT COLUMN. IF THEY ARE CHECKED BY DEFAULT, UNCHECK THEM.

Additional Settings
Crystal Freq: 40M
SPI SPEED: 40MHz
SPI MODE: QIO
FLASH SIZE: 32Mbit
COM: Port: Enter the port noted in the Device Manager. **If** you only have the ESP32 plugged in to the computer, this field will automatically select the correct COM port.
BAUD: Select 921600. If the update fails, try a slower baud rate.

DO NOT SET OR CHANGE ANY OTHER SETTINGS. REVIEW TO MAKE SURE ALL SETTINGS ARE CORRECT, ESPECIALLY THE ADDRESS NUMBER AFTER "@." IF INCORRECT SETTINGS ARE FLASHED, THE MICROCONTROLLER MAY HAVE TO BE RETURNED FOR REPROGRAMMING.

[6] https://docs.espressif.com/projects/esp-test-tools/en/latest/esp32/production_stage/tools/flash_download_tool.html

Click **START**. When finished, disconnect the USB cable and power up the clock.

Notices