MOD-SIX Lumina
Nixie Clock
User's Guide

March, 2023

This manual describes the installation and operation of the MOD-SIX Lumina Nixie Clock.

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WARNING: This clock makes use of high voltages within the case. Never attempt to operate the clock with the cover removed.

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Preface

This manual explains how to install and use the MOD-SIX Lumina Nixie Clock, hereafter generally referred to as the Lumina or the clock.

Intended Audience

This manual is intended for all clock users. It describes the unpacking, installation, and configuration of the clock as well as providing a history of the tubes used in the clock and other interesting information.

Important Cautions

WARNING: DO NOT operate the clock without the cover in place - hazardous voltages are present at some locations on the circuit boards when the clock is operating.

The tubes are extremely fragile and expensive (several hundred dollars each, when available). Use ultimate care when unpacking them from their shipping materials and installing them in the clock. **NEVER** ship the clock with the tubes installed.

Like all electronic devices, the clock components can be damaged by static electricity. When installing the clock or accessories, or changing settings on them, always touch the aluminum baseplate first to discharge any static electricity.

Useful Web Sites

- BadNixie: http://www.badnixie.com
- MOD-6 Google Group: https://groups.google.com/group/mod-6_7971
- NEONIXIE-L Google Group: https://groups.google.com/group/neonixie-l
- Industrial Alchemy: https://www.industrialalchemy.org

Conventions

In this document, the following conventions will be used:

- **For future use** and similar terms are used to describe some items in this manual. The presence of **"For future use"** material in this manual does not indicate that the functions or options are available, nor imply any promise that they will be offered at any point in the future.
- **Clock** refers to the MOD-SIX Lumina base / electronics, tubes, and acrylic cover as an assembled unit.
- **MET-PIR** refers to the optional wireless passive infrared sensor with integrated temperature / humidity / barometric pressure sensors.
- **Keyfob** refers to the optional handheld remote control.

- **Center design** refers to the dimple in the middle of the clock base with an overhead programmable RGB LED.
- **Bold** words generally refer to menu settings described in detail in Chapter 4.
- *UPPERCASE ITALIC* words generally refer to options described in detail in Chapter 5.
- **Note** calls your attention to a procedure that should be followed closely (when referring to hardware) or to a setting that needs an additional explanation (when referring to firmware). Ensure you are familiar with the relevant documentation before performing any procedures or changing any settings marked with **Note**.
- **Caution** indicates that you should take care to perform the referenced procedures as per the documentation, as damage to one or more clock components can happen if any procedure with a **Caution** is performed improperly.
- **WARNING** indicates that particular care needs to be taken to prevent possible personal injury.

1 Introduction and package contents

Figure 1–1 Clock in operation

This chapter describes the MOD-SIX Lumina package contents so you will know what to expect when you unpack it in the next chapter.

Note: Certain items, such as the MET-PIR and the keyfob, may not be included with your clock, depending on the option(s) you ordered.

The package contains:

- This manual
- Clock base with circuit boards installed
- Colon towers
- Clear acrylic clock cover
- Sheet with 4 clear bumpers for clock cover
- AC adapter for clock (US customers only)
- MET-PIR (Optional)
- 2 * AAA batteries for MET-PIR (Optional)
- Keyfob (Optional)

You will also need:

- Six B-7971 Nixie tubes (preferably matching styles - see Section B.1)

- AC adapter for clock (non-US customers only)

Note:

An AC adapter is supplied for US customers only. If you are installing the clock outside the US, you will need to obtain an appropriate AC adapter with the following specifications:

- **Input voltage/frequency: As appropriate for your location**
- **Output voltage: 12V DC**
- **Output current: 2A (minimum)**
- **Output connector: 10mm X 5.5/2.1mm ID coaxial plug, center positive (+)**
- **Safety certifications: As appropriate for your location**

- Cotton gloves to avoid getting fingerprints on the tubes, cover and baseplate (Optional)

Figure 1–2 Other clock system components (some optional)

- Keyfob
- MET-PIR
- 2 AAA batteries for MET-PIR
- Clock AC adapter (US customers only)

Note: The AC adapter shipped to US customers may appear slightly different than the one shown in the picture.

2 Unpacking and installing the clock

This chapter provides information necessary to install the clock system. Please read these instructions completely before proceeding with unpacking and setup.

Unpack each item carefully, as described below, and verify that all items are present and undamaged.

2.1 Unpacking the clock cover and base assembly

The clock cover is wrapped in plastic and shipped on top of the clock base assembly which consists of a machined aluminum base and circuit boards. The entire package is cushioned by custom cut plastic foam inserts.

Cautions: DO NOT use any sharp objects such as a razor blade or scissors during the unpacking procedure as you may scratch or otherwise damage the plastic cover or base.

NEVER attempt to lift or move a complete clock by grasping the cover - instead, lift it out of the packaging or move it by firmly grasping the base assembly. The base assembly is quite heavy and has sharp edges, so make sure you have a good grip on it and have prepared a location to place it before unpacking.

Note: You may wish to use cotton gloves at this point to avoid getting fingerprints on the clock cover and base assembly.

Carefully open the outer carton to expose the clock and packing materials. Lift the clear acrylic cover and set it aside (still in its protective plastic wrap) for later. If you ordered any accessories such as the MET-PIR or keyfob, they will be packaged in protective bubble wrap next to the base assembly. Remove those and set them aside for now. Do the same for the AC adapter (US customers only).

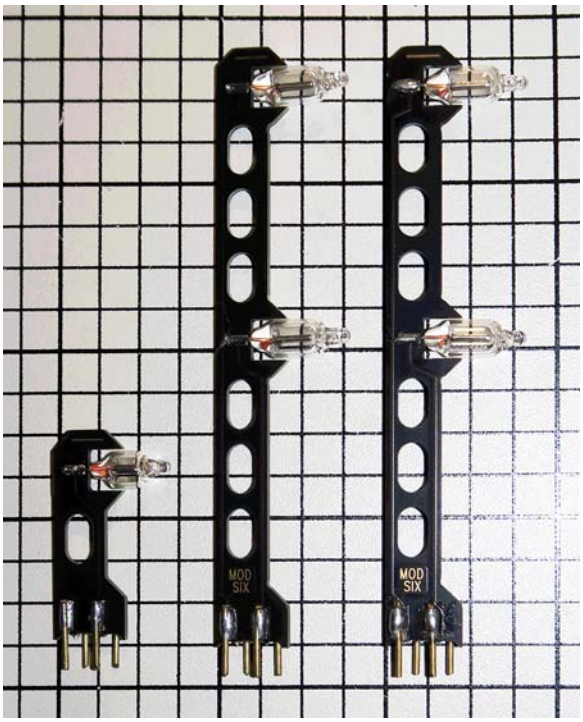
Lift the clock by the base assembly, taking care to avoid sharp edges, and position it in the desired installation location. Retain all packing materials in case you ever need to return anything (or in case you move).

2.2 Installing the colon towers and tubes

Note: Tubes are not supplied with the clock and must be purchased separately elsewhere.

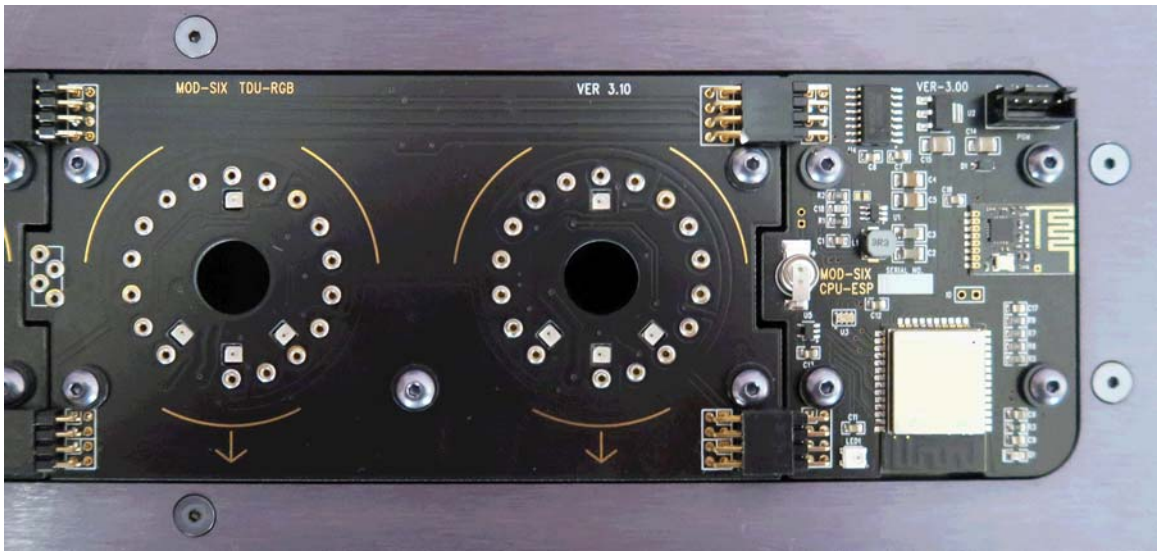
The colon towers are packaged in a bag taped to the top of the clock base assembly. Remove the tape and take the colon towers out of the bag. There is one short colon tower (AM/PM indicator) and two taller ones (the actual colons).

Figure 2–1 Colon towers



Each of the three tube boards (labeled "MOD-SIX TDU-RGB") has four socket pins on its left edge. Install the shorter colon tower on the leftmost tube board. If you have trouble inserting a colon tower, check to make sure none of its pins are bent. The colon towers should seat in their socket pins with minimal difficulty.

Figure 2–2 Tube board showing colon tower socket pins on far left



The tubes are over 50 years old and have been in and out of equipment. This will likely have caused the pins to become misaligned, so you can't simply push a tube into a socket on the clock - you'll need to adjust some of the pins first. At the same time, you may be tempted to clean off any grime which has accumulated on the tubes from their years of use and storage. We suggest making sure each tube fits into its socket and works before cleaning it, in case you need to return any to the seller in as close to "as-sold" condition as possible. Therefore, in Section 2.5 we provide cleaning procedures which have worked well for us, for use *after* you have verified all tubes are working correctly.

First, carefully unwrap a single tube and examine the pins on the underside. If any are bent substantially out of line, **carefully** bend them back toward the proper position. You may use needle nose pliers or your fingers for this process. Do **NOT** grasp the pins too close to the glass when straightening them - this can apply stress to the glass and possibly ruin the tube. Also, the tubes do not seat all the way into the sockets, so any slight curves in the half of the pins closest to the glass don't really matter.

Caution: The pins are made of a rather soft metal. Take care when adjusting them to avoid bending them further than necessary.

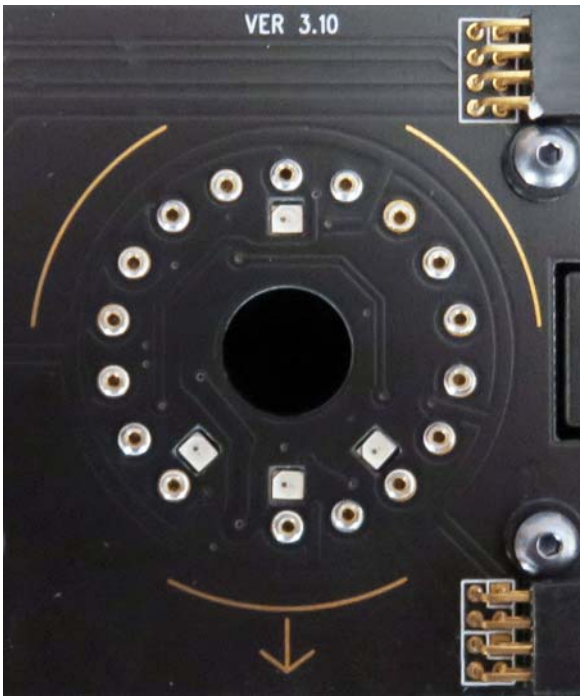
Once you have all of the pins close to the correct positions, place the tube over one of the sockets on the clock. You should be able to position the tube with pins 1 and 17 (the ones separated by the gap) directly over the corresponding positions of the tube socket. Don't try to press the tube down yet - just hold it with those pins sitting on the socket. While continuing to hold the tube with one hand (you don't want to let go and have it fall), examine each of the other pins in relation to their corresponding socket positions. This will give you an idea which pins need

to be moved and in which directions in order for the tube to fully seat in the socket. Remove the tube and perform the necessary pin adjustments. Repeat this procedure until all pins are aligned.

Note: In some cases, the correct adjustment will be to move a previously-adjusted pin slightly - if you discover a series of pins all out of line by the same amount, the problem may be with a prior pin instead.

Once all adjustments are complete, grasp the tube and hold it on top of the socket. Double-check your alignment and gently insert the tube into the socket. If the tube will not seat into the socket, check for a misaligned pin hanging up on the inner lip of a socket position.

Figure 2–3 Tube socket showing keyed pin



Caution: The hole in the circuit board is to accommodate the glass protrusion left over from when the tube was manufactured. That protrusion is one of the most fragile components of the tube, so be careful not to bump it on anything and never try to stand a tube on a flat surface.

After making sure each pin is seated in the socket, gently push the tube down to fully seat it in the socket. You can wiggle the tube from side to side or front to back **slightly** (less than 1/8" away from straight at the top) if necessary. Do not move the tube further than this - that can damage it. The tube should move approximately 1/8" down into the socket. The pins do not go all the way into the socket - as shown in the following figure, a portion of the pins remains exposed. The tubes are interchangeable -

there's no specific order, but it is most convenient to install them from left to right.

Figure 2–4 Tubes installed in sockets

After installing the first pair of tubes, install a taller colon tower in the next colon tower socket. Install the next pair of tubes and a colon tower, and then finally the last pair of tubes.

Figure 2–5 Detail of installed colon tower

Once installed, you can tilt the tubes slightly (as described above) if any appear tilted compared with each other or the colon towers.

2.3 Installing the cover

Note: You may wish to use cotton gloves at this point to avoid getting fingerprints on the clock cover and base assembly.

Taped to the top of the protective plastic on the cover is a sheet with four clear plastic bumpers. Remove the bumpers and set them aside for now.

Carefully unwrap the protective plastic from the cover. Place the cover upside down on a soft, clean surface such as a cloth towel.

Peel the bumpers off the sheet, one at a time, and place one on each of the four corners of the cover as shown in the following picture.

Figure 2–6 Bumper installed on cover (shown upside down)

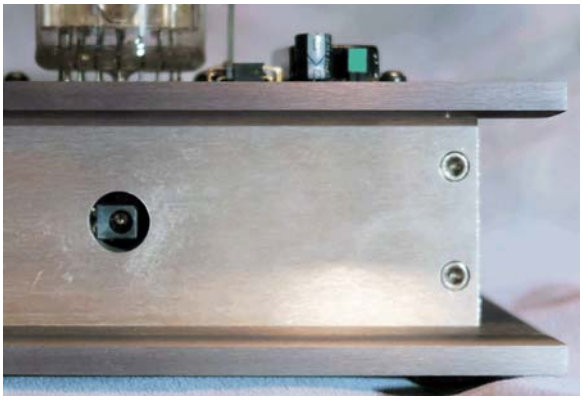
Position the clock in the location you selected for it. Be sure to leave enough clearance for the power cord to enter on the back left as well as space on the back right to access the control knob.

Place the acrylic cover on top of the clock.

2.4 Connecting power and starting the clock

Unpack the clock AC adapter. Plug the round connector into the back left opening on the base assembly and plug the adapter into a wall outlet.

Figure 2–7 Power connector location



The clock should light up and display the following (in order):

RGBW LED cycle test on CPU, tube boards and center design

Red CPU LED remains lit
Tube segment and colon test (individually, then all on at once)
MODSIX
CPU LED changes to green
LUMINA
V01-57 (these numbers may vary)
REL014 (these numbers may vary)
CONFIG
PASS
RTC IC
PASS
RTCNOW
TIME
PASS
RUN TM
PASS
RFLINK
PASS
All LEDs will ramp up through red, yellow and green and remain green

Note: At this point, the clock display dims down. Segments may not be fully lit, depending on your particular tubes. This is nothing to be concerned about.

HH:MM:SS (time) with 1 PPS pulse green on CPU LED
Day of week
Month / day
Year
Random word

At this point, the clock should be cycling between displaying the time and (once a minute) the other information.

If any tubes are not lit or the colons in HH:MM:SS are not lit, unplug the clock, remove the cover and check your installation of the tubes and/or colon towers.

Note: If you are not using the supplied (for US customers only) AC adapter and your clock "boot-loops" by starting the power-up sequence but resets during the tube segment test, check to make sure your AC adapter provides at least 2A at 12VDC as described earlier. Insufficient current may cause the clock to reset when it tries to light all tube segments simultaneously.

WARNING: Do not operate the clock without the cover in place - hazardous voltages are present at some locations on the circuit boards when the clock is operating.

If any of the messages say FAIL instead of PASS or there is unexpected behavior, contact us for support via one of the methods described in Section B.6.

2.5 Cleaning the tubes

Once you have the six B-7971 tubes installed and known to be working properly with all segments lighting up, no tubes substantially brighter or dimmer than the others and so on, you can proceed to clean the tubes if desired. There are likely decades of accumulated dust and grime on them. If you had a problem with one or more tubes, you want to return it to the seller in as close to "as received" condition so we suggest verifying all tubes are working properly before cleaning them.

WARNING: Make sure that power to the clock has been disconnected before touching any of the circuitry or tubes.

Caution: Do not attempt to clean the tubes "in place" in the clock - instead remove them one at a time for cleaning. This provides you with a larger work area while also preventing water from coming into contact with other clock components. It also reduces the possibility of multiple tubes rolling away and breaking.

We have found that removing a tube and carefully blotting it with a damp paper towel will remove most accumulated grime. Be careful when cleaning the back of the tube, as it is easy to wipe off the factory print with the brand, date code, etc. Some tubes sold as surplus in the 1970's may have price stickers on the top which are somewhat harder to remove. Patience and gentleness are key here.

There is normally no need to attempt to clean the underside of the tubes where the pins are located.

Once each tube is cleaned and dry, re-install it in the clock. You may want to use cotton gloves to avoid getting fingerprints all over your newly cleaned tubes.

Note: Removing and installing the tubes involves a fair amount of dexterity to avoid bumping the colon towers.

2.6 Clock initial WiFi setup

The primary setup and configuration method for the clock is via WiFi. This requires at least one device (cell phone, tablet, etc.) with the ability to connect to WiFi networks, and at least one WiFi network already installed and within range. You will need to know the SSID (network name) and password of your existing WiFi network.

Note: If you do not have WiFi available where the clock is, almost all features can be configured via the menu options available via the rear control knob. Refer to Chapter 5 for more information.

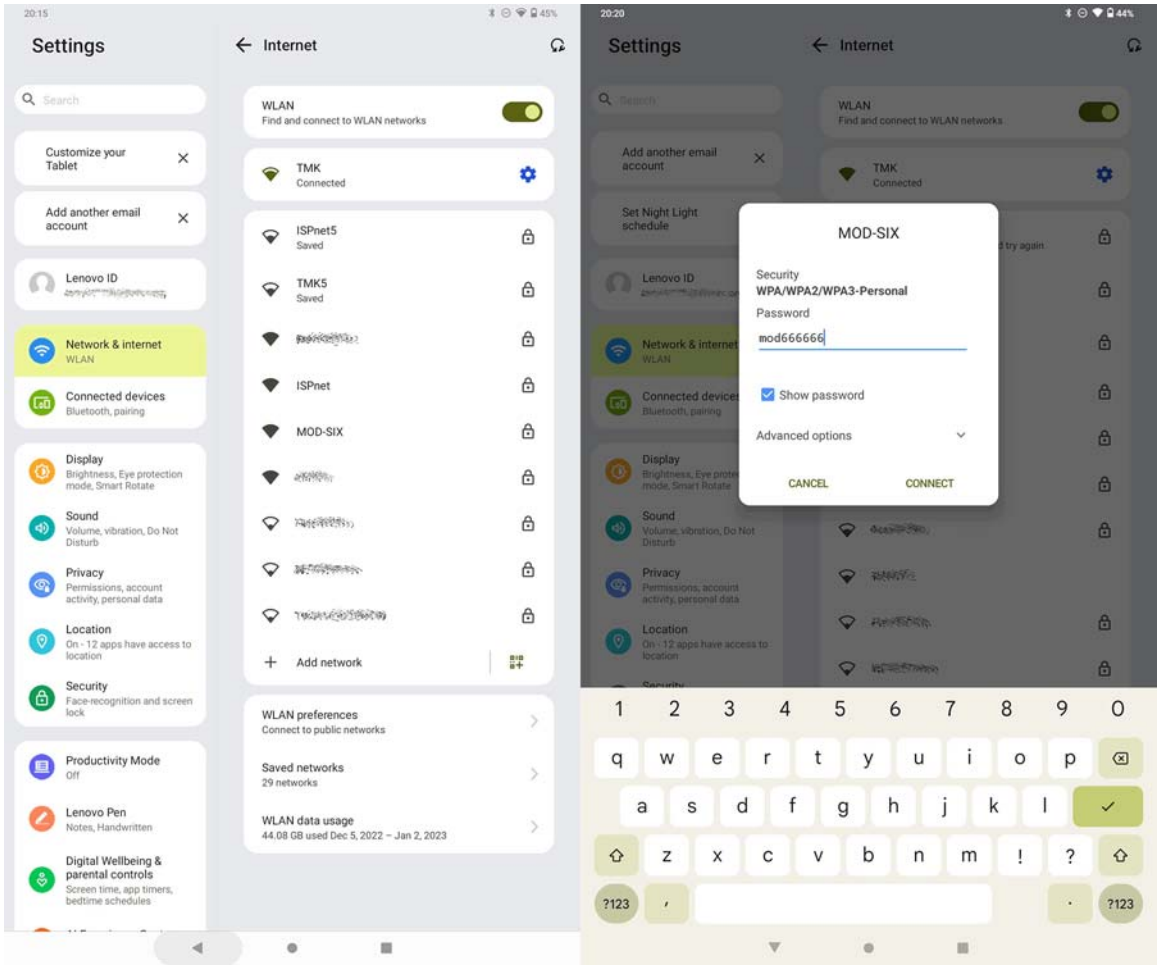
Using a phone, tablet or other WiFi client, search for and select the network named "MOD-SIX".

Notes: Depending on your device, you may need to disconnect from an existing WiFi network first.

The following examples are from an Android™ tablet. The same procedure is followed for Apple® or other devices, although the screen images will be different.

Once you have selected the MOD-SIX network, you will be prompted to enter the password as shown. The password is "mod666666" (all lower case, without the quotation marks).

Figure 2–8 Accessing the clock's internal network

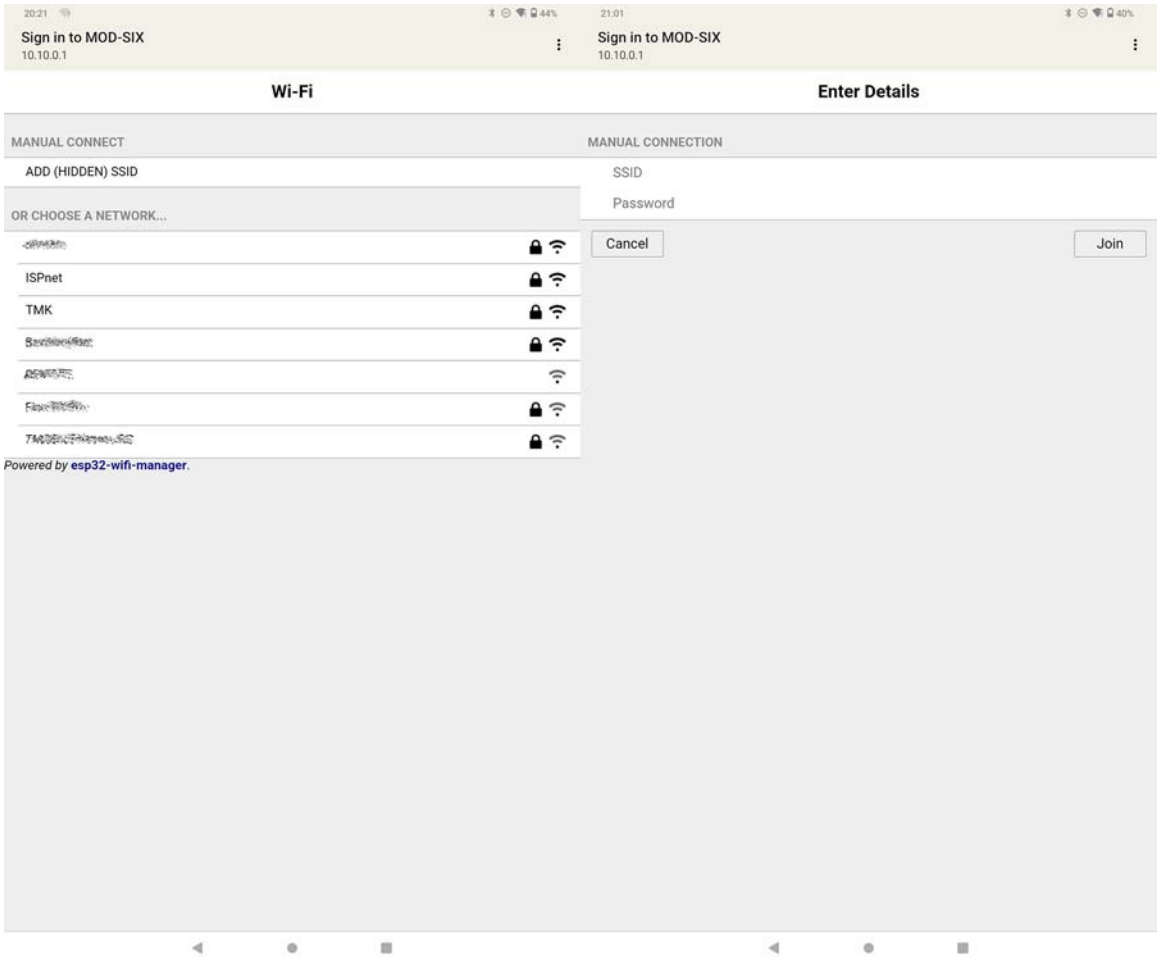


At this point if you have entered the password correctly your device will normally automatically redirect you to the clock's network configuration page. If not, use any web browser and connect to http://10.10.0.1.

Note: This connection must be done using the http:// prefix, not the https:// prefix or with no prefix at all.

The clock will now display a list of WiFi networks within range. One of these should be your existing WiFi network. If you see it (ISPnet in this example), click on it. If you do not see your WiFi network, either the clock is out of WiFi range or your network is using what is known as a "hidden SSID" network. In that case, click on the "Add hidden SSID" text and enter the SSID and password as shown on the right side of the following figure.

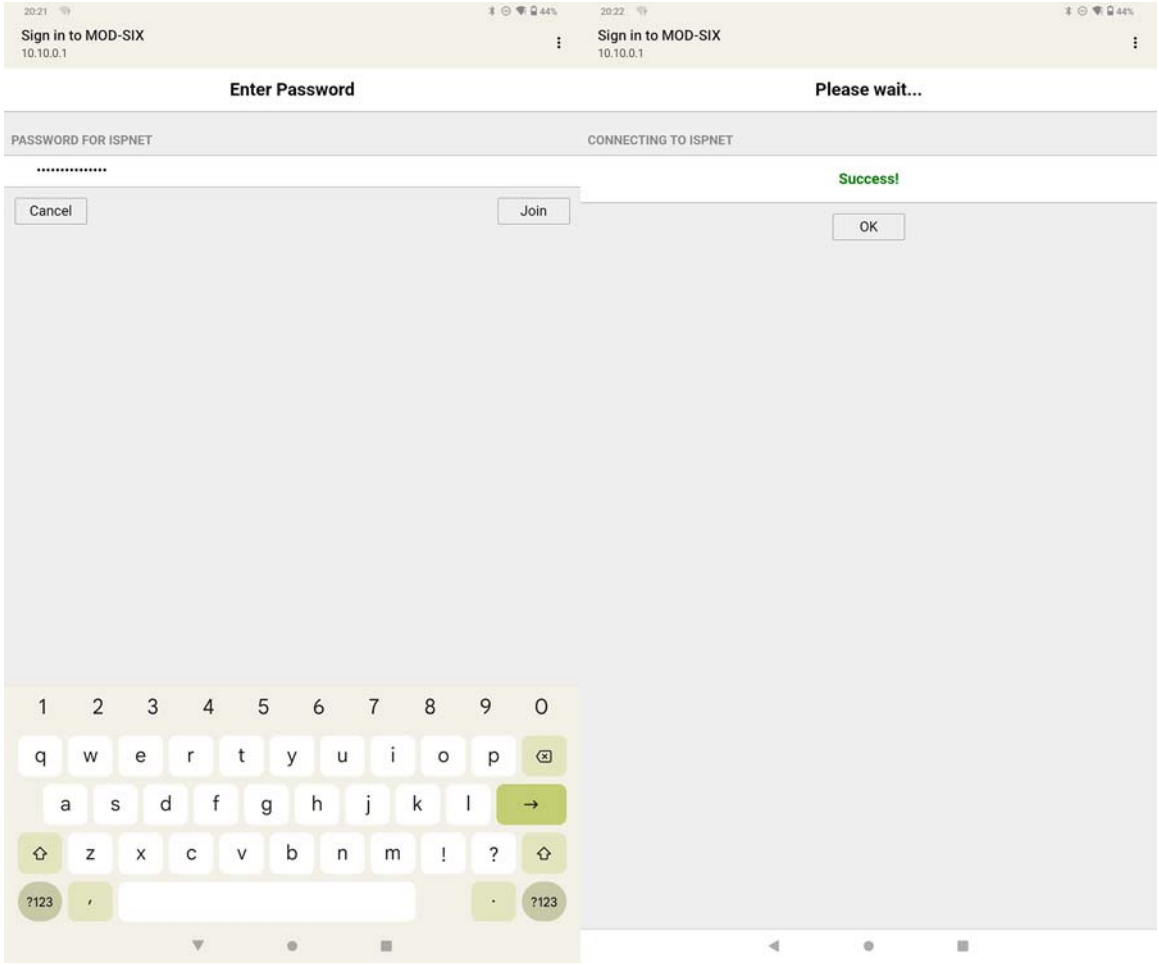
Figure 2–9 Selecting the desired WiFi network SSID



The clock will then prompt you to provide the password for your network. Enter it and press the Join button. You should normally see the "Success!" message as shown on the right half of the following figure. If you receive an error, it probably indicates that you have mis-typed the password.

Note: This is the password for your regular WiFi network, NOT the "mod666666" password used when first connecting to the clock.

Figure 2–10 Entering the SSID password



Immediately after successfully entering the password and pressing the OK button, the clock will scroll the IP address assigned to it by your network across the tubes. It will be in the form aaa.bbb.ccc.ddd. For example, 192.168.35.100. Write this address down as you will need it in the following steps.

Notes: If you miss the display of the IP address, don't worry. Simply unplug the clock, wait a moment and plug it back in. The IP address will be displayed at the end of the usual power-up sequence. You can also use the control knob function *SYSMNU / MY IP* to re-display the address.

Depending on how "well-mannered" your network (technically, your DHCP server) is, the IP address assigned to the clock can change over time. This will normally happen only after a power failure or if your router is reset. You can check to see if the clock has "noticed" the new IP address by using the control knob function *SYSMNU / MY IP*. If the clock is still reporting the old IP

address you will need to unplug the clock, wait a few moments and plug it back in. The new IP address will be displayed at the end of the startup message sequence.

Note: A future firmware update is expected to provide a method to tell the clock to request a new IP address and display it without needing to reset the clock.

It is unlikely (but possible) that your network does not have a DHCP server and the clock will be unable to automatically obtain an IP address and will not be able to access the network. In that case, you will need to configure the clock via the control knob as described in Chapter 5.

Note: We are looking into the capability of configuring a "static" IP address and other network settings in a future firmware update.

Now that you have your MOD-SIX Lumina connected to the Internet, you can begin customizing it to your individual desires. Refer to Chapter 3 for detailed instructions.

2.7 The MET-PIR (Optional)

If this option was ordered, unpack the MET-PIR and determine where you want to eventually locate it. The MET-PIR contains the environmental sensors for the clock, so you will want to locate it away from any sources of temperature changes such as windows, heaters, and so forth. It also contains the Passive Infrared (PIR) room occupancy sensor, so you will want to position it where the sensor can detect motion in the room. Avoid placing it where it is "looking" at heating registers, drafty windows, etc. in order to prevent false wake-up events.

The MET-PIR will operate over distances up to 100 feet, depending on the levels of radio interference in your area. The clock and MET-PIR are normally already paired with each other. If you change the radio channel or baud rate (see menu options **CFG_RFLINK / channel** and **CFG_RFLINK / rate** or control knob settings *LNKMNU* / *RFCHAN* and *LNKMNU* / *RFBAUD*, respectively) you will need to re-pair the clock and MET-PIR. Refer to Chapter 6 for details on this procedure.

Note: While we describe the MET-PIR as "optional", many features of the clock require it. Metrology (temperature / humidity / barometric pressure), and empty room detection all require a MET-PIR. Therefore, we expect that most users will have ordered this option.

Figure 2–11 MET-PIR top view

2.7.1 Installing the batteries and starting the MET-PIR

For now, we will place the MET-PIR near the clock for convenience when setting it up. Additional information about the MET-PIR and suggestions for where to locate it are provided in Chapter 6.

Make sure that the swiveling PIR head is fully seated on the MET-PIR as it may have come loose during shipping. The MET-PIR PIR head uses a standard TRS ("headphone jack") connector.

Note: There should be a fairly obvious "click" when the PIR head is fully seated. If you don't feel or hear the click, check to make sure that the PIR head is not binding on the MET-PIR top board. In extreme cases, you may need to loosen the four hex cap screws slightly to allow the PIR head to seat fully.

Caution: Do not install or remove the PIR head while the batteries are installed in the MET-PIR. Swiveling the head is fine.

Open the package containing the 2 AAA batteries and install them in the battery compartment on the underside of the MET-PIR, taking care to match the polarity marks in the battery compartment with the batteries.

Caution: Make certain that the batteries are oriented correctly.

Once the CPU in the MET-PIR starts, it will blink a series of codes on the LED. This is discussed in more detail in Section J.1.

The MET-PIR will then display information on the clock. The information will be shown in the following order.

PIR 15 (these numbers may vary)
PIR-0
STA-1
3P121V (these numbers will vary)

SNSBME

Note: These messages will only appear on the clock if the MET-PIR firmware is V1.5a or higher.

The MET-PIR will then begin sending messages about the temperature, humidity and barometric pressure to the clock. It also sends motion detection events to the clock. How the clock processes and displays this information is discussed in Chapter 6.

Once the MET-PIR is powered on and communicating with the clock you can move it to the desired location.

2.8 A word about options

The clock comes preset with generic options. See the detailed information on setup options later in this document. There are many, many possible settings that may seem confusing at first. Feel free to read through the documentation and experiment.

2.9 Important Notes

2.9.1 High voltages and general safety

The clock is powered by an approved "wall wart" power supply. It produces perfectly safe low voltages. Inside the clock, there are a number of places where high voltages are exposed.

WARNING: This clock is NOT a toy - please keep the provided clear acrylic cover in place at all times when the clock is operating. It also does a good job of keeping dust out and protecting the expensive tubes.

US customers should not use any AC adapter other than the one provided with the clock.

2.9.2 Buzzing noises

In a very quiet room, you may notice a high-pitched buzzing coming from the clock. This is normal and is caused by the tubes vibrating as they are switched on and off thousands of times a second. Adjusting the display brightness (using the menu options **CFG_DISPLAY / lum_brt** and **CFG_DISPLAY / lum_dim** or control knob settings *DSPMNU / LUMBRT* and *DSPMNU / LUMDIM*, respectively) will normally clear this up - even a change of a single digit can make the noise disappear or become much less obvious.

Note: Running the clock with the cover on can also reduce buzzing noises.

2.9.3 "Cathode poisoning"

Don't worry, "cathode poisoning" isn't dangerous to you or any other form of life. It is a technical term referring to a particular type of damage inside the tubes. "Cathode poisoning" is when not all of each segment lights fully. The ends of the segment could light and not the middle, or vice versa. Or the segment could flicker. This can begin to damage the tubes (expensive!) if it persists for an extended period.

Be sure to set the brightness levels (using the menu options **CFG_ DISPLAY / lum_brt** and **CFG_DISPLAY / lum_dim** or control knob settings *DSPMNU* / *LUMBRT* and *DSPMNU* / *LUMDIM*) settings high enough that the segments light completely.

Note: The brief period where the display flickers on its way to fully off will not cause problems.

2.10 General care and maintenance

The acrylic cover on the clock may be cleaned if necessary. Normally all that will be needed is a light dusting with a dry Swiffer® cloth. Deeper cleaning can be done with a slightly damp soft cloth. Use water only, not any cleaning products. Never use an abrasive cleaner on any clock component. To remove scratches in the acrylic cover or for extra-deep cleaning, NOVUS® brand plastic polish is recommended.

The metal base of the clock may also be cleaned with a dry Swiffer cloth if needed. Be sure to wipe in the direction of the sanded finish (in other words, "with the grain") to avoid pushing dirt particles deeper into the pores of the aluminum.

Make sure that all dust or other particles have been removed from the component you are polishing (via a light dusting) before polishing the component. Trapped particles can damage the finish if not removed before final polishing.

Never clean any components other than the baseplate and acrylic cover of the clock or the top surface of the MET-PIR.

Cautions: The clock base, particularly the anodized top and bottom plates, can be easily scratched if proper cleaning procedures are not followed.

Ensure no liquids or other contaminants come near the MET-PIR circuit board as the environmental sensors on it can easily become contaminated and produce incorrect readings.

Like all electronic devices, the clock and MET-PIR can be damaged by static electricity. When installing the clock or any accessory, or changing settings on them, always touch the aluminum baseplate first to discharge any static.

The clock uses a "supercap" battery to keep track of time during power failures. It takes about an hour to charge and will maintain the correct time for approximately one day.

The MET-PIR and keyfob use batteries for all of their functions as they are cordless devices. In the MET-PIR and keyfob the battery lifetime depends on how heavily those devices are used, as well as whether or not the status LED on the MET-PIR is enabled. As an estimate, both the MET-PIR and the keyfob battery should last at least a year. The MET-PIR uses a pair of AAA batteries, while the keyfob uses the CR2032 type which your local drugstore, camera store, etc. will have in stock. You may also order batteries from online retailers such as Amazon®. Detailed battery replacement procedures for each clock component are provided in Appendix J.

Replacement tubes are occasionally available on eBay® (currently over US $200 each). The expense and rarity of these tubes add to the uniqueness of the clock, but also means you should be extra careful to not damage them, either when installing them or during normal operation. A stray softball coming through the window and knocking the acrylic cover off the top of the clock will likely ruin your entire year.

3 Clock configuration via WiFi

At the end of Section 2.6 you were instructed to write down the clock's IP address. You will need that information now. If you do not have it, you will need to either use the control knob function *SYSMNU / MY IP* to display the IP address, or restart the clock by disconnecting the power connector, waiting 30 seconds, and re-connecting power. Observe the IP address scrolling across the tubes at the end of the startup message sequence.

Using a web browser, navigate to the clock's IP address. For example, if your clock was assigned IP address 192.168.35.100, you would enter http://192.168.35.100 in your browser's address bar.

Note: This connection must be done using the http:// prefix, not the https:// prefix or with no prefix at all.

Note: Some users with advanced networking knowledge might like to assign a hostname to the clock so they can refer to it as (for example) http://modsix.example.com instead of http://192.168.35.100. This functionality is being investigated for a future firmware update.

At this point, the clock should be displaying its home page.

3.1 Clock home page

The clock's home page is the entry point for all web-based control and management functions.

Note: At the present time it is not possible to protect the clock's web pages with a password. This is being considered for a future firmware update. In the meantime, if you are concerned about unauthorized users accessing the clock's web server, once you are done configuring the clock you can disable the web server by modifying a setting in the CFG_SYSTEM section of the configuration file. Change the line:

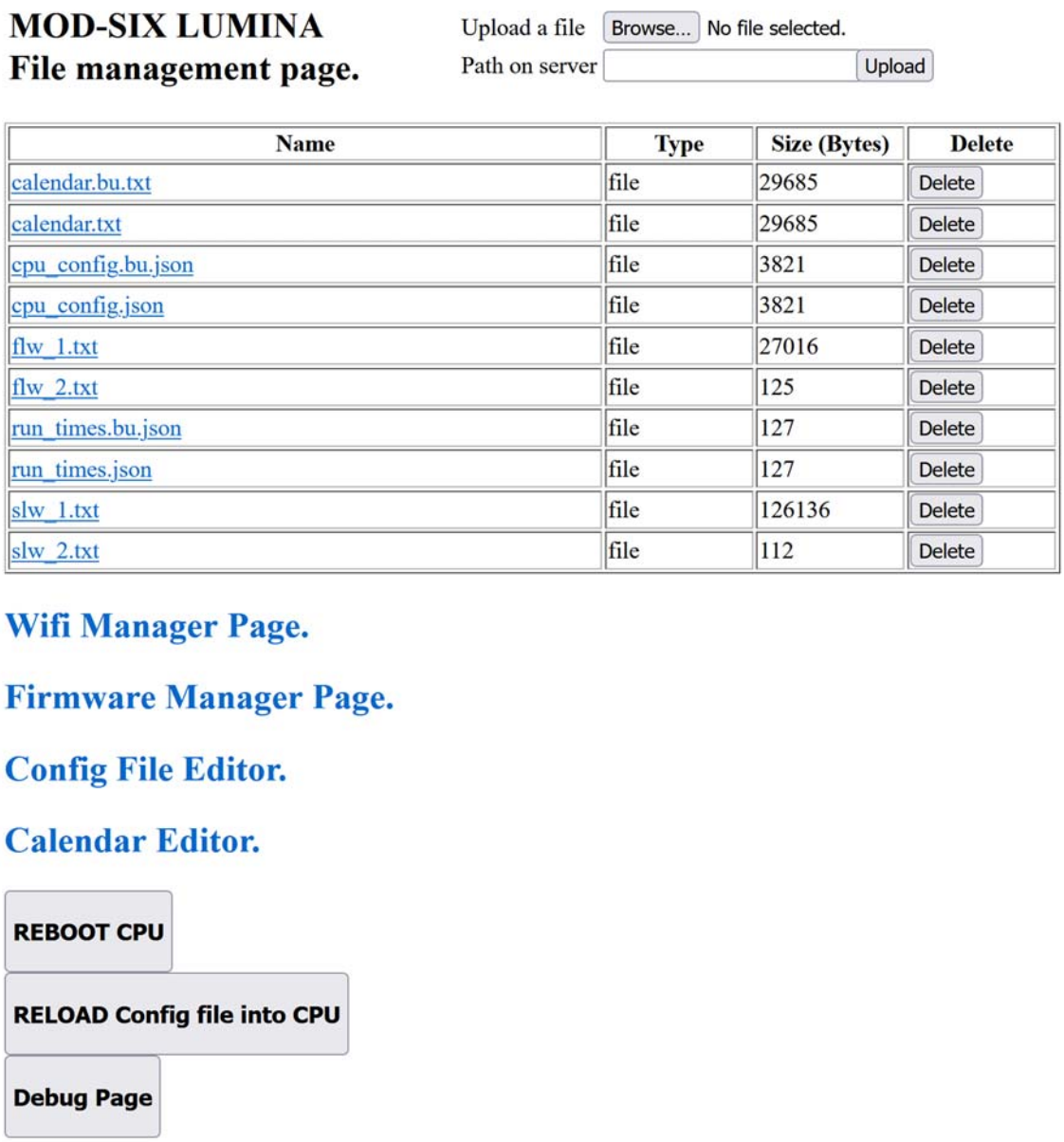
```
"web_server_en": true,
```

to:

```
"web_server_en": false,
```

You can re-enable the web server by using the control knob setting SYSMNU / WEBSRV.

Figure 3–1 Clock home page



3.1.1 Upper half of the home page

The top half of the page is used to manage the contents of the clock's file directory. At the top right is the file chooser used to upload files to the clock's file directory.

Note: Attempting to upload a file when there is already one with the same name will result in the error message "*File already exists*". In

that case, simply use the Delete button to the right of any files you wish to delete. You will be prompted to confirm the file deletion or to cancel the delete operation.

Next is an alphabetical list of files in the directory, along with their type (normally "file" for regular files) and their size in bytes. At the right is a Delete button for deleting the file. The following table shows the names and descriptions of files you might see in the directory.

Table 3–1 Home page directory example

File name	Function
calendar.bu.txt	Backup copy of calendar event file †
calendar.txt	Calendar event file ‡
cpu_config.bu.json	Backup copy of clock configuration file in JSON format †
cpu_config.json	Clock configuration file in JSON format
flw_1.txt	Random word lexicon, four-letter "clean" words §
flw_2.txt	Random word lexicon, four-letter "dirty" words §
run_times.bu.json	Backup copy of data about various clock statistics in JSON format †
run_times.json	Data about various clock statistics in JSON format †
slw_1.txt	Random word lexicon, six-letter "clean" words §
slw_2.txt	Random word lexicon, six-letter "dirty" words §

§ Information about these word files is described in Appendix L.

† This file is automatically generated at periodic intervals by the clock.

‡ Information about the calendar file is described in Appendix G.

3.1.2 Lower half of the home page

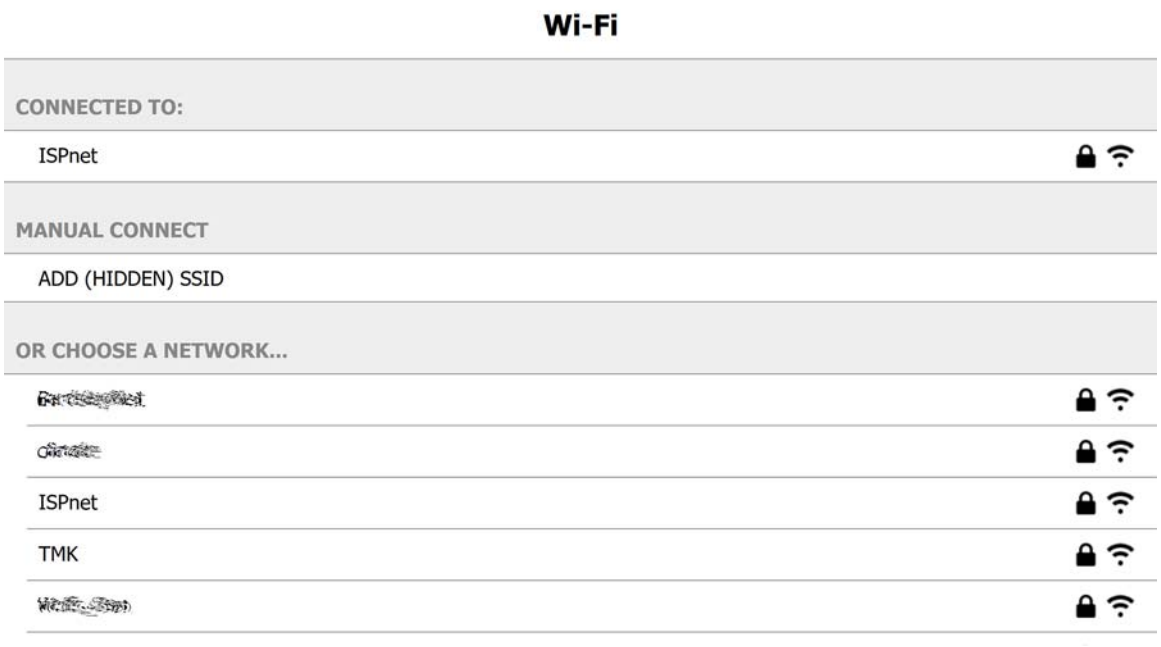
The bottom half of the home page contains links to other pages for managing WiFi setup, updating the clock firmware and editing the clock configuration options and calendar contents.

There are also buttons to reboot the clock, apply configuration changes and display various debugging information.

3.2 The WiFi manager page

The WiFi manager lets you configure the clock to connect to a different WiFi network. Usage is identical to the initial setup as described in Section 2.6.

Figure 3–2 WiFi manager page

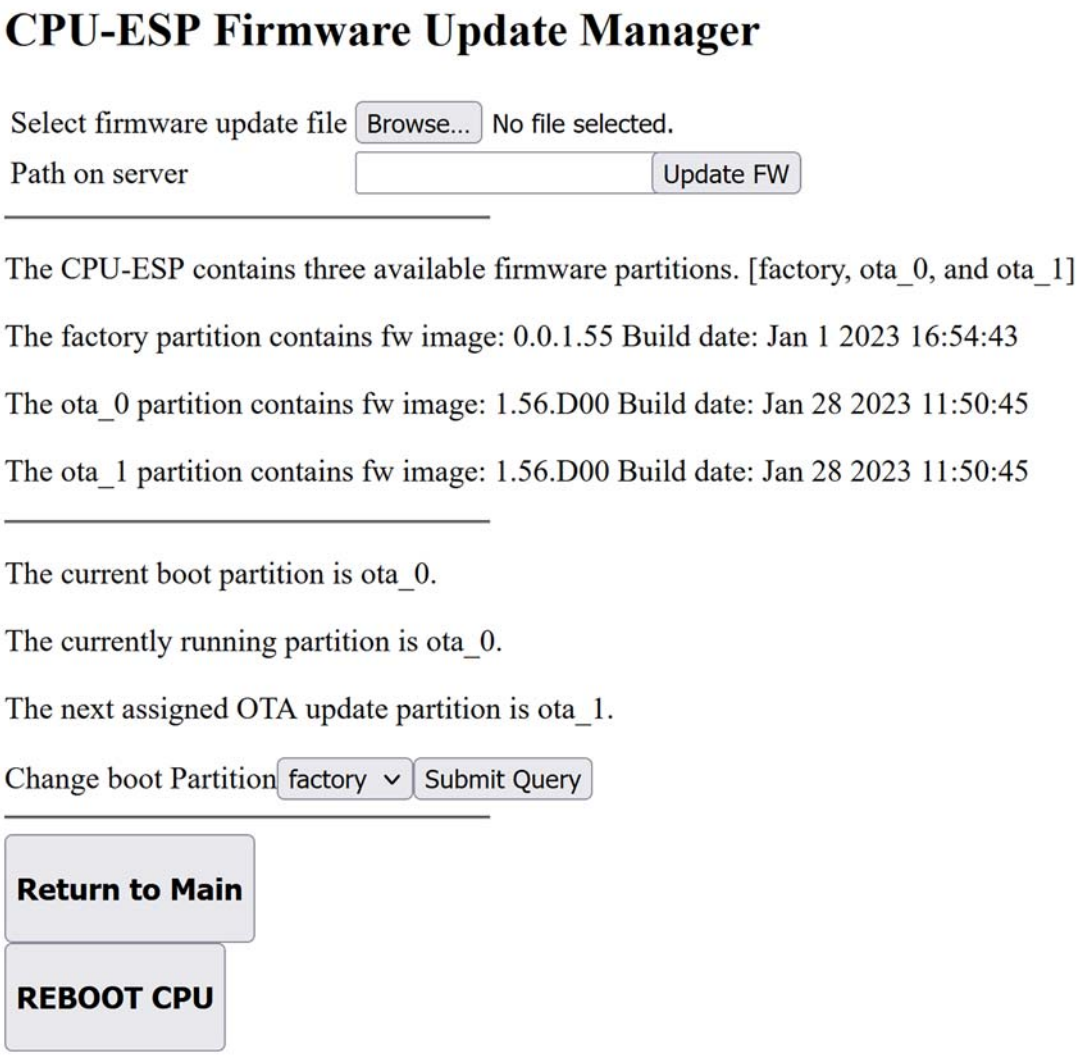


3.3 The firmware manager page

From time to time, firmware updates may be made available to add features, simplify operation, or fix bugs. These can be easily installed via the clock's WiFi connection. There is no longer any need to use special updating dongles. In addition to the permanent factory firmware there are two OTA (Over-The-Air) firmware partitions, so you can have up to three different firmware versions on the clock and easily switch between them.

Note: Any firmware updates will be made available for download at http://badnixie.com/MOD-SIX_Info_Page.html and announced in the MOD-6_7971 Google Group.

Figure 3–3 Firmware manager page



The page displays the current boot partition which can be factory, ota_0 or ota_1. The boot partition selects which firmware will be loaded at the next boot. The page also displays the currently running partition which can also be factory, ota_0 or ota_1.

To upload a firmware file, use the Browse button to select the firmware to upload and then use the Update FW button to upload it to the CPU. After upload, the boot partition will be updated to reflect the upload to either the ota_0 or ota_1 partition. If for some reason you are uploading a file but do not want to make it the default for future boots, you can use the "Change boot partition" dropdown to select the desired partition. You can also switch between partitions without uploading new firmware by using this option.

The [Return to Main] button returns you to the clock's main menu without rebooting, and the [Reboot CPU] button reboots the clock immediately from the selected firmware partition.

Notes: In the unlikely event that there is a problem with an uploaded firmware file and the clock fails to boot properly, refer to the CLROTA section of Appendix K for recovery procedures to reset the clock to erase all OTA firmware and boot from the factory firmware partition.

Complete compatibility of configuration files between different firmware versions is not guaranteed. We recommend that you keep a copy of the configuration file on your device to refer to in the event that you need to re-enter any of your non-default configuration options. In the unlikely event of a configuration file change that prevents the clock from booting properly, refer to the CLRCFG section of Appendix K to reset the clock to the factory configuration.

3.4 The configuration file editor

The clock's configuration options are stored in JSON format in a file in the clock's file directory. The current config is saved in *cpu_config.json* and a backup of the previous config is saved in *cpu_config.bu.json*. These are text files that you can download to your device by right-clicking on the filename from the clock's home page and doing a "*Save link as...*".

The configuration file is displayed in a window where you can directly edit each option. Detailed descriptions of each option are provided in Chapter 4.

Figure 3–4 Config editor page

If you get lost in the configuration editor or don't remember if you made the correct changes, you can start over by using the [Discard edits. Reload original file into edit window.] button or the [Discard edits. Return to main.] button to exit the editor and return to the clock's home page.

If you are happy with your changes, use the [Save all edits to config file.] button to save your changes and return to the clock's home page.

3.4.1 Validating your configuration file

If you are using a browser that understands JSON such as Firefox® on Windows®, you can check to see if your edited configuration is valid JSON by clicking on the *cpu_config.json* link. If it is valid JSON the browser will parse and display the file with multi-color syntax highlighting. If there is an error that prevents it from being properly parsed, it will report an error such as:

```
SyntaxError: JSON.parse: expected ',' or '}' after property value in
object at line 18 column 3 of the JSON data
```

If your configuration reports an error, go back into the editor to correct it and try again. If your configuration successfully validates (or you do not have access to a browser that does JSON validation), click on the [Reload config file into CPU] button. If the clock returns you to the main menu, the configuration was successfully loaded. If it reports "RELOAD ERR", it means that there is a structural error in your configuration. Click on the [Back] button in your browser to return to the clock's home page and retry your configuration edits.

Notes: The "RELOAD ERR" message just means that the clock determined that there was a JSON format error. It does NOT mean that the configuration is valid. For example, using "APPLE" as a time interval would not be detected on a reload.

Configuration changes are not applied until you click the [Reload config file into CPU] button on the clock's home page or the clock is rebooted.

You can save the current configuration file by right clicking on the *cpu_config.json* link and doing a "*Save link as...*" on the clock's home page. This lets you store an unlimited number of possible configurations. To restore a saved configuration file, use the [Delete] button to the right of *cpu_config.json* on the clock's home page, then upload your saved configuration and click on the [Reload config file into CPU] button to activate it.

Also refer to Appendix I for information on saving just your customizations in a subset settings file.

Note: The file you upload must be named *cpu_config.json* in order for the clock to utilize it.

Basic help for the configuration options is available by clicking the [Basic config help page] button. This will display a page where the possible settings for each item are shown.

Figure 3–5 Editor help page

Auto-generated basic config file help.

Valid for FW Revision 1.57

Note that all data entries are case sensitive.

Section: **"CFG_TIME"** Name: **"time_src"** Hint: USE
Description: Select the time source that will be used to sync the clock's internal timebase.
Valid Entries: ("quoted"). Default = "SNTP"
"RTC"
"SNTP"
"RPTR"
"CON"
"DEBUG"

Section: **"CFG_TIME"** Name: **"time_sync"** Hint: STRAT
Description: Sets how a sync event will adjust the time. Either an immediate jump to the new time, or a gradual adjustment.
Valid Entries: ("quoted"). Default = "IMMED"
"IMMED"
"SMOOTH"

Section: **"CFG_TIME"** Name: **"rtc_en"**
Description: Enables the external RTC IC low level "driver" functions. Must be enabled before using as a time source.
BOOL: true or false (no quotes). Default = true

Section: **"CFG_TIME"** Name: **"rtc_update_rate"** Hint: SECNDS
Description: Sets how often the RTC driver will attempt to sync the clock's timebase. Units = seconds.
Number Range: 30 to 1200 (no quotes). Default = 120

Section: **"CFG_TIME"** Name: **"sntp_en"**
Description: Enables the SNTP network client functions. Must be enabled before using as a time source.
BOOL: true or false (no quotes). Default = true

Section: **"CFG_TIME"** Name: **"sntp_update_rate"** Hint: MINUTE
Description: Sets how often the SNTP client connects to the server and attemps to sync the clock's timebase. Units = minutes.
Number Range: 10 to 1500 (no quotes). Default = 121

Section: **"CFG_TIME"** Name: **"rptr_en"**
Description: Enables the legacy MOD-SIX RPTR "driver" functions. Must be enabled before using as a time source.
BOOL: true or false (no quotes). Default = false

Section: **"CFG_TIME"** Name: **"rptr_update_rate"** Hint: SECNDS
Description: Sets how often the RPTR driver will attempt to sync the clock's timebase. Units = seconds.
Number Range: 30 to 1200 (no quotes). Default = 120

Notes: Settings in the configuration file are case-sensitive. Some settings need to be entered between double-quote marks and some do not.

The current firmware does not do full validation of changes you make in the editor window or in a config file you upload. It is therefore possible (but unlikely) to get into a situation where the clock cannot properly interpret the configuration and may either not finish rebooting or not operate as expected once it reboots. If the clock is still reachable via its home page, simply delete the *cpu_config.json* file and reboot the clock to restore the default configuration. If the clock fails to boot properly, refer to the

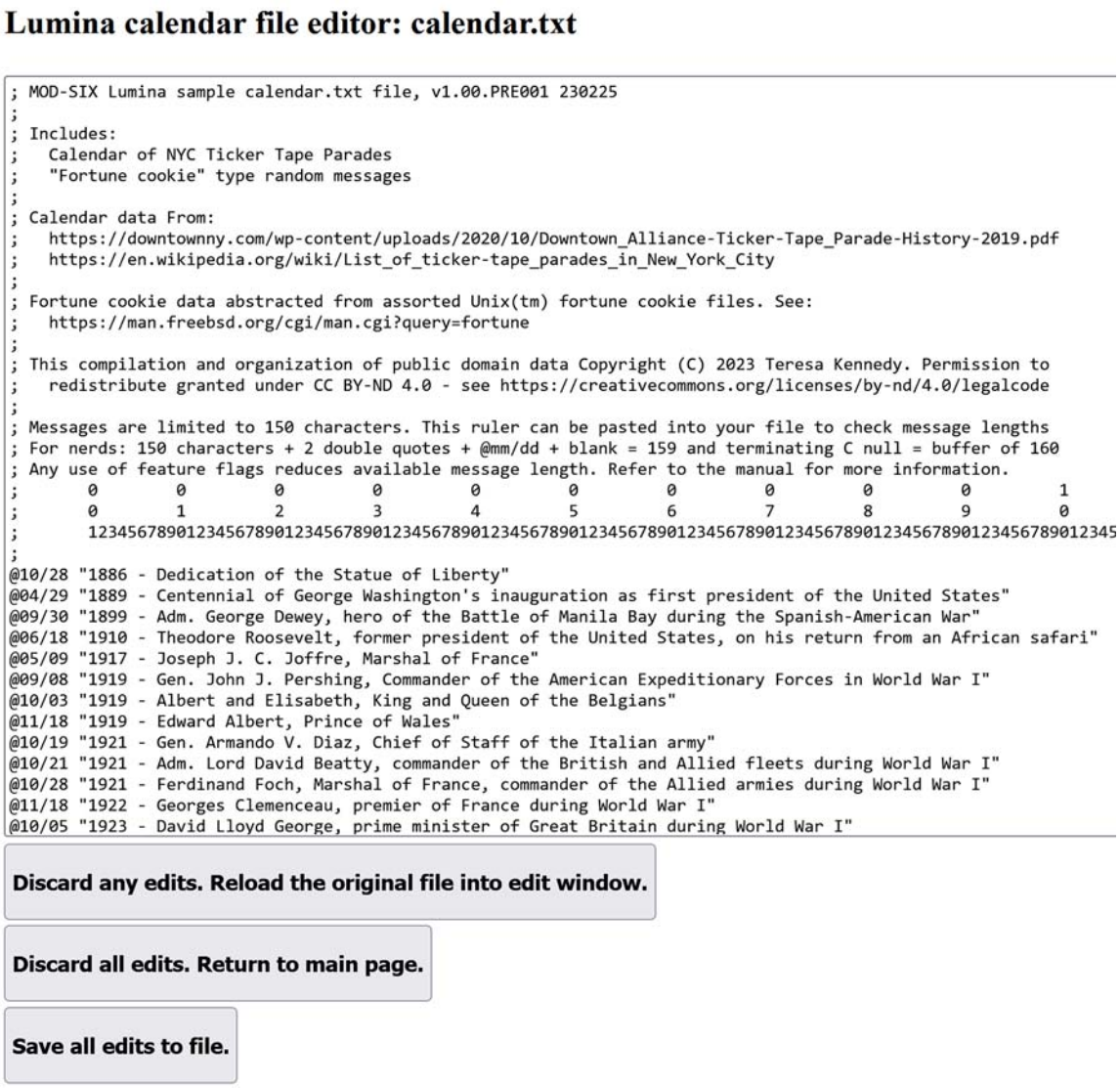
CLRCFG section of Appendix K to use recovery mode to restore the default configuration.

We expect that future firmware updates will improve both the clock's tolerance to incorrect configurations and provide more extensive online help.

3.5 The calendar editor page

The Lumina has the ability to display both calendar events and random "fortune cookie" type messages. The calendar data is stored in a file named *calendar.txt*. The format of the calendar file is explained in detail in Appendix G. A calendar file editor is provided for your convenience. It operates in the same manner as the config file editor.

Figure 3–6 Calendar editor page



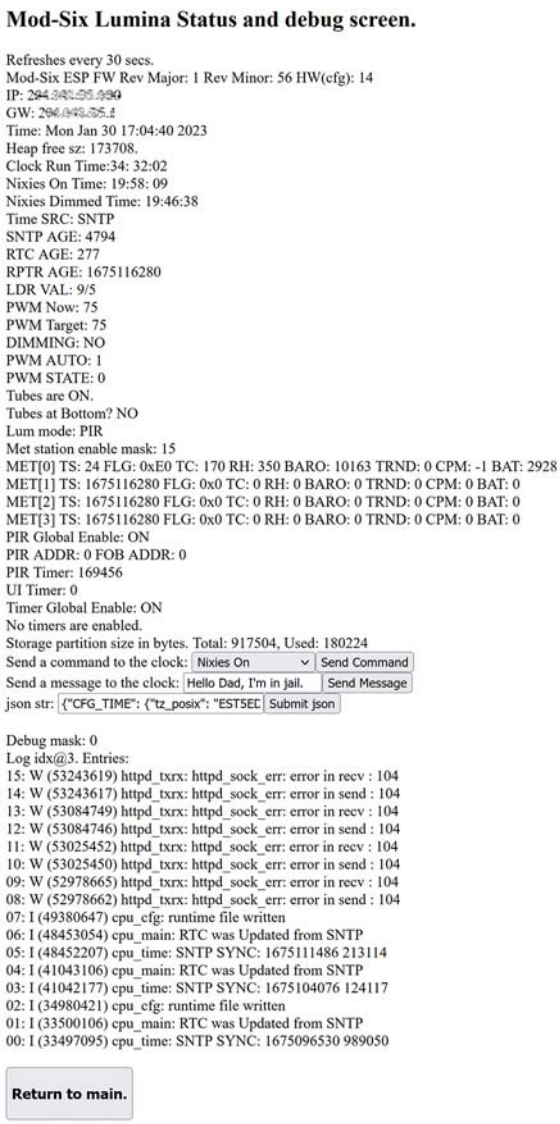
3.6 The debugging information page

A page to view various debugging information was added during the development of the Lumina firmware. The Debug page button on the clock's home page will bring up the debug page. Most of the information here is of interest only to the clock's firmware developer, but it was left in place for inquisitive Lumina owners.

Notes: There is no guarantee that the contents of this page will remain the same in future firmware updates - in fact, expect it to undergo quite a few changes.

There are a few places in the debug page where you can send various commands to the clock. These may or may not have the expected effect.

Figure 3–7 Debugging information page



Mod-Six Lumina Status and debug screen.

Refreshes every 30 secs.
Mod-Six ESP FW Rev Major: 1 Rev Minor: 56 HW(cfg): 14
IP: 2[redacted]
GW: 2[redacted]
Time: Mon Jan 30 17:04:40 2023
Heap free sz: 173708.
Clock Run Time:34: 32:02
Nixies On Time: 19:58: 09
Nixies Dimmed Time: 19:46:38
Time SRC: SNTP
SNTP AGE: 4794
RTC AGE: 277
RPTR AGE: 1675116280
LDR VAL: 9/5
PWM Now: 75
PWM Target: 75
DIMMING: NO
PWM AUTO: 1
PWM STATE: 0
Tubes are ON.
Tubes at Bottom? NO
Lum mode: PIR
Met station enable mask: 15
MET[0] TS: 24 FLG: 0xE0 TC: 170 RH: 350 BARO: 10163 TRND: 0 CPM: -1 BAT: 2928
MET[1] TS: 1675116280 FLG: 0x0 TC: 0 RH: 0 BARO: 0 TRND: 0 CPM: 0 BAT: 0
MET[2] TS: 1675116280 FLG: 0x0 TC: 0 RH: 0 BARO: 0 TRND: 0 CPM: 0 BAT: 0
MET[3] TS: 1675116280 FLG: 0x0 TC: 0 RH: 0 BARO: 0 TRND: 0 CPM: 0 BAT: 0
PIR Global Enable: ON
PIR ADDR: 0 FOB ADDR: 0
PIR Timer: 169456
UI Timer: 0
Timer Global Enable: ON
No timers are enabled.
Storage partition size in bytes. Total: 917504, Used: 180224
Send a command to the clock: Nixies On Send Command
Send a message to the clock: Hello Dad, I'm in jail. Send Message
json str: {"CFG_TIME": {"tz_posix": "EST5ED Submit json

Debug mask: 0
Log idx@3. Entries:
15: W (53243619) httpd_txrx: httpd_sock_err: error in recv : 104
14: W (53243617) httpd_txrx: httpd_sock_err: error in send : 104
13: W (53084749) httpd_txrx: httpd_sock_err: error in recv : 104
12: W (53084746) httpd_txrx: httpd_sock_err: error in send : 104
11: W (53025452) httpd_txrx: httpd_sock_err: error in recv : 104
10: W (53025450) httpd_txrx: httpd_sock_err: error in send : 104
09: W (52978665) httpd_txrx: httpd_sock_err: error in recv : 104
08: W (52978662) httpd_txrx: httpd_sock_err: error in send : 104
07: I (49380647) cpu_cfg: runtime file written
06: I (48453054) cpu_main: RTC was Updated from SNTP
05: I (48452207) cpu_time: SNTP SYNC: 1675111486 213114
04: I (41043106) cpu_main: RTC was Updated from SNTP
03: I (41042177) cpu_time: SNTP SYNC: 1675104076 124117
02: I (34980421) cpu_cfg: runtime file written
01: I (33500106) cpu_main: RTC was Updated from SNTP
00: I (33497095) cpu_time: SNTP SYNC: 1675096530 989050

Return to main.

4 Clock configuration via the web page

This chapter describes how to customize the Lumina's configuration using the web page to suit your individual preferences. Most configuration options are also configurable via the control knob or optional keyfob, described in Chapter 5.

Configuration options are arranged in groups of related functions. The settings in the configuration file are case-sensitive. Some settings need to be entered between double-quote marks and some do not. The values *true*, *false* and numbers are not quoted. All other values need double-quote marks. Each setting requires a comma at the end of the line, except for the last line in a settings group.

Note: While these rules may seem odd to you, they describe an industry-standard file format called JSON (JavaScript Object Notation). We are investigating a more user-friendly format for a future firmware release.

The configuration file is displayed in a window where you can directly edit each option. The following sections describe each option, list the possible values for the option, and provides the default value.

4.1 The display configuration (CFG_DISPLAY) group

This group configures the various display options for the Nixie tubes and colon lamps.

4.1.1 The time_font setting

Selects the font used to display the time. Examples of each font are shown in Chapter 8. The default setting is "*GRUNGE*". *Equivalent control knob setting: DSPMNU / FONT (also see SYSMNU / FNTCAT)*

4.1.2 The disp_font setting

Selects the font used to display the numbers (other than time). The same fonts as above are available. The default setting is "*STNDRD*". *Equivalent control knob setting: DSPMNU / DFONT*

4.1.3 The xfade_rate setting

This setting controls how long it takes for a new character to finish appearing when the display changes. It is in milliseconds and can be set to between *1* and *64*. The default value is *20*. *Equivalent control knob setting: DSPMNU / XFADE MSEC*

Note: A millisecond is 1/1000 of a second.

4.1.4 The time_fmt setting

This setting controls whether the clock displays the time in 12 hour or 24 hour (often called "military") time. It can be set to "*12HR*" or "*24HR*". The default value is "*24HR*". *Equivalent control knob setting: DSPMNU / 12/24*

4.1.5 The time_lzs setting

For times earlier than 10:00:00, the clock can either leave the first tube off (referred to as leading zero suppression) or display a zero. It can be set to *true* or *false*. The default value is *false*. *Equivalent control knob setting: DSPMNU / LZS*

4.1.6 The time_colon setting

This setting controls the colon behavior when the tubes are in bright mode. The default value is "*BLINK*". *Equivalent control knob setting: DSPMNU / COL MD*

Table 4–1 Colon tower options

Value	Definition
"OFF"	Colons off
"ON"	Colons on
"BLINK"	Colons blink †
"ALT"	Colons alternate between top and bottom †
"RAILRD"	Colons cycle between top left / bottom right and bottom left / top right †
"SAME"	This special setting name selects the same value as the one used in bright mode ‡

† For all of the animated settings the cycle time is one second in the first state and one second in the second state.
‡ This value is only available for dim settings.

4.1.7 The time_ampm setting

The leftmost (short) colon tower can be used as an AM/PM indicator. The default value is "*ON*". *Equivalent control knob setting: DSPMNU / AMPM*

Table 4–2 AM/PM indicator options

Value	Definition
"OFF"	AM/PM indicator off
"ON"	AM/PM indicator on in PM (when in 12-hour mode)

Table 4–2 (Cont.) AM/PM indicator options

Value	Definition
"SWAP"	AM/PM indicator Off in PM (when in 12-hour mode)
"24ON"	AM/PM indicator on in PM (when in 24-hour mode)
"24SWAP"	AM/PM indicator Off in PM (when in 24-hour mode)

4.1.8 The date_mod setting

This setting controls how frequently the date is displayed (if at all). The default value is "*1MIN*". *Equivalent control knob setting: DSPMNU / DATMOD*

Table 4–3 Display interval options

Value	Definition
"OFF"	Do not display this item
"1MIN"	Display item every minute †
"2MIN"	Display item every 2 minutes †
"3MIN"	Display item every 3 minutes †
"5MIN"	Display item every 5 minutes †
"10MIN"	Display item every 10 minutes †
"15MIN"	Display item every 15 minutes †
"30MIN"	Display item every 30 minutes †
"SAME"	This special setting name selects the same value as the one used in bright mode ‡

† This setting can end with a *"B"* to move the display to the bottom of the minute (at the 30-second mark).

‡ This value is only available for dim settings.

4.1.9 The date_fmt setting

This setting controls the display order of the day of the month and the month. When set to "*MMMDD*" the date is displayed as (for example) "DEC 11" and if it is set to *DDMMM* the date is displayed as "11 DEC". The default value is "*MMMDD*". *Equivalent control knob setting: DSPMNU / DATFMT*

4.1.10 The date_delay setting

This setting determines how long each component of the date cycle is displayed, in 10ths of a second. The allowable values are *1* through *50* and the default is *10* for a one second display of each component. *Equivalent control knob setting: DSPMNU / DATDLY*

4.1.11 The date_year setting

This setting controls whether the year is displayed as part of the date cycle. The allowable values are *true* and *false*. The default value is *true*. *Equivalent control knob setting: DSPMNU / YEAR*

4.1.12 The date_dow setting

This setting determines whether or not the named day of the week is displayed during the date cycle. The allowable values are *true* and *false*. The default value is *true*. *Equivalent control knob setting: DSPMNU / DAY*

4.1.13 The lum_brt setting

This setting controls the brightness of the tubes when the ambient room light level reading is above the *lum_ldr* value. It is expressed as a percentage from *10* to *100* percent. The default value is *95*. *Equivalent control knob setting: DSPMNU / LUMBRT*

Note: A setting of *100* does not necessarily select the maximum brightness obtainable from the tubes. The *pwm_map_max* setting controls the maximum brightness, even when the *lum_brt* setting is set to *100*.

4.1.14 The lum_dim setting

This setting controls the tube brightness when the ambient room light level reading is below the *lum_ldr* value. It is expressed as a percentage from *1* to *100* percent. The default value is *30*. *Equivalent control knob setting: DSPMNU / LUMDIM*

Notes: A setting of *1* does not necessarily select the minimum brightness obtainable from the tubes. The *pwm_map_min* setting controls the absolute minimum brightness, even when the *lum_dim* setting is set to *1*.

To avoid cathode poisoning, ensure that the value you select for *lum_dim* allows all tube segments to light fully. Refer to Section 2.9.3 for more information.

4.1.15 The lum_ldr setting

This setting determines the room ambient light threshold for selecting between BRIGHT and DIM clock display settings. It is compared with the value read from the ambient light sensor on the front right of the CPU-ESP board It can be set to values from *0* to *64*. The default value is *10*. *Equivalent control knob setting: DSPMNU / LUMLDR*

Notes: The control knob setting *SYSMNU / LDRTST* can be used to monitor the reading in real time in order to determine the optimum setting.

Setting *lum_ldr* to *0* configures the clock to never switch to DIM mode, regardless of the ambient light level.

LDR stands for a sensing device called a Light Dependent Resistor, although the Lumina uses a more sophisticated device.

4.1.16 The lum_spd setting

This setting controls how rapidly the clock transitions from dim to bright (or bright to dim) when room brightness changes. The value is in 10ths of a second. Supported values range from *5* to *250*. The default value is *20* for a 2 second pause at each intermediate brightness level. For example, assume you have *lum_brt* set to *70* and *lum_dim* set to *40*. That will result in a brightness change done in 30 steps. With the default value of *20* for *lum_spd*, that will be 2 seconds per step * 30 steps, giving a 1 minute transition. *Equivalent control knob setting: DSPMNU / LUMSPD*

4.1.17 The scroll_speed setting

This setting controls the speed at which messages scroll from right to left across the tubes. The value is in 10ths of a second and can be set to a value in the range *1* to *30*. The default value is *3* for an approximate speed of 1/3 second between characters. *Equivalent control knob setting: DSPMNU / SCLSPD*

4.1.18 The scroll_xfade setting

This setting controls how long it takes for a new character to finish appearing when the display scrolls. It is in milliseconds and can be set to between *1* and *64*. The default value is *8*. *Equivalent control knob setting: DSPMNU / SCLXFD*

4.1.19 The under_score setting

This setting controls the behavior of the underscore segments when the tubes are in bright mode. A variety of animations are available. The default value is "*OFF*". *Equivalent control knob setting: DSPMNU / USCORE*

Table 4–4 Underscore animation options

Value	Definition
"OFF"	Underscores always off
"SWEEP1"	Slow sweep right (1 tube per second)

Table 4–4 (Cont.) Underscore animation options

Value	Definition
"SWEEP2"	Slow sweep from center out (2 tubes per second)
"LARSON"	Slow sweep left to right and back †
"ZIPPY"	Fast sweep left to right
"RUNWAY"	Fast sweep from center to both sides
"BOUNCE"	Fast sweep from left to right
"PNGPNG"	Fast sweep from left to right and back
"PENDLM"	Fast sweep from left to right, pause and back
"IPGOOD"	Underscores on when the clock has not obtained a valid IP address
"TMGOOD"	Reserved for potential future use
"SAME"	This special setting name selects the same value as the one used in bright mode ‡

† This reference should be obvious if you've ever seen the 1980s TV series *Knight Rider*.
‡ This value is only available for dim settings.

4.1.20 The zippy_spd setting

This setting controls the speed of underscore animation when the *under_score* setting is set to one of "*ZIPPY*", "*BOUNCE*", "*RUNWAY*", "*PNGPNG*" or "*PENDLM*". It can be set to values between *10* and *250* milliseconds. The default value is *32*. *Equivalent control knob setting: DSPMNU / ZIPSPD*

4.1.21 The xfade_effect setting

This setting controls how the Lumina handles tube display transitions. The possible values are defined in the following table. The default value is "*XFADE*". *Equivalent control knob setting: DSPMNU / XFDEFF*

Table 4–5 Tube animation effects

Value	Definition
"XFADE"	The traditional crossfade effect
"PINWH1"	Displays a pinwheel sweep at regular brightness on any tubes that have changed
"PINWH2"	Displays a pinwheel sweep at a dimmer brightness on any tubes that have changed
"SAME"	This special setting name selects the same value as the one used for all other display changes †

† This value is only available for word effects.

4.1.22 The effect_time_a_setting

This setting determines the segment delay in milliseconds for wiping the old display off the tube(s). It can be set to between *1* and *250* and has a default value of *10* milliseconds. *Equivalent control knob setting: DSPMNU / SWPTMA*

Notes: The *effect_time_X* settings only have an effect when the *xfade_effect* setting is set to one of the sweep effects.

Using large values for the *effect_time_X* settings can result in a "jumpy" clock, since the effect may take more than one second to complete.

These effects control all transitions on the tubes, not just when the time changes.

4.1.23 The effect_time_b_setting

This setting works in the same manner as *effect_time_a* except that it controls the segment delay when writing the new display to the tubes. The range and default values are identical. *Equivalent control knob setting: DSPMNU / SWPTMB*

4.1.24 The disp_order setting

This setting controls the order in which the various effects display. It supports all combinations of D (Date), C (Calendar), M (Metrology) and W (Words). The default value is "*DCWM*". *Equivalent control knob setting: DSPMNU / DSPORD*

Note: This setting just controls the order of display. Other configuration settings control whether each item is displayed.

4.1.25 The disp_max setting

This setting controls the number of display effects per display cycle. This is used to prevent display overcrowding. Refer to Appendix H for more information. The default value is *4* which enables all 4 effects (date, calendar, metrology and words). *Equivalent control knob setting: DSPMNU / DSPMAX*

Note: Depending on the clock's other settings, all four effects may not display during a cycle even if this setting has a value of 4.

4.1.26 The cal_mod setting

This setting controls the calendar display mode when the tubes are in bright mode. The available options are described in Table 4–3. The default value is "*15MIN*". *Equivalent control knob setting: DSPMNU / CALMOD*

Note: The calendar functions are described in Appendix G.

4.1.27 The cal_order setting

This setting controls the order of calendar event displays when there is more than one matching event. The default value is "*SEQRND*". *Equivalent control knob setting: DSPMNU / CALORD*

Table 4–6 Calendar event order options

Value	Definition
"OFF"	Do not display calendar events
"ALL"	Display all matching calendar events †
"SEQ"	Displays a single matching calendar event per cycle in sequential order †
"RND"	Displays a single matching calendar event per cycle in random order †
"ALLRND"	Display all matching calendar events and a single random message † ‡
"SEQRND"	Displays a single matching calendar event per cycle in sequential order and a single random message † ‡
"RNDRND"	Displays a single matching calendar event per cycle in random order and a single random message † ‡

† A *calendar.txt* file is required for calendar event display. A matching event is a calendar entry with today's date or a wildcard date.

‡ A *calendar.txt* file with at least one random message is required for random message display.

4.1.28 The date_mod_dim setting

This setting controls the date display mode when the tubes are dim. The available options are described in Table 4–3. The default value is "*SAME*". *Equivalent control knob setting: DIMMNU / DATE*

Note: The reason for having separate "dim" settings is to allow the user to configure the Lumina to avoid potential distractions in dark rooms and simply display the time (with any other desired information).

4.1.29 The time_colon_dim setting

This setting controls the colon tube behavior when the tubes are in dim mode. Refer to Table 4–1 for a list of available values. The default value is "*SAME*". *Equivalent control knob setting: DIMMNU / COLON*

4.1.30 The under_score_dim setting

This setting controls the underscore animation when the tubes are in dim mode. Refer to Table 4–4 for a list of available values. The default value is "*SAME*". *Equivalent control knob setting: DIMMNU / USCORE*

4.1.31 The cal_mod_dim setting

This setting controls the calendar display mode when the tubes are dim. The available options are described in Table 4–3. The default value is "*SAME*". *Equivalent control knob setting: DIMMNU / CALNDR*

4.2 The time configuration (CFG_TIME) group

This group controls timekeeping-related functions. There are a number of possible timekeeping sources available in the Lumina. The following table lists the available sources:

Table 4–7 Time synchronization sources

Value	Definition
"RTC"	Use the internal RTC chip for timekeeping
"SNTP"	Obtain time from the Internet via SNTP †
"RPTR"	Obtain time from a "legacy" GPS repeater
"CON"	Receive timekeeping instructions over the serial debug port ‡
"DEBUG"	Additional debugging methods ‡

† This setting requires the clock to have an Internet connection.

‡ This setting is intended for debugging use and should not be selected by the user.

When the clock boots and has passed its self-tests, it will load the current date and time into the CPU from the RTC chip. This time will be used until a more accurate time source becomes available.

The selected source will be used to keep the time on the Lumina CPU synchronized. The RTC is also updated every 2 hours from the selected time source (if that source is not the RTC itself).

Most of these values have a corresponding *xxx_en* and *xxx_update_rate* setting. The *xxx_en* setting determines whether or not that time source is enabled and the *xxx_update_rate* setting controls how often the clock's CPU time is updated by that source, if it is selected.

Note: Just because a particular time source is enabled does not necessarily mean it is being used. At the present time, only a single time source can be selected. Future firmware updates may expand on this functionality.

4.2.1 The time_src setting

This setting controls which time source the clock uses, selected from the following table. The default setting is "*SNTP*". *Equivalent control knob setting: TM MNU / TM SRC*

4.2.2 The time_sync setting

This setting controls the Lumina's behavior when the CPU's time differs from time obtained from the selected source. It can be set to "*IMMED*" which immediately causes the displayed time to change to the correct time or "*SMOOTH*" to cause the displayed time to run slower or faster (as appropriate) than normal until the displayed time matches the correct time. The default value is "*IMMED*". *Equivalent control knob setting: TM MNU / TMSYNC*

Note: The "*SMOOTH*" effect will only be used if the difference between the CPU's time and the actual time is 35 minutes or less. If the difference is greater than 35 minutes, the clock's display will update immediately to the correct time.

4.2.3 The rtc_en setting

This setting enables or disables possible use of the on-board Real Time Clock chip on the CPU board. The RTC is a separate timekeeping chip that will continue to run for approximately one day if power is removed. It is relatively accurate, but is likely the least accurate of all of the standard sources. It can be set to *true* or *false* and the default value is *true*. *Equivalent control knob setting: TM MNU / RTC EN*

4.2.4 The rtc_update_rate setting

This setting controls how often the CPU's internal clock is updated from the RTC chip. The value is in seconds and the available settings range from *30* to *1200*. The default value is *120* seconds (2 minutes). *Equivalent control knob setting: TM MNU / RTC UR*

Note: Normally there is no need for the user to change this setting.

4.2.5 The sntp_en setting

This setting determines whether or not a SNTP server is enabled. SNTP (Simple Network Time Protocol) is an Internet-based service that provides extremely accurate time. Its accuracy is roughly equivalent to the repeater time source (described below). It can be set to *true* or *false* and the default value is *true*. *Equivalent control knob setting: TM MNU / NET EN*

4.2.6 The sntp_update_rate setting

This setting controls how often the Lumina CPU obtains time information from the selected SNTP server. It can be set to any number of minutes between *10* and *1500*. The default value is *121* minutes. *Equivalent control knob setting: TM MNU / NET UR*

Notes: Unless you are using your own SNTP server (very unlikely), it is impolite to ask for time more frequently than necessary. Making requests more frequently than every 30 minutes may cause your Lumina to be banned from the public NTP pool.

The value *121* may seem unusual at first. Hundreds of thousands (if not millions) of devices obtain time from the public NTP pool on a periodic basis. Choosing this value means that the Lumina does not join a swarm of devices asking for the time every 2 hours.

4.2.7 The rptr_en setting

The Lumina CPU can also update its time from a "legacy" GPS repeater. A variety of models of GPS repeater were options on prior generations of MOD-SIX clocks. They all consist of a standalone device with a GPS receiver and a short-range radio to transmit time (and possibly other) information to the MOD-SIX. It is possible to use a GPS repeater as the time source for the Lumina. Its accuracy is approximately equal to SNTP. The advantage of SNTP is that (as long as you have an Internet connection) no additional hardware is needed. It can be set to *true* or *false* and the default value is *false*. *Equivalent control knob setting: TM MNU / RPT EN*

Note: The Lumina and the legacy GPS repeater must be set to the same radio channel and rate in order to communicate.

4.2.8 The rptr_update_rate setting

This setting controls how often the CPU's internal clock is updated from the GPS repeater. The value is in seconds and the available settings range from *30* to *1200*. The default value is *120* seconds (2 minutes). *Equivalent control knob setting: TM MNU / RPT UR*

Note: Normally there is no need for the user to change this setting.

4.2.9 The tweak_ms setting

This setting is reserved for future use. It should not be changed by the user. *Equivalent control knob setting: TM MNU / TWK MS*

4.2.10 The tz_offset_hh setting

This setting specifies the hour offset of the local time from UTC (formerly GMT). It can be set to a value between *-11* and *11*. The default value is *0*, representing US Eastern time. You will almost certainly need to change this to match your location's time zone. *Equivalent control knob setting: TM MNU / TZHOUR*

4.2.11 The tz_offset_mm setting

This specifies the minute offset of the local time from UTC. It can be set to a value between *0* and *59*. The default value is *0*, representing the offset as a simple number of hours. *Equivalent control knob setting: TM MNU / TZMINS*

Note: A value of *0* works for all US time zones as well as most of the rest of the world. There are countries with non-zero minute offsets. As an example, the Western Australia offset is 8 hours, 45 minutes.

4.2.12 The tz_dst setting

This setting controls whether the time zone described by *tz_offset_hh* and *tz_offset_mm* observes some form of Daylight Saving Time. It can be set to *true* or *false*. The default value is *true*. *Equivalent control knob setting: TM MNU / DST EN*

Notes: This setting does not control whether the clock is currently displaying DST, just that the user wants the displayed time to change when DST begins and ends. Not all US states observe DST. For example, Arizona does not, but the Navajo tribal lands in Arizona do.

This is actually a rather abbreviated description. Governments can (and often do) make arbitrary changes to the start and end dates for DST. The clock's built-in rules are based on the latest information available at the time. Refer to the *tz_posix* setting for a way to tell the clock about updated rules.

4.2.13 The sntp_server setting

This setting determines which SNTP server is used for time synchronization. The default, "*pool.ntp.org*", is a free service donated by members of the Internet community. This setting should not be changed unless you are using your own SNTP server (very unlikely). *Equivalent control knob setting: None*

4.2.14 The tz_posix setting

This allows the user to provide the clock with an updated timezone rule if it ever becomes necessary. Setting **tz_offset_hh** to *-5*, **tz_offset_mm** to *0* and **tz_dst** to *true* represents the equivalent of setting **tz_posix** to "*EST5EDT*", which assumes the current defaults for US DST rules. You could also set it to "*EST5EDT,M3.2.0/2:00:00,M11.1.0/2:00:00*" which is the full specification (and quite a mouthful!). Explaining the meaning of each of those fields is beyond the scope of this document. Doing a web search for "POSIX™ timezone strings" will provide more information (and possibly leave you even more confused). You can also contact us via one of the methods listed in Section B.6 for assistance. *Equivalent control knob setting: None*

4.3 The system configuration (CFG_SYSTEM) group

This group contains general information and settings for the Lumina.

4.3.1 The hw_ver setting

This setting specifies the Lumina hardware version. The firmware uses this to alter its operation to match specific hardware. It should not be changed by the user. *Equivalent control knob setting: SYSMNU / HW VER*

Note: If this value is changed, the clock may report errors during startup or behave improperly during operation.

4.3.2 The clk_addr setting

This setting determines the name advertised in mDNS (Multicast Domain Name System) broadcasts. If it is set to *0* the broadcast name will be *MOD-SIX*. If it is set to another number, that number will be appended to the broadcast name. For example, a value of *2* will cause the clock to use the name *MOD-SIX2*. It can be set to a number from *0* to *7* and the default value is *0*. *Equivalent control knob setting: SYSMNU / MYADDR*

Notes: The *CFG_WIFI / mdns_en* setting controls whether or not mDNS broadcasts are enabled or disabled.

At this time, mDNS support is experimental and subject to change.

4.3.3 The web_server_en setting

This setting controls whether or not the clock's web server is enabled. Setting it to *false* disables the web server to prevent random people from connecting to the clock and making changes. The default value is *true*. *Equivalent control knob setting: SYSMNU / WEBSRV*

Notes: If the web server is disabled, the only way to re-enable it is with the control knob or by using the CLRCFG function in the recovery menu as described in Section K.1.2.

At the present time it is not possible to protect the clock's web pages with a password. This is being considered for a future firmware update.

4.3.4 The debug setting

This setting changes the level information provided for debugging. It is a 4-bit bitmask that controls specific debugging. The default value is 0 and should not be changed by the user unless requested by technical support. *Equivalent control knob setting: SYSMNU / MISC / DEBUG*

4.3.5 The rev_major setting

This setting holds the firmware major revision value. It and the following rev_minor setting define the firmware version that created this configuration. If the clock is booted with a different firmware version, the clock will display a **REVERR** message during startup to alert the user of the mismatch between the configuration file and firmware versions. This message is purely informational.

Note: Compatibility of configuration files between different firmware versions is not guaranteed.

This setting should normally not be changed by the user. *Equivalent control knob setting: Part of SYSMNU / STATS*

4.3.6 The rev_minor setting

This setting holds the firmware minor revision value. See the above setting for additional information. This setting should only be changed if the firmware is updated to a new version, to eliminate the **REVERR** startup message as described above. *Equivalent control knob setting: Part of SYSMNU / STATS*

4.3.7 The device setting

The device name for the Lumina CPU is "*CPU-ESP*". This option is provided for configuration file compatibility with possible future CPUs. It should not be changed from the default value. *Equivalent control knob setting: None*

4.4 The radio configuration (CFG_RFLINK) group

The RFLINK is the Lumina component that communicates with the other clock components such as the MET-PIR and keyfob. It is **NOT** involved in WiFi communications.

4.4.1 The channel setting

The RFLINK can be configured to operate on any channel in the range of *0* to *127*. The default value is *77*. *Equivalent control knob setting: LNKMNU / RFCHAN*

Notes: The RFLINK uses the license-free 2.4GHz radio band. These frequencies are shared with Wi-Fi networks, cordless phones, baby monitors, and even microwave ovens. The operating range of the MET-PIR and keyfob will vary depending on which of those are operating nearby.

The clock, MET-PIR and keyfob can be set to any of up to 128 channels (depending on country) to avoid interference with these other gadgets.

If you change the value of *channel* you will need to re-pair the MET-PIR and keyfob. Refer to Section 6.1.1 and Section 7.1, respectively, for the pairing procedure.

In the United States, the allowed channels are 1 through 79.

4.4.2 The rate setting

This setting controls the transmission speed of messages between the Lumina, the MET-PIR and the keyfob. The allowable values are "*250K*", "*1MEG*" and "*2MEG*". The default setting is "*250K*". *Equivalent control knob setting: LNKMNU / RFBAUD*

Notes: Messages sent at lower speeds will generally travel further distances. But if you have a source of periodic interference, selecting a higher speed may allow the message to get through without interference.

As with *channel*, if this setting is changed you will need to re-pair the MET-PIR and keyfob as described above.

4.4.3 The power setting

The power setting controls the signal strength used when transmitting messages to other devices. It can be set to values between *0* (lowest power) and *3* (highest power). The default value is *2*. *Equivalent control knob setting: LNKMNU / RF PWR*

Note: This setting only controls the signal strength when the Lumina is transmitting messages to other RFLINK devices. Most messages are sent from other RFLINK devices to the clock, so this setting is not as useful as it initially appears to be.

4.4.4 The fob_mode setting

This setting controls how the clock responds to messages from the keyfob. A value of "*OFF*" causes the keyfob to be ignored completely, a value of "*ON*" causes the keyfob to behave identically to the clock's rear control knob, and a setting of "*VALET*" provides all normal keyfob functions except that the keyfob cannot be used to change the configuration of the clock. The default value is "*ON*". *Equivalent control knob setting: LNKMNU / FOB MD.*

4.4.5 The fob_addr setting

This setting controls the "address" used when the clock listens for messages from the keyfob. In order to act on keyfob messages, the keyfob and clock must be using the same address. Values range from *0* to *7* and the default value is *0*. *Equivalent control knob setting: LNKMNU / FOBADR*

Notes: It is not normally necessary for users to change this value unless they are operating multiple clocks as described in Appendix D.

Setting the keyfob address is described in Chapter 7.

4.4.6 The pir_addr setting

This setting operates in the same manner as the *fob_addr* setting, except that it applies to the MET-PIR. *Equivalent control knob setting: LNKMNU / PIRADR*

Note: Setting the MET-PIR address is described in Section 6.1.

4.4.7 The findable setting

This setting determines whether the Lumina responds to pairing requests from other devices such as the MET-PIR and keyfob. It can be set to *true* or *false*. The default value is *true*. *Equivalent control knob setting: LNKMNU / FINDME*

Notes: Most users will not need to change this setting as it is intended for configurations with multiple clocks. Refer to Appendix D for additional information.

Setting the value to *false* means that the clock will not respond to pairing requests.

4.4.8 The beacon setting

This setting controls whether or not the Lumina will transmit date and time messages to "legacy" MOD-SIX clocks. It can be set to *true* or *false*. The default value is *false*. *Equivalent control knob setting: LNKMNU / BEACON*

Note: Most users will not need to change this setting as it is only needed when operating with "legacy" MOD-SIX clocks. Refer to Section D.3 for further information.

4.5 The metrology (environment) configuration (CFG_MET) group

The settings in this menu group control how data from remote sensors is displayed on the clock.

Note: These displays rely on there being a MET-PIR present and paired with the clock.

4.5.1 The met_mod setting

This setting controls how frequently the sensor data is displayed on the clock when in bright mode. Refer to Table 4–3 for the possible values. The default value is "*1MIN*". *Equivalent control knob setting: METMNU / MOD*

4.5.2 The met_mod_dim setting

This setting corresponds to *met_mod*, except it is used when the clock is in dim mode. The default value is "*SAME*". *Equivalent control knob setting: DIMMNU / MET*

4.5.3 The met_delay setting

This setting controls how long each line of sensor data is displayed before switching to the next line. The value is in 10ths of a second. Values between *1* and *50* are supported. The default value is *15* for a 1.5 second delay. *Equivalent control knob setting: METMNU / DELAY*

4.5.4 The rh_units setting

This setting determines whether relative humidity will be displayed. A value of "*ON*" displays humidity and a value of "*OFF*" disables the display. The default value is "*ON*". *Equivalent control knob setting: METMNU / RH ENA*

Note: Relative humidity readings can vary greatly between different sensors, even when they are located close to each other. Therefore, we provide the option to disable the display of relative humidity.

4.5.5 The rh_suffix setting

This setting controls the suffix used for display of humidity. It can be set to one of the values in the table below. The default setting is *RH*. *Equivalent control knob setting: METMNU / RHSUFF*

Table 4–8 Relative humidity suffixes

Value	Definition
"RH"	Use a suffix of "RH"
"H"	Use a suffix of "H"
"%"	Use a suffix of "%" †
"%H"	Use a suffix of "%H" †
"$"	Use a suffix of "%" (alternate font) †
"$H"	Use a suffix of "%H" (alternate font) †

† The percent symbol is somewhat unusual looking due to limitations imposed by the number of segments in the tube. There are two different styles to accommodate user preferences.

4.5.6 The temp_units setting

This setting selects the scale used when displaying temperature. A value of "*F*" selects Fahrenheit, while "*C*" selects Celsius. The default value is "*F*". *Equivalent control knob setting: METMNU / C/F*

4.5.7 The baro_units setting

This setting selects the scale used when displaying barometric pressure. "*HG*" selects inches of mercury, while "*MB*" selects millibars. The default value is "*HG*". *Equivalent control knob setting: METMNU / HG/MB*

4.5.8 The show_trend setting

This setting controls whether or not trends in changing barometric pressure are reported. It can be set to "*OFF*" to not display trend data, "*TEXT*" to display one of the words from Table 4–9 or "*COMPCT*" to display the trend in compact format on the same line as the barometric pressure. The default value is *TEXT*. *Equivalent control knob setting: METMNU / TREND*

Table 4–9 Barometric trend indicators

Display	Meaning
STEADY	Barometric pressure is constant
RISE	Barometric pressure is rising

Table 4–9 (Cont.) Barometric trend indicators

Display	Meaning
RISE*	Barometric pressure is rising rapidly †
FALL	Barometric pressure is falling
FALL*	Barometric pressure is falling rapidly †

† Rapidly is defined as a change of 2 millibar or more within three hours.

Note: The MET-PIR needs to acquire readings for at least three hours in order for trends to be displayed.

4.5.9 The cal_tc_0 setting

This setting allows adjustment of the temperature reported by the temperature sensor. It is configured in 10ths of a degree Celsius. For example, a setting of *12* will raise the reported temperature by 1.2 degrees Celsius or approximately 2 degrees Fahrenheit. The allowable values are the range *-100* through *100*. The default value of *0* reports the temperature exactly as received from the MET-PIR. *Equivalent control knob setting: METMNU / CAL TC*

4.5.10 The cal_rh_0 setting

Similarly to *cal_tc_0*, this setting allows the reported relative humidity to be adjusted. Values from *-20* to *20* percent may be used. The default value is *0*. *Equivalent control knob setting: METMNU / CAL RH*

4.5.11 The cal_baro_0 setting

This setting fine-tunes the reported barometric pressure. The adjustment range is *-100* to *100*. This value is always in millibars regardless of the value of the *baro_units* setting. The default value is *0*. *Equivalent control knob setting: METMNU / CAL MB*

Note: One millibar is approximately equivalent to 0.03 inches of mercury.

4.5.12 The sta_en_mask setting

This setting is used when there are multiple clocks and MET-PIRs or "legacy" GPS repeaters in the system. Refer to Section 6.1.6 for additional information. The allowable values are *0* through *15* and the default value of *1* configures the clock to listen to only a paired MET-PIR within range. *Equivalent control knob setting: METMNU / STAENA BITMSK*

Table 4–10 sta_en_mask settings

Slot 0	Slot 1	Slot 2	Slot 3	Value	Comments
X				1	Default for MET-PIR and Lumina
	X			2	Slot 1 is reserved for "legacy" GPS repeaters
		X		4	
			X	8	

The setting of **sta_en_mask** is the sum of the numbers in the "Value" column of the table. For example, if you wanted to show environmental data from the default MET-PIR (Value = 1) and a "legacy" GPS repeater (Value = 2) you would set **sta_en_mask** to *3*.

Notes: Most users will never need to change this setting from the default value.

Enabling more than one station may be confusing as the Lumina will display two or more sets of environmental readings, one after the other, without indicating which is which. We are considering adding a method to identify the source in a future firmware release.

4.6 The timers configuration (CFG_TIMERS) group

This group contains the settings for various timers such as the PIR (motion detection) timeout and the various action timers. The action timers are described in further detail in Appendix E.

4.6.1 The tmr_mode setting

This setting controls whether the timer functions described below are active or not. The allowable values are "*OFF*" and "*ON*" with the default being "*OFF*". *Equivalent control knob setting: TMRMNU / TMR MD*

Notes: The Lumina has twelve timers. Each of them has a starting time, an action, and the day(s) of the week that they will activate.

In the following examples, the specific timer number is marked with an *x* to avoid redundant pages in this manual.

4.6.2 The pir_mode setting

This setting controls whether or not the clock responds to motion detection events from the MET-PIR. It can be set to "*OFF*" or "*ON*". The default value is "*ON*". *Equivalent control knob setting: TMRMNU / PIR MD*

4.6.3 The pir_time setting

This setting controls how long the clock waits for a motion event before turning off the tubes (and potentially the RGB displays). The setting is in minutes and can be set to values between *1* and *180*. The default value is *5*. *Equivalent control knob setting: TMRMNU / PIR TM*

Note: Using short values for *pir_time* can lead to undesirable cycling of the clock between display off and display on. These short values are most useful when determining the optional location for the MET-PIR. Once you have settled on a location, a *pir_time* value of *15* or longer is probably a reasonable starting point.

4.6.4 The tmrx_time setting

The start time for the action performed by this timer. It may be set to any valid time in "*HH:MM:SS*" format. The default value is "*00:00:00*". *Equivalent control knob setting: TMRMNU / TMx TM*

Note: Regardless of whether the clock displays in 12 hour or 24 hour format, these times are always in 24 hour format. For example, if you wanted a timer to activate at 6 PM, you would specify "*18:00:00*".

4.6.5 The tmrx_action setting

This setting controls what action the clock takes when the timer activates. The following table lists the possible values. The default value is "*ON*". *Equivalent control knob setting: TMRMNU / TMxACT*

Table 4–11 Timer actions

Value	Definition
"OFF"	Turn tubes off, LEDs to configured OFF mode
"ON"	Turn tubes on in bright mode (see the *lum_brt* setting) and LEDs to configured BRT mode
"DIM"	Turn tubes on in dim mode (see the *lum_dim* setting) and LEDs to configured DIM mode
"PIR"	Let PIR motion detection control tube brightness and LED mode

4.6.6 The tmrx_dow setting

This setting controls which day(s) the timer will activate. The table below lists the options. The default value is "*TMROFF*". *Equivalent control knob setting: TMRMNU / TMxDAY*

Table 4–12 Timer day(s)

Value	Definition
"TMROFF"	The timer never takes action, even if enabled
"SUN"	Activate on Sundays only
"MON"	Activate on Mondays only
"TUE"	Activate on Tuesdays only
"WED"	Activate on Wednesdays only
"THU"	Activate on Thursdays only
"FRI"	Activate on Fridays only
"SAT"	Activate on Saturdays only
"MONFRI"	Activate every weekday
"SATSUN"	Activate every weekend
"EVERY"	Always activate

4.7 The WiFi configuration (CFG_WIFI) group

This group contains settings related to WiFi networking.

Note: We anticipate adding additional items to this group in future firmware updates.

4.7.1 The mdns_enable setting

This setting determines whether or not mDNS (Multicast Domain Name System) broadcasts are enabled. It can be set to "*ON*" or "*OFF*". The default value is "*ON*". *Equivalent control knob setting: SYSMNU/ MDNS*

Notes: The *CFG_SYSTEM / clk_add* setting determines what name is transmitted in mDNS broadcasts.

At this time, mDNS support is experimental and subject to change.

4.7.2 The show_messages setting

This setting controls whether the clock displays informational messages if the WiFi connection drops or the clock re-connects. It can be set to *true* or *false*. The default is *true*. *Equivalent control knob settings: SYSMNU / MISC / MSGSIP*

Note: If the *CFG_MISC / show_messages* setting is set to *false* this setting has no effect due to being overridden by that setting.

4.8 The random word configuration (CFG_WORDS) group

This group provides settings controlling the display of random words. Additional information about the random word function is provided in Appendix L.

4.8.1 The word_mod setting

This setting controls how frequently random words are displayed when the clock is in bright mode. The available values are listed in Table 4–3. The default value is "*3MIN*". *Equivalent control knob setting: WRDMNU / MOD*

4.8.2 The num_words setting

This setting controls the number of words displayed during a display cycle. It can be set to a value between *1* and *4*. The default value is *2*. *Equivalent control knob setting: WRDMNU / NWORDS*

4.8.3 The dirty setting

This setting controls whether or not words considered "dirty" are displayed. Valid settings are *true* and *false*. The default value is *false*. *Equivalent control knob setting: WRDMNU / DIRTY*

Note: We have tried to ensure that no offensive words will be displayed if this setting is set to *false*. It is possible that a few have been missed. If you encounter an offensive word, contact us via one of the methods listed in Section B.6 and we will move it to the dirty word file.

4.8.4 The censor setting

This setting determines whether "dirty" words are censored when displayed. The censoring is performed by replacing one or more letters in the word with an asterisk (*). It can be set to *true* or *false*. The default value is *false*. *Equivalent control knob setting: WRDMNU / CENSOR*

Note: This setting has no effect unless *dirty* is set to *true*.

4.8.5 The lexicons setting

This setting selects which words are displayed. The valid settings are "*FLW*" (display only four-letter words), "*SLW*" (display only six-letter words) or "*ALL*" (display both four-letter and six-letter words). The default value is "*ALL*". *Equivalent control knob setting: WRDMNU / LEXCON*

4.8.6 The effect setting

This setting selects the method for displaying words. The following table lists the available values. The default value is "*RNDRND*". *Equivalent control knob setting: WRDMNU / EFFECT*

Table 4–13 Word display options

Value	Definition
"NONE"	No special effect (just display word)
"L-FILL"	Letters appear from left to right
"R-FILL"	Letters appear from right to left
"RNDLET"	Letters appear in random order
"RNDSEG"	Tube segments form letters in random order
"RND"	Selects one of the above methods at random †
"RNDRND"	Selects from the above methods at random ‡

† If more than one word will be displayed, use the same random method for each word.
‡ This value selects a (possibly) different random method if the clock is configured to display more than one word per display cycle.

4.8.7 The xfade_effect setting

This setting controls how the Lumina handles tube display transitions while displaying words. The possible values are defined in Table 4–5. The default value is "*SAME*". *Equivalent control knob setting: WRDMNU / XFDEFF*

4.8.8 The word_delay setting

This setting controls the length of time each word is displayed in 10ths of a second. It can be set to a value between *1* and *50*. The default value is *10* for a display time of 1 second. *Equivalent control knob setting: WRDMNU / WRDDLY*

4.8.9 The letter_delay setting

This setting controls the delay between word letters appearing, in 10ths of a second. The allowable values are *1* through *50* and the default is *3*. *Equivalent control knob setting: WRDMNU / LETDLY*

4.8.10 The segment_delay setting

This setting controls the delay between letter segments appearing, in milliseconds. The allowable values are *1* through *250* and the default is *8*. *Equivalent control knob setting: WRDMNU / SEGDLY*

Note: This setting only has meaning if the effect setting causes a word to appear segment by segment.

4.8.11 The bookends setting

This setting controls what is displayed in the 1st and 6th characters of the display when a 4-letter word is displayed. "*OFF*" will leave those positions blank, "-" will display dashes and "*" will display asterisks. The default value is "-". *Equivalent control knob setting: WRDMNU / BKENDS*

4.8.12 The word_mod_dim setting

This setting is the same as *word_mod* except that it is used when the tubes are dimmed. Refer to the *word_mod* description above for more information. The default value is "*SAME*". *Equivalent control knob setting: DIMMNU / WORDS*

4.8.13 The flw_file*X* setting

These settings select the file names for the "clean" *(X=1)* and "dirty" *(X=2)* four-letter word files. For more information, refer to Appendix L. *Equivalent control knob setting: None*

Note: There is normally no need for the user to change these from the default file names.

4.8.14 The slw_file*X* setting

These settings select the file names for the six-letter word files in the same manner as the four-letter word files described above. *Equivalent control knob setting: None*

4.9 The LED configuration (CFG_LEDs) group

This section describes how to configure the various operating modes (brightness, color, etc.) of the 3 groups of LEDs. A more detailed explanation with an example is provided in Appendix F.

There are 3 possible groups of LEDs as shown in the xxx part of the following settings. When xxx is cpu, the settings control the single RGB LED on the CPU board. When xxx is tdu, the settings control the 24 LEDs under the tubes. When xxx is aux, the settings control the LED in the center design.

For each device, the mode and color can be individually set for when the tubes are bright, when the tubes are dim, and when the tubes are off.

4.9.1 The led_editor setting

This setting determines the color space the interactive color editor (available only via the control knob) operates in. "*RGB*" selects Red/Green/Blue encoding while "*HSV*" selects Hue/Saturation/Value encoding. The default value is "*HSV*". *Equivalent control knob setting: LEDMNU / EDITOR*

Note: The Lumina always stores colors in RGB format, converting from HSV if necessary. The choice of color space is offered as a convenience to users.

4.9.2 The *xxx*brt_mode setting

This controls the operating mode of the LED group when the tubes are in bright mode. The possible values are listed in the following table. The default value varies depending on the value of *xxx*. Refer to Appendix C for the individual default values. *Equivalent control knob setting: LEDMNU / xxxMNU*

Table 4–14 LED mode options

Value	Definition
"OFF"	LEDs are off
"ON"	LEDs are on
"1PPS"	LEDs will strobe once per second †
"UPDOWN"	LEDs will ramp up and down in 2 second cycles †
"RCV"	LEDs will do one UPDOWN cycle in response to any message from the MET-PIR or keyfob †
"SYNC"	LEDs will do one UPDOWN cycle when the clock's internal time is updated †
"PIR"	LEDs will do one UPDOWN cycle in response to PIR events †
"WIFI"	LEDs will be on if the clock has a good WiFi connection †
"TIME"	Reserved for possible future use †
"SAME"	Use the same LED behavior as in bright mode ‡

† The LEDs will light with the color and intensity configured later in this chapter.

‡ This value is only available for the dim and off settings.

4.9.3 The *xxx*brt_rgb setting

This setting selects a color from the palette of 8 colors defined later in this chapter. Values from "*RGB_1*" through "*RGB_8*" are supported. The default value varies depending on the value of *xxx*. Refer to Appendix C for the individual default values. *Equivalent control knob setting: LEDMNU / xxxMNU*

4.9.4 The *xxx*dim_mode setting

This setting functions the same as *xxx_brt_mode* except it applies when the tubes are in their dimmed state. The default value is "*SAME*". *Equivalent control knob setting: LEDMNU / xxxMNU*

4.9.5 The *xxx*dim_rgb setting

This setting functions the same as *xxx_brt_rgb* except it applies when the tubes are in their dimmed state. The default value varies depending on the value of *xxx*. Refer to Appendix C for the individual default values. *Equivalent control knob setting: LEDMNU / xxxMNU*

4.9.6 The *xxx*off_mode setting

This setting functions the same as *xxx_brt_mode* except it applies when the tubes are off. The default value is "*SAME*". *Equivalent control knob setting: LEDMNU / xxxMNU*

4.9.7 The *xxx*off_rgb setting

This setting functions the same as *xxx_brt_rgb* except it applies when the tubes are off. The default value varies depending on the value of *xxx*. Refer to Appendix C for the individual default values. *Equivalent control knob setting: LEDMNU / xxxMNU*

4.9.8 The rgb_*x* setting

This defines the color and intensity for each of the 8 LED palette slots via six hexadecimal digits. Refer to Appendix F for how the colors and intensities are defined. The default value varies depending on the value of *x*. Refer to Appendix C for the individual default values. *Equivalent control knob setting: LEDMNU / RGBMNU*

4.10 The miscellaneous configuration (CFG_MISC) group

This group contains a number of miscellaneous settings that don't fit in any other group.

4.10.1 The show_messages setting

This setting controls whether or not the clock displays informational messages transmitted by other devices such as the MET-PIR and keyfob. It may be set to *true* or *false*. The default is *true*. *Equivalent control knob settings: SYSMNU / MISC / MSGS GLOBAL*

Note: This setting only changes whether or not the clock displays the messages it receives. It does not affect any action the clock may take when a message is received.

4.10.2 The pb_press setting

This setting controls the clock's response when the center keyfob button or control knob on the rear of the clock is pressed briefly. The following table describes each of the possible values and what they mean. The default value is "*TIMER*". *Equivalent control knob setting: SYSMNU / MISC / PBPRES ACTION*

Table 4–15 Pushbutton configuration options

Value	Description
"NOP"	Do nothing (No OPeration) §
"WAKE"	Wakes the clock up from the off condition, as if the MET-PIR had detected motion
"TIMER"	Enables or disables timer mode
"DATE"	Display the date immediately †
"MET"	Display the metrology information (temperature, humidity and barometric pressure) immediately †
"WORDS"	Display random word(s) immediately † ‡
"CALNDR"	Display matching calendar event(s) immediately †

§ However, the clock will "wake up" for 30 seconds if the tubes are off.

† Instead of waiting for the next regular display cycle (if configured).

‡ The number of words displayed is configured in the CFG_WORDS section.

4.10.3 The pwm_map_max setting

This setting controls the absolute maximum brightness of the tubes when the *lum_brt* setting is set to 100. Values between *64* and *255* are supported. The default value is *255*. *Equivalent control knob setting: SYSMNU / MISC / MAPMAX*

Notes: This is actually a scaling function as the *1* to *100 lum_XXX* settings are scaled by the value selected here.

Users will not normally need to change this setting.

4.10.4 The pwm_map_min setting

This setting operates in the same manner as *pwm_map_max*, except that it controls the lower limit. Refer to *pwm_map_max* for more information. The supported range is *0* to *255* and the default value is *0*. *Equivalent control knob setting: SYSMNU / MISC / MAPMIN*

5 Clock configuration via the control knob or optional keyfob

The Lumina contains a large number of settings which allow it to be configured for your particular tastes. Most users will likely configure it via its built-in web server as described in Chapter 4. For those who do not have a network connection or simply prefer to use the control knob, nearly all configuration options can be configured via the control knob, which can be rotated, pressed briefly and released (a "short press") or pressed and held for longer than 3 seconds (a "long press") to select options.

Figure 5–1 Control knob location

Normally, the optional keyfob can be used as a substitute for the control knob. This is convenient as the user doesn't have to reach around to the back of the clock to make changes. When the following text refers to "the knob", that is the center button on the keyfob when the clock is in menu mode. The up and down keyfob buttons are equivalent to rotating the control knob clockwise and counterclockwise, respectively.

Note: The web menu setting *fob_mode* or the control knob setting *LNKMNU / FOB MD* must be set to "*ON*" for the keyfob to function as a substitute for the control knob.

While in normal time display mode, if the knob is pressed for more than three seconds, the clock will enter configuration mode. Release the knob and rotate it to select the option to be modified. When the name of the option to be changed is displayed, a short press will then allow modification of the option by rotating the knob.

Options are grouped by related functions. Some options are organized within sub-menus. You may return to the next higher level menu by selecting the RETURN option from within these sub-menus. Configuration mode can be exited by selecting EXIT from the main menu, or at any time by a long press from within most menus.

If the clock is left in configuration mode, it will time out after 120 seconds of inactivity and exit to the next higher menu (if any). After a 120 second timeout in the top level menu, it will exit configuration mode, displaying "TM OUT" and without saving any changes. This is to prevent accidental button presses from leaving the clock in configuration mode unexpectedly.

Note: Changes to options will not take effect until the configuration mode is exited *and* the user selects "SAVE".

The following table lists the control knob menu items in the order they appear. Some menu items display a useful hint about the setting type or options for that item. These are shown in italic in the following table. Each menu item has a reference to where the setting is discussed in detail.

Note: There are some menu items which function differently than the equivalent web configuration setting, as well as some menu items that have no equivalent web configuration setting. These are indicated by dagger symbols in the following table with a reference to a more complete description later in this chapter.

Table 5–1 Control knob / keyfob menu tree

Menu Item	Hint(s)	Section reference for additional info
FONT		Section 4.1.1, The time_font setting
DSPMNU		N/A
FONT	*TIME*	Section 4.1.1, The time_font setting
DFONT	*DATMET*	Section 4.1.2, The disp_font setting
XFADE	*MILSEC*	Section 4.1.3, The xfade_rate setting
12/24		Section 4.1.4, The time_fmt setting
LZS		Section 4.1.5, The time_lzs setting
COLONS		Section 4.1.6, The time_colon setting
AMPM		Section 4.1.7, The time_ampm setting
DATMOD	*EVERY*	Section 4.1.8, The date_mod setting
DATFMT		Section 4.1.9, The date_fmt setting
DATDLY	*10THS*	Section 4.1.10, The date_delay setting
YEAR	*SHOW*	Section 4.1.11, The date_year setting
DAY	*SHOW*	Section 4.1.12, The date_dow setting
LUMBRT	*PERCNT*	Section 4.1.13, The lum_brt setting
LUMDIM	*PERCNT*	Section 4.1.14, The lum_dim setting
LUMLDR	*0-64*	Section 4.1.15, The lum_ldr setting
LUMSPD	*10THS*	Section 4.1.16, The lum_spd setting
SCLSPD	*10THS*	Section 4.1.17, The scroll_speed setting
SCLXFD	*MILSEC*	Section 4.1.18, The scroll_xfade setting
USCORE		Section 4.1.19, The under_score setting
ZIPSD	*MILSEC*	Section 4.1.20, The zippy_spd setting
XFDEFF	*EFFECT*	Section 4.1.21, The xfade_effect setting

Table 5–1 (Cont.) Control knob / keyfob menu tree

Menu Item	Hint(s)	Section reference for additional info
EFFTMA	*MILSEC*	Section 4.1.22, The effect_time_a_setting
EFFTMB	*MILSEC*	Section 4.1.23, The effect_time_b_setting
DSPORD	*ORDER*	Section 4.1.24, The disp_order setting
DSPMAX	*1-4*	Section 4.1.25, The disp_max setting
CALMOD	*EVERY*	Section 4.1.26, The cal_mod setting
CALORD	*ORDER*	Section 4.1.27, The cal_order setting
RETURN		N/A
TM MNU		N/A
TM SRC	*USE*	Section 4.2.1, The time_src setting
TMSYNC	*STRAT*	Section 4.2.2, The time_sync setting
RTC EN		Section 4.2.3, The rtc_en setting
RTC UR	*SECNDS*	Section 4.2.4, The rtc_update_rate setting
NET EN		Section 4.2.5, The sntp_en setting
NET UR	*MINUTE*	Section 4.2.6, The sntp_update_rate setting
RPT EN		Section 4.2.7, The rptr_en setting
RPT UR	*SECNDS*	Section 4.2.8, The rptr_update_rate setting
TWK MS	*MILSEC*	Section 4.2.9, The tweak_ms setting
TZHOUR	*+-HOUR*	Section 4.2.10, The tz_offset_hh setting
TZMINS	*MINUTE*	Section 4.2.11, The tz_offset_mm setting
DST EN	*ENABLE*	Section 4.2.12, The tz_dst setting
TIME ‡	*HHMMSS*	Section 5.1, Setting the time via the control knob
DATE ‡	*YYMMDD*	Section 5.2, Setting the date via the control knob
RETURN		N/A
LNKMNU		N/A
RFCHAN		Section 4.4.1, The channel setting
RFBAUD		Section 4.4.2, The rate setting
RF PWR		Section 4.4.3, The power setting
FOB MD		Section 4.4.4, The fob_mode setting
FOBADR	*0-7*	Section 4.4.5, The fob_addr setting
PIRADR	*0-7*	Section 4.4.6, The pir_addr setting
FINDME		Section 4.4.7, The findable setting
BEACON	*SENDTM*	Section 4.4.8, The beacon setting
RETURN		N/A
DIMMNU		N/A
DATE	*EVERY*	Section 4.1.28, The date_mod_dim setting
COLONS		Section 4.1.29, The time_colon_dim setting
USCORE		Section 4.1.30, The under_score_dim setting

‡ There is no web menu equivalent for this setting.

Table 5–1 (Cont.) Control knob / keyfob menu tree

Menu Item	Hint(s)	Section reference for additional info
MET	*EVERY*	Section 4.5.2, The met_mod_dim setting
WORDS	*EVERY*	Section 4.8.12, The word_mod_dim setting
CALNDR	*EVERY*	Section 4.1.31, The cal_mod_dim setting
RETURN		N/A
WRDMNU		N/A
MOD	*EVERY*	Section 4.8.1, The word_mod setting
NWORDS		Section 4.8.2, The num_words setting
DIRTY	*ENABLE*	Section 4.8.3, The dirty setting
CENSOR		Section 4.8.4, The censor setting
LEXCON		Section 4.8.5, The lexicons setting
EFFECT	*WORD*	Section 4.8.6, The effect setting
XFDEFF	*EFFECT*	Section 4.8.7, The xfade_effect setting
WRDDLY	*10THS*	Section 4.8.8, The word_delay setting
LETDLY	*10THS*	Section 4.8.9, The letter_delay setting
SEGDLY	*MILSEC*	Section 4.8.10, The segment_delay setting
BKENDS	*ENABLE*	Section 4.8.11, The bookends setting
RETURN		N/A
TMRMNU		N/A
TMR MD		Section 4.6.1, The tmr_mode setting
PIR MD		Section 4.6.2, The pir_mode setting
PIR TM	*MINUTS*	Section 4.6.3, The pir_time setting
TM1 TM	*HHMM*	Section 4.6.4, The tmrx_time setting
TM1ACT	*ACTION*	Section 4.6.5, The tmrx_action setting
TM1DAY	*DAYS*	Section 4.6.6, The tmrx_dow setting
TM2 TM	§	§
TM2ACT	§	§
TM2DAY	§	§
TM3 TM	§	§
TM3ACT	§	§
TM3DAY	§	§
TM4 TM	§	§
TM4ACT	§	§
TM4DAY	§	§
TMMORE		N/A
TM5 TM	§	§
TM5ACT	§	§
TM5DAY	§	§

§ This indicates that there is a repeating group of option hints (for example *HHMM*, *ACTION* and *DAYS*) repeating through a group of settings, or that the section number for additional info also repeats in a sequence.

Table 5–1 (Cont.) Control knob / keyfob menu tree

Menu Item	Hint(s)	Section reference for additional info
TM6 TM	§	§
TM6ACT	§	§
TM6DAY	§	§
TM7 TM	§	§
TM7ACT	§	§
TM7DAY	§	§
TM8 TM	§	§
TM8ACT	§	§
TM8DAY	§	§
TM9 TM	§	§
TM9ACT	§	§
TM9DAY	§	§
T10 TM	§	§
T10ACT	§	§
T10DAY	§	§
T11 TM	§	§
T11ACT	§	§
T11DAY	§	§
T12 TM	§	§
T12ACT	§	§
T12DAY	§	§
RETURN		N/A
RETURN		N/A
LEDMNU		N/A
CPUMNU		N/A
CPMBRT	*MODE*	Section 4.9.2, The xxxbrt_mode setting
CPLBRT	*RGBSEL*	Section 4.9.3, The xxxbrt_rgb setting
CPMDIM	§	Section 4.9.4, The xxxdim_mode setting
CPLDIM	§	Section 4.9.5, The xxxdim_rgb setting
CPMOFF	§	Section 4.9.6, The xxxoff_mode setting
CPLOFF	§	Section 4.9.7, The xxxoff_rgb setting
RETURN		N/A
TDUMNU		N/A
TDMBRT	§	§
TDLBRT	§	§
TDMDIM	§	§
TDLDIM	§	§

§ This indicates that there is a repeating group of option hints (for example *HHMM*, *ACTION* and *DAYS*) repeating through a group of settings, or that the section number for additional info also repeats in a sequence.

Table 5–1 (Cont.) Control knob / keyfob menu tree

Menu Item	Hint(s)	Section reference for additional info
TDMOFF	§	§
TDLOFF	§	§
RETURN		N/A
AUXMNU		N/A
AXMBRT	§	§
AXLBRT	§	§
AXMDIM	§	§
AXLDIM	§	§
AXMOFF	§	§
AXLOFF	§	§
RETURN		N/A
RGBMNU		N/A
RGB 1 †	*HHSSVV*	Section 4.9.1, The led_editor setting, Section 4.9.8, The rgb_x setting and Appendix F, Selecting RGB colors and modes for the LEDs
RGB 2 †	"	"
RGB 3 †	"	"
RGB 4 †	"	"
RGB 5 †	"	"
RGB 6 †	"	"
RGB 7 †	"	"
RGB 8 †	"	"
RETURN		N/A
EDITOR	*SPACE*	Section 4.9.1, The led_editor setting and Appendix F, Selecting RGB colors and modes for the LEDs
RETURN		N/A
METMNU		N/A
MOD	*EVERY*	Section 4.5.1, The met_mod setting
DELAY	*10THS*	Section 4.5.3, The met_delay setting
RH ENA	*ON OFF*	Section 4.5.4, The rh_units setting
RHSUFF	*SUFFIX*	Section 4.5.5, The rh_suffix setting
C/F		Section 4.5.6, The temp_units setting
HG/MB		Section 4.5.7, The baro_units setting
TREND	*SHOW*	Section 4.5.8, The show_trend setting
CAL TC	*C/10*	Section 4.5.9, The cal_tc_0 setting
CAL RH	*PERCNT*	Section 4.5.10, The cal_rh_0 setting
CAL MB	*MB HPA*	Section 4.5.11, The cal_baro_0 setting

§ This indicates that there is a repeating group of option hints (for example *HHMM*, *ACTION* and *DAYS*) repeating through a group of settings, or that the section number for additional info also repeats in a sequence.

† This setting operates slightly differently than the web menu version.

Table 5–1 (Cont.) Control knob / keyfob menu tree

Menu Item	Hint(s)	Section reference for additional info
STAENA	*BITMSK*	Section 4.5.12, The sta_en_mask setting
RETURN		N/A
SYSMNU		N/A
FNTCAT ‡		Section 5.3, Font catalog display via the control knob
LDRTST ‡		Section 5.4, LDR (room brightness) test function
SEGTST ‡		Section 5.5, The segment test function
RGBTST ‡		Section 5.6, The RGB test function
STATS ‡		Section 5.7, Clock statistics reporting
HW VER	*SETVER*	Section 4.3.1, The hw_ver setting
MY IP ‡	*WIFI*	Section 5.8, Displaying the clock's IP address
MYADDR	*CLOCK*	Section 4.3.2, The clk_addr setting
WEBSRV	*ENABLE*	Section 4.3.3, The web_server_en setting
MDNS	*ENABLE*	Section 4.7.1, The mdns_enable setting
REBOOT	*CONFIRM LONGPB*	Section 3.1.2, Lower half of the home page
MISC		N/A
MSGALL	*GLOBAL*	Section 4.10.1, The show_messages setting
MSGNET	*WIFI*	Section 4.7.2, The show_messages setting
CLRNET ‡	*CONFIRM LONGPB*	Section K.1.1, CLRNET
PBPRES	*ACTION*	Section 4.10.2, The pb_press setting
MAPMAX	*PWMMAX*	Section 4.10.3, The pwm_map_max setting
MAPMIN	*PWMMIN*	Section 4.10.4, The pwm_map_min setting
DEBUG	*BITMSK*	Section 4.3.4, The debug setting
F-SAVE ‡		Section 5.9, The F-SAVE function
D-SAVE ‡		Section 5.10, The D-SAVE function
RETURN		N/A
RETURN		N/A
CANCEL		Section 5.11, Canceling pending changes
-SAVE-		Section 5.12, Saving pending changes

‡ There is no web menu equivalent for this setting.

5.1 Setting the time via the control knob

If there is no external time source (SNTP or a "legacy" GPS repeater) available, you will need to set the time manually using the control knob.

While the TIME menu option is displayed, a short press on the control knob will produce a (likely incorrect) time display with underscores under the hours tubes. Rotate the control knob to set the correct hour, then press the control knob again to advance the underscores to the minutes. Again, rotate the control knob to set the minutes, then press again to advance the underscores to the seconds tubes. Rotate the control knob to set the seconds and press again to exit.

5.2 Setting the date via the control knob

Similarly to setting the time, the date is also entered via the control knob, in the format YYMMDD.

5.3 Font catalog display via the control knob

This function will display the characters used in each of the clock's numeric fonts. A brief press of the control knob will cycle through the available font names, one per press. Rotate the control knob to cycle between displaying digits 1-6 and 5-0. Press the control knob briefly to return to the font catalog. A long press while a font name is being displayed will return to FNTCAT and a second long press will exit the menus completely.

Notes: This manual includes complete samples of each font in Chapter 8.

This function only displays font samples. To select a font for the clock to use, use either the DSPMNU / FONT and DFONT control knob functions or the CFG_TIME / time_font or disp_fontweb configuration settings.

5.4 LDR (room brightness) test function

In order to set the proper threshold between what the Lumina considers a brightly-lit room vs. a dimly-lit room, a sensor on the CPU board is used. The LDRTST function displays a real-time reading from that sensor. Once you have determined the appropriate bright and dim thresholds for the Lumina's location, make a note of the average of the two values and enter it via the control knob DSPMNU / LUMLDR function or the web configuration **CFG_DISPLAY / lum_ldr** setting.

Note: The LDRTST function will time out after 120 seconds and exit the menu.

5.5 The segment test function

This function provides an extended version of the tube segment test routine performed when the clock boots. Rotating the control knob will first cycle through illuminating the same segment on each tube simultaneously, then through the tubes one at a time. A brief press of the control knob will display "PWM 75", indicating that the tubes are being driven at 75% power. You can rotate the control knob to increase or decrease the drive power. This is useful to test if one tube is "weaker"

than the others, for example. A second brief press of the control knob returns to the segment test. A long press returns to the menu.

5.6 The RGB test function

Similar to the SEGTST function to test the tubes and colon towers, the RGBTST function allows for extensive testing of the LEDs. Upon selecting the RGBTST function the tubes display "RRGGBB" as a hint. The tubes will then display "080808" with underscores under the leftmost two tubes. That means the red component of the LEDs is selected. Use the up and down buttons on the keyfob or rotation of the control knob to select the brightness of the red component of the LEDs. The values range from 00 to FF, with FF representing maximum brightness. Use a short press on the center keyfob button or control knob to cycle between the red, green and blue components of the LEDs. The underscores on the tubes will indicate which component is selected. Use a long press on the center keyfob button or control knob to exit the segment test function.

5.7 Clock statistics reporting

The STATS function provides information on the clock's version and accumulated run-time. The following information is provided:

MODSIX
V01-57 (these numbers may vary)
CLKRUN
######
HOURS
NIX ON
######
HOURS
NIXDIM
######
HOURS

Note: The hours displayed only reflect the service hours of tubes in this Lumina. The tubes likely have tens of thousands of hours of operation in their previous life as stock ticker displays. Fortunately, they are practically indestructible if treated properly.

5.8 Displaying the clock's IP address

This menu function displays the clock's IP address. You need to know that IP address in order to use the web interface. Although the clock will display its IP address during its startup sequence, using this control knob function lets you determine the address without needing to disturb the clock's operation. After pressing the control knob, the assigned IP address will scroll across the tubes. For example, 192.168.35.100.

Note: Depending on how "well-mannered" your network (technically, your DHCP server) is, the IP address assigned to the clock can

change over time. This will normally happen only after a power failure or if your router is reset.

5.9 The F-SAVE function

The F-SAVE function writes default values to the configuration file for any settings **not** already present in the configuration file. This is useful for two reasons:

- To add any options introduced after upgrading the firmware to a new version.
- To fill in default values after applying a subset configuration. Refer to Appendix I for more information about subset configurations.

Notes: Both the F-SAVE and D-SAVE functions execute immediately upon button or knob press without confirmation and report "SAVEOK" when complete. Make sure that you intend to use them before executing them.

The F-SAVE and D-SAVE functions operate outside of the normal button / knob -SAVE- function. Use a long press to exit the menus after performing an F-SAVE or D-SAVE.

5.10 The D-SAVE function

The D-SAVE function replaces the *cpu_config.json* file with the factory default configuration settings. This is useful to get back to a known state, particularly if you do not have access to the web interface.

Notes: Web-only configuration options such as the WiFi SSID and password are not affected by this operation.

All of the notes under F-SAVE also apply here.

5.11 Canceling pending changes

Changes made via the control knob do not take effect until saved by the user. At the end of the knob menu tree is the CANCEL function. If pressed, your configuration changes will not be saved, the clock will display "NOSAVE" and return to normal operation.

5.12 Saving pending changes

Just past CANCEL is the -SAVE- option. Pressing the control knob when -SAVE- is displayed will report either "SAVEOK" (your changes were successfully saved) or "NOCHNG" if you didn't actually make any changes. In either case, the clock will exit the menu and return to normal operation

6 The MET-PIR (Optional)

The MET-PIR is a small, battery-operated device which measures environmental data (temperature, humidity and barometric pressure) and reports it to the clock approximately once every five minutes. This interval was chosen to maximize the lifetime of the batteries used in the MET-PIR.

The MET-PIR also includes a PIR (passive infrared) sensor which allows the clock to turn its display off by a slow fade after a period of time where no motion has been detected nearby. The sensor works on the same principle as a burglar alarm motion sensor - it detects changes in heat patterns in the surrounding area. For best results, the MET-PIR should be located in an area without drafts from non-human sources such as windows and radiators. The sensor has a relatively wide angle of view (110 degrees horizontal x 70 degrees vertical) and up to a 20-foot range. You may need to experiment with the location and orientation of the sensor for best results in your room.

Figure 6–1 MET-PIR top view

Note: Finding the ideal location for the MET-PIR depends on finding a location with stable airflow that can also "see" room occupants. Experimentation is likely needed to find the best location.

The MET-PIR has an RGB LED on the front which communicates various options and events. If the LED is enabled, during normal operation, it will flash green when a motion event is detected and sent to the clock and will flash blue approximately every five minutes when environmental data is sent to the clock.

Notes: If left enabled, these LED flashes substantially decrease the battery lifetime in the MET-PIR.

The clock will always process environmental messages from the MET-PIR, but the PIR functionality requires the MET-PIR and clock to be configured to the same address.

A brief press of the pushbutton on the top of the MET-PIR will toggle the LED display between on and off.

After the button is pressed and released, the LED will flash green if LED blinks have been enabled or will remain off if LED blinks have been disabled.

Note: Disabling the LED event flashes will provide the longest possible battery lifetime. With event flashes disabled, battery lifetime should range from six months to one year.

6.1 MET-PIR configuration

To enter configuration mode on the MET-PIR, press and hold the pushbutton on the top of the MET-PIR. The RGB LED will slowly cycle through various colors, where each color corresponds to a configuration function. Releasing the button while a color is displayed selects that function. If you do not want to change any options, wait for the RGB LED to turn off and then release the button to exit configuration mode. The following table summarizes each color and its function.

Table 6–1 MET-PIR configuration functions

Color	Function
Yellow	Pair MET-PIR with clock
Blue	Send MET-PIR version and other information to clock
Green	Increment MET-PIR PIR address †
Red	Decrement MET-PIR PIR address †
Magenta	Reset MET-PIR configuration to factory defaults ‡
White	Increment MET-PIR STA address ‡ §
Off	Exit MET-PIR configuration mode

§ STA addresses range from 0 to 3 and a clock will only report MET-PIR environment readings when the clock's **CFG_MET / sta_en_mask** includes the MET-PIR's STA address.
† PIR addresses range from 0 to 7 and a clock will only respond to MET-PIR motion detection events when the clock and MET-PIR are set to the same PIR address.
‡ This option will only appear after three complete cycles through all colors.

The following sections describe each configuration function in more detail.

6.1.1 Pair MET-PIR with clock

This function is used to pair the MET-PIR with the clock.

Note: The MET-PIR is normally already paired with the clock when delivered. If you change the clock's radio channel or baud rate (see menu options CFG_RFLINK / channel and CFG_RFLINK / rate or control knob settings *LNKMNU* / *RFCHAN* and *LNKMNU* / *RFBAUD*, respectively) you will need to re-pair the MET-PIR with the clock.

After you release the pushbutton, the MET-PIR will blink the RGB LED blue and begin searching for a clock. During the search process the RGB LEF will alternate between blinking red and blue. If a Lumina is detected, the RGB LED will end with a green blink. If a Lumina is not detected, it will end with a red blink. A successful pairing will produce the following messages on the clock.

PING
PIR 15 (these numbers may vary)
PIR-0

The meaning of the various messages is described in the following section.

Note: A red LED blink does not necessarily indicate a failure to pair with the clock - the MET-PIR may not have received an acknowledgment from the clock for some reason. Repeat the pairing procedure and observe the clock to see if pairing messages are displayed on the clock.

A failure to pair may be due to a weak battery or the MET-PIR may be out of radio range. Refer to the troubleshooting steps in Section 6.2 for more information.

6.1.2 Send MET-PIR version and other information to clock

This function displays information about the MET-PIR on the clock. The information will be shown in the following order.

PIR 15 (these numbers may vary)
PIR-0
STA-1
3P118V (these numbers will vary)
SNSBME

The first item displays the firmware version installed on the MET-PIR. The second displays the currently selected PIR address. Next is the currently selected station address, followed by the approximate battery voltage. The P indicates the decimal point, so a reading of 3P118V corresponds to 3.118 Volts. This can give you an indication of how soon you will need to replace the battery in the MET-PIR. The last item reports the type of sensor (in this case, a Bosch BME280).

6.1.3 Increment MET-PIR PIR address

This will increment the MET-PIR PIR address. In addition to matching the clock's radio channel and baud rate, the clock will only respond to motion detection events from a MET-PIR set to the same PIR address as the clock (see **CRG_RFLINK / pir_addr** in Section 4.4.6). The address can be set to a value between 0 and 7. Incrementing past 7 wraps around to 0. When the pushbutton is released, the MET-PIR will send a message with the new address to the clock, which will display it in the form PIR-# where # is the address. The MET-PIR will also display the address on the RGB LED. A blue flash indicates the beginning of the address display, 0 or more magenta flashes indicate the selected address and the display ends with a green flash. For example, a MET-PIR set to address 3 would flash Blue Magenta Magenta Magenta Green.

Note: The Lumina will always display the PIR address as received from the MET-PIR, but will only respond to PIR events if the clock and MET-PIR are set to the same address.

6.1.4 Decrement MET-PIR PIR address

Similar to the increment function, this function decrements the MET-PIR PIR address. Decrementing below 0 wraps around to 7. The new address is displayed on the clock and MET-PIR as described above.

6.1.5 Reset MET-PIR configuration to factory defaults

Resets the MET-PIR configuration to the factory defaults. These defaults are PIR address 0, STA address 1 and LED enabled. The clock will display a "RESET" message if the MET-PIR is within radio range.

Note: This option will only appear after three complete cycles through all colors.

6.1.6 Increment MET-PIR STA address

Increment the MET-PIR STA address. In addition to matching the clock's radio channel and baud rate, the clock will only report environmental data when the clock's **CFG_MET / sta_en_mask** includes the MET-PIR's STA address (see Section 4.5.12). The address can be set to a value between 0 and 3. Incrementing past 3 wraps around to 0. When the pushbutton is released, the MET-PIR will send a message with the new address to the clock, which will display it in the form STA-# where # is the address. The MET-PIR will also display the address on the RGB LED. A blue flash indicates the beginning of the address display, 0 or more magenta flashes indicate the selected address and the display ends with a green flash. For example, a MET-PIR set to STA address 3 would flash Blue Magenta Magenta Magenta Green.

Note: This option will only appear after three complete cycles through all colors.

There is a slight subtlety in the way the Lumina and MET-PIR handle station addresses.

Table 6–2 Station address mapping

MET-PIR STA address	Lumina MET slot	Comments
0	1	Lumina slot 1 is reserved for messages from "legacy" repeaters
1	0	This is the default setting for both the Lumina and the MET-PIR
2	2	
3	3	

6.1.7 Exit MET-PIR configuration mode

This exits configuration mode and returns to normal MET-PIR operation.

6.2 MET-PIR troubleshooting

The following list describes various troubleshooting steps if the MET-PIR is not working properly:

- If the MET-PIR had been working previously but stopped at some point, the battery may be too weak to communicate with the clock. Try temporarily relocating the MET-PIR next to the clock and see if you can send a status message to the clock (refer to Section 6.1.2 for details). The last item in the message displayed by the clock will be the voltage of the MET-PIR battery. You should change the battery if the voltage displayed on the clock is less than 2.5V (displayed as 2P500V). The battery replacement procedure is described in Appendix J.

Note: Toward the end of the battery's service life the voltage can drop rapidly. You may wish to replace the battery even if the reported voltage is above 2.5V (a new battery is approximately 3.0V or higher).

- If the MET-PIR is reporting spurious motion events and turning on the clock when not desirable, avoid aiming the PIR head where it will sense false events due to changing heat patterns - radiators, windows, etc.
- Verify that the clock's PIR MD is set to ON.
- Try moving the MET-PIR closer to the clock - it is possible that it is simply out of range.
- You can use the pushbutton on the top of the MET-PIR to configure the LED to blink when motion is detected or an environmental message is sent to the clock.

Note: Enabling MET-PIR event flashes reduces the service life of the battery, so you should normally disable them after troubleshooting is complete.

- The MET-PIR may be set to an incorrect channel, baud rate or PIR address. Refer to Section 4.4 or Chapter 5 for information on configuring these options.
- Does the MET-PIR report its information to the clock (refer to Section 6.1.2 for more information), but motion is not detected? Confirm that the clock and MET-PIR are set to the same address (0-7). Verify that the swiveling PIR detector head is seated firmly into the MET-PIR circuit board and has a clear view of the area. The PIR head swivels through a 360-degree range so you can point it at a specific area.

6.3 MET-PIR bootloader mode

Holding down the MET-PIR pushbutton while inserting the MET-PIR batteries puts the MET-PIR into bootloader (firmware update) mode, indicated by a solid magenta LED. Bootloader mode will time out after 120 seconds unless a firmware update is in progress. Bootloader mode and MET-PIR firmware updating instructions will be provided should an update to the MET-PIR firmware ever become necessary.

7 The keyfob (Optional)

The keyfob is an optional remote control which can be used to configure and operate the clock via a convenient hand-held device. Depending on your preference the keyfob can be configured to allow full control of the clock via the setup menus or be restricted to a subset of functions which don't change the clock's setup options. The keyfob can also be completely ignored by the clock if so desired.

The clock and keyfob are normally already paired with each other. If you change the radio channel, baud rate, or fob address (see menu options **CFG_RFLINK / channel**, **CFG_RFLINK / rate** and **CFG_RFLINK / fob_addr** or control knob settings *LNKMNU / RFCHAN*, *LNKMNU / RFBAUD* and *LNKMNU / FOBADR*, respectively) you will need to re-pair the clock and keyfob.

Figure 7–1 Keyfob

Each button on the keyfob performs a specific function. Additionally, certain combinations of buttons have additional functions. These are described briefly in the following table.

Notes: Up is defined as the button closest to the key ring loop.

When multiple buttons are shown in the table, they should both be pressed simultaneously and held until the keyfob LED flashes (approximately 5 seconds).

Table 7–1 Keyfob button functions

Button(s)	Function
Up	Equivalent to rotating the control knob clockwise (normally cycling through tube states OFF/ON/DIM/PIR)
Down	Equivalent to rotating the control knob counterclockwise (normally cycling through the same tube states in reverse order)
Left	Normally the same as down button
Right	Normally the same as up button
Center	Equivalent to pressing the control knob for a brief or long press (see Section 4.10.2 or *SYSMNU / MISC / PBPRES ACTION*)
Left + Right	Pair keyfob with clock
Center + Up	Increment keyfob address (see Section 4.4.5 or LNKMNU / FOBADR)
Center + Down	Decrement keyfob address (see Section 4.4.5 LNKMNU / FOBADR)
Up + Down	Display keyfob address and firmware version on clock
Center + Right	Factory test mode (see below)

There are some interactions between the right button on the keyfob (NX ON) and other clock settings. Turning on the tubes with the keyfob will last only until the next clock timer interval (see Section 4.6) would turn the tubes off.

7.1 Keyfob pairing

7.1.1 Pairing overview

A long press on the left and right keyfob buttons will cause the keyfob to try to "pair" with the clock. Pairing is necessary if you change the radio channel or baud rate on the clock, as the keyfob needs to know these settings in order to be able to properly communicate with the clock. The radio channel and baud rate are set in the clock's configuration (see menu options **CFG_RFLINK / channel** and **CFG_RFLINK / rate** or control knob settings *LNKMNU / RFCHAN* and *LNKMNU / RFBAUD*, respectively). The keyfob will then scan the radio channel range, transmitting "ping" packets and looking for the correct response from the Lumina. This procedure allows the keyfob to determine and then match its radio channel and baud rate to that of the clock. The information is then saved in the keyfob's non-volatile memory so that the procedure does not have to be performed again unless the radio channel or baud rate has been changed on the clock.

7.1.2 Pairing procedure

The clock should be powered on and operating normally. The keyfob should have a fresh battery in it (one is pre-installed in the keyfob). You must be able to read messages displayed on the clock from where you are using the keyfob.

Press and hold the left and right buttons on the keyfob simultaneously until the LED on the keyfob flashes orange once, then release. This will normally happen within 10 seconds of pressing the buttons. The clock will then display a message like "FOB-0". The "0" in the message indicates that the keyfob is configured to address 0. If your clock's configuration also has its **CFG_RFLINK / fob_addr** or *LNKMNU* / *FOBADR* option set to address 0, you're all set.

7.2 Keyfob address

If you have multiple clocks on the same radio channel, but want to control them independently with a separate keyfob for each, you will need to change the keyfob's address. To increment the keyfob address press the center and up buttons on the keyfob simultaneously for approximately 5 seconds until the LED on the keyfob flashes orange once, then release. The clock will then display a message such as "F1 3/2" indicating that the keyfob is now at address 1 and the keyfob firmware version is 3.2. Similarly, you can decrement the keyfob address by pressing the center and down buttons on the keyfob simultaneously for approximately 5 seconds until the keyfob LED flashes orange. The keyfob will also display the address on its LED per the following table. Continue as needed to set the desired keyfob address.

Table 7–2 Keyfob address displays

Address	LED Display
0	orange flash / orange flash
1	orange flash / 1 green flash / orange flash
2	orange flash / 2 green flashes / orange flash
3	orange flash / 3 green flashes / orange flash
...	...
7	orange flash / 7 green flashes / orange flash

If necessary, change the **CFG_RFLINK / fob_addr** or *LNKMNU* / *FOBADR* setting on the clock to match the address set on the keyfob.

You can quickly determine the configuration of a paired keyfob by pressing and holding the up and down buttons simultaneously for approximately 5 seconds until the keyfob LED flashes orange. The clock will then display a message of the form "F# x/x" where # indicates the keyfob's current address (0-7) and x/x indicates the keyfob's firmware version.

Note: Internal clock and MET-PIR messages have priority over informational messages from the keyfob. It is best to pair and / or change the address of the keyfob when the clock is expected

to continue its normal time display. Otherwise, the informational display message from the keyfob may not appear on the clock, even if the function requested has been performed. You may press the center button on the keyfob briefly to "get the clock's attention" and revert to time display in order to ensure messages from the keyfob are displayed.

7.3 Keyfob test mode

The keyfob includes a factory test mode which is documented here for completeness. Press and hold the center and right buttons until the amber LED on the keyfob blinks. Then release the buttons. The keyfob LED should illuminate solid green. Press and hold any button until the green LED turns off. This tests the basic processing functions of the keyfob, the LED, and the buttons.

If there is no response in test mode, the CR2032 battery in the keyfob may need to be replaced. Refer to Appendix J for detailed instructions.

7.4 Keyfob uses

There are many possible uses for the keyfob. In this section we will cover some of them. We're sure you can come up with some more good ideas. All of the clock's functions can be controlled by the keyfob, so you never need to use the control knob on the clock. This can be quite useful if the clock is out of convenient reach.

Note: It is possible to "paint yourself into a corner" by using the keyfob to change the clock's radio channel, baud rate, or address. If you change any of those settings, once you exit the menu (applying your changes), the clock will no longer respond to the keyfob. In this case, you will need to re-pair the keyfob with the clock and / or change the keyfob's address to match the clock.

7.4.1 Bedside remote control

The clock can be configured to turn the tubes off and back on at specific times (see the TMRMNU settings). It can also be set to turn the tubes off when the room is dark (the DIM and LVLSET menu settings). The keyfob provides another way to control the clock display remotely. The tubes can be immediately turned off and back on with the left and right keyfob buttons, respectively. You can also enable and disable turning off the tubes at the scheduled times using the up and down buttons on the keyfob.

7.4.2 "Valet Mode" in a display case

You may wish to install the clock inside a display case. Perhaps you'd like to exhibit it in a museum. In this situation, you might want to allow staff to turn the tubes on and off with the keyfob, but prevent them from making any changes to the clock's configuration. Setting the clock's LNKMNU / FOB MD option to VALET will enable this mode.

8 Fonts

The clock can display digits in a variety of fonts, from the standard one to ones that are funky or downright weird. This chapter provides illustrations of the fonts which can be selected, in order to help you pick the one that suits you best. A complete list is also available from the clock itself in the configuration menu.

Please note that the segments shown in the following illustrations are deliberately shortened in order to make it obvious where one ends and another begins. In actual operation, these will look like completed lines from one edge to the other. Each font shown below represents the numbers 0-4 across the top line and 5-9 across the bottom line.

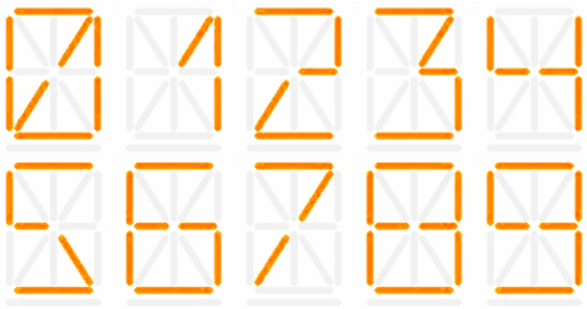
8.1 Quick selection of fonts

It is possible to directly select the font the clock uses from within the font catalog, so if you see a font you'd like to try you can select it here. Simply do a long press of the control knob while a font sample (not a font name) is displaying. After a short period, the display will show a "SETFNT" message. When you release the knob, the message will change to "CONFRM". Perform another long press to select this font, or rotate the knob one click to "ABORT" the font selection and return to the font catalog.

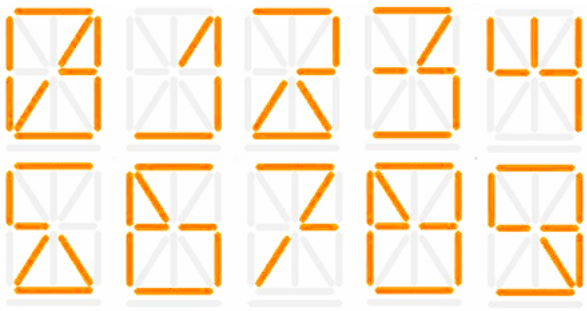
8.2 The font catalog

8.2.1 STNDRD

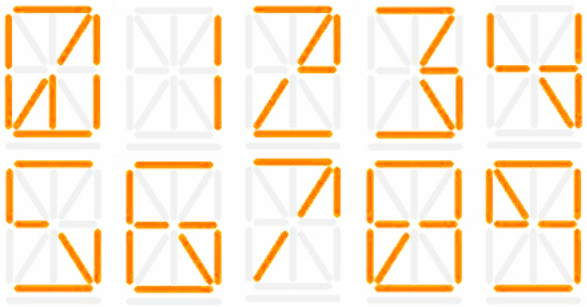
This is the standard font for the clock. While it might be considered rather boring (particularly compared with some of the other fonts in the clock), it maximizes readability.



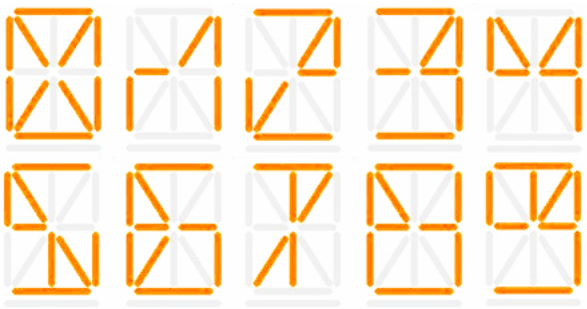
8.2.2 ALIEN



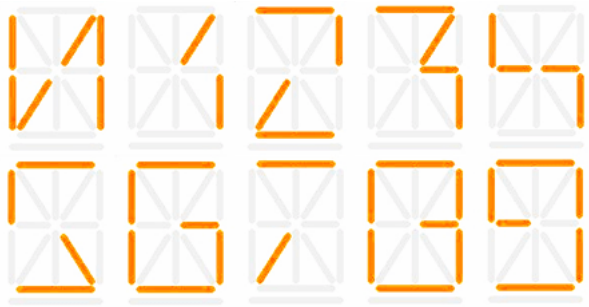
8.2.3 STINGY



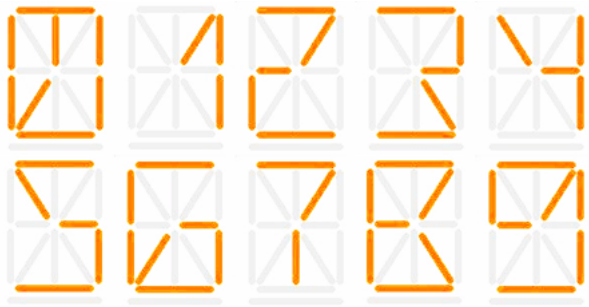
8.2.4 OUTLND



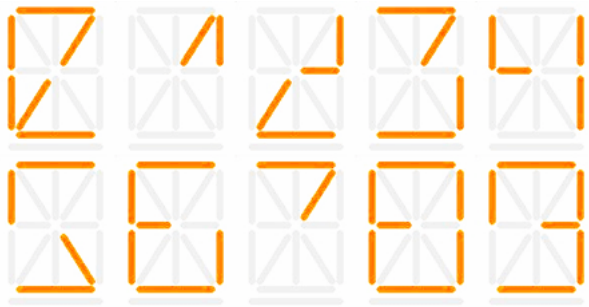
8.2.5 STOLEN



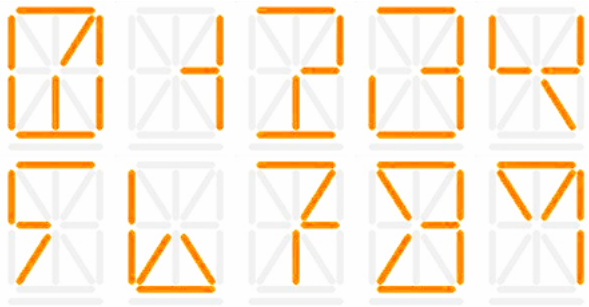
8.2.6 GRUNGE



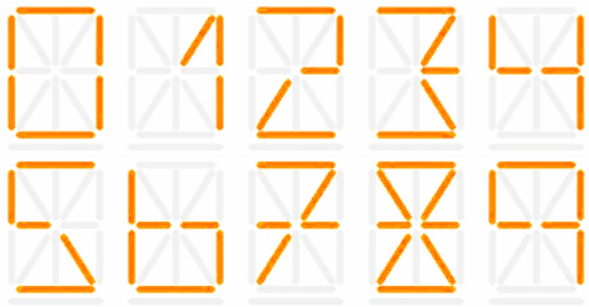
8.2.7 WITHER



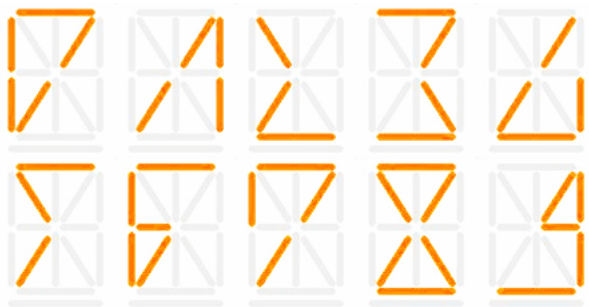
8.2.8 SKEWED



8.2.9 NICE 1

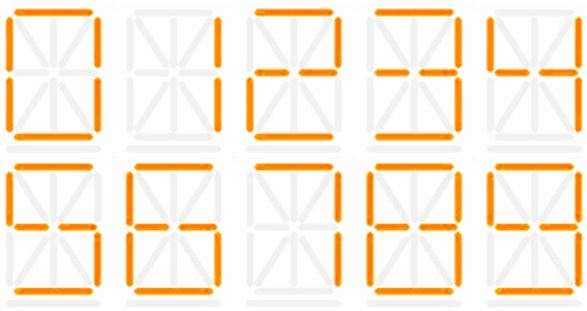


8.2.10 DECO 1



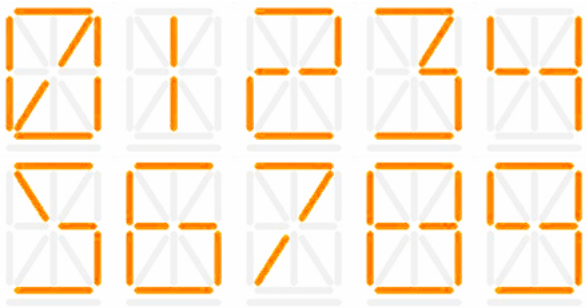
8.2.11 7 SEG

This is the standard 7-segment font found on many display devices over the years.



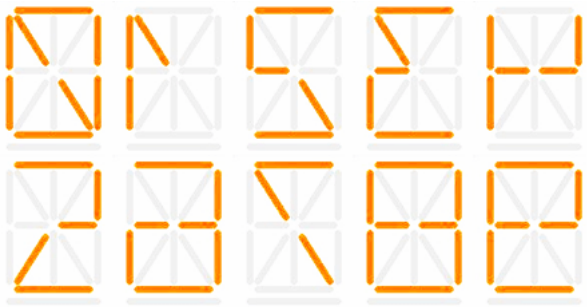
8.2.12 B7971

This is the font that these tubes used when they were in service as stock quote tickers.

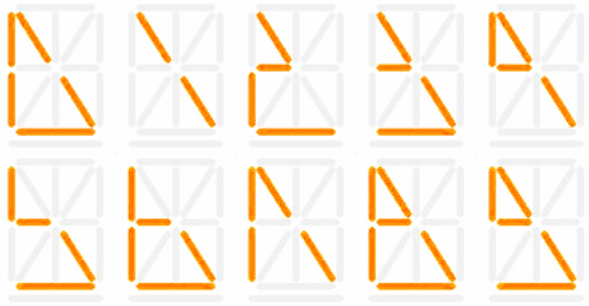


8.2.13 MIRROR

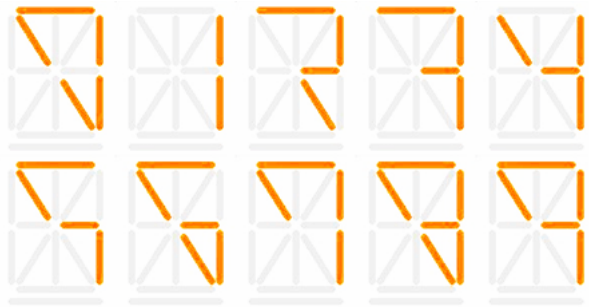
This is the STNDRD font, but in reverse.



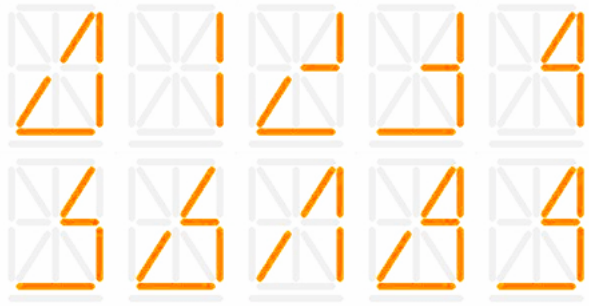
8.2.14 TILTNE



8.2.15 TILTSW

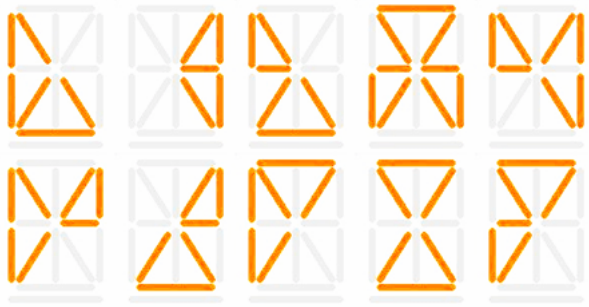


8.2.16 TILTNW

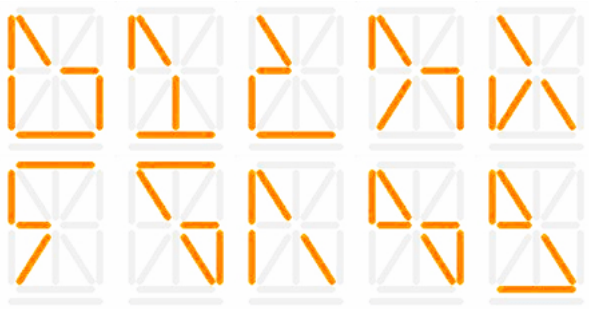


8.2.17 TILTSE

8.2.18 TRIANG



8.2.19 SKEWUP



A Technology and History

The tubes used in this clock have a fascinating history and you can read more about them on the web. We've included a little background here to get you started.

A.1 Nixie tubes in general

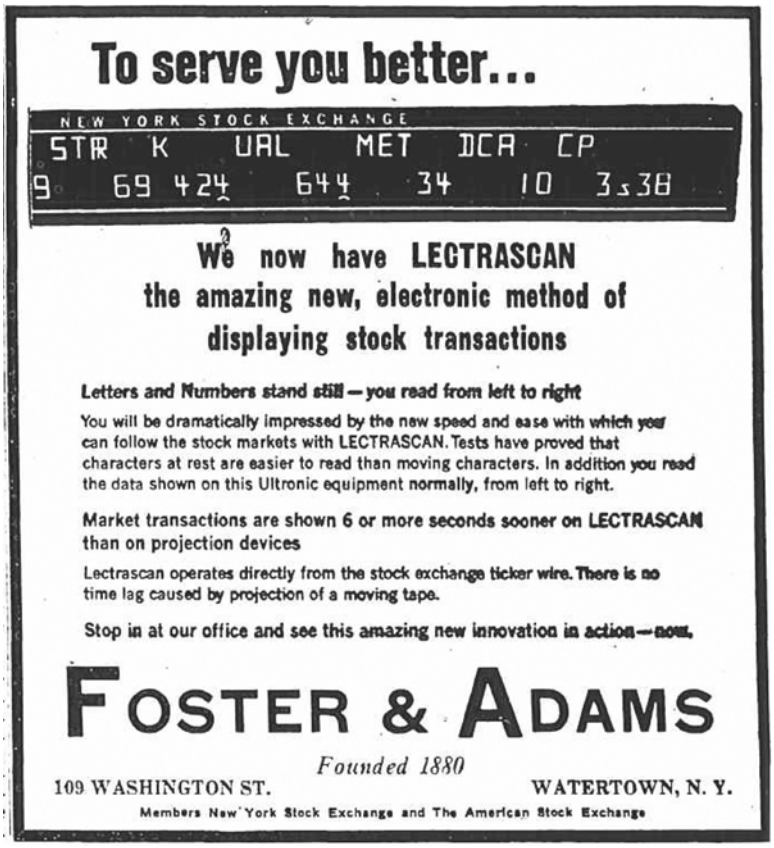
The display tubes are called "Nixie tubes", which were introduced in 1955. The basic method of operation is the same as of a neon light bulb (not the same as a neon sign), where applying electricity causes an orange glow to form around a wire inside the tube. Most tubes had wire elements in the shapes of the digits 0 through 9. The tubes in this clock are unusual in that they have 15 wire segments which can be combined to display letters as well as numbers. Despite being called tubes, Nixies do not contain the heating element that most other electron tubes use. Therefore, they run quite cool and efficiently.

After a number of years where various oddball technologies tried to take over from Nixie tubes, the first practical replacement came in the early 1970's with the LED (light emitting diode) display. LEDs were cheaper to manufacture, were much easier to connect to other electronics, and (later) came in a variety of colors. Depending on the desired use, other technologies also appeared around the same time - LCDs (liquid crystal displays) and VFDs (vacuum fluorescent displays). Some types of Nixie tubes continued to be sold as new until the mid-2000's, though they were actually older stock marked with later dates. For lots of information about every possible display technology, visit the web site of Industrial Alchemy at https://www.industrialalchemy.org

A.2 The tubes in this clock

The tubes in this clock, which were manufactured from 1964-1968, were used in the "LECTRASCAN" stock ticker system found in major brokerage firms. When those systems were decommissioned, a few tubes were saved by collectors. 6 of them have now made their way into this clock for your enjoyment. As genuine antiques, they are quite rare and now cost over $200 each. They are among the largest Nixie tubes ever produced.

Figure A–1 Newspaper advertisement from January, 1966



To serve you better...

NEW YORK STOCK EXCHANGE

STR	K	UAL	MET	DCA	CP
9	69 4 2 4	64 4	34	10	3 s 38

We now have LECTRASCAN the amazing new, electronic method of displaying stock transactions

Letters and Numbers stand still — you read from left to right

You will be dramatically impressed by the new speed and ease with which you can follow the stock markets with LECTRASCAN. Tests have proved that characters at rest are easier to read than moving characters. In addition you read the data shown on this Ultronic equipment normally, from left to right.

Market transactions are shown 6 or more seconds sooner on LECTRASCAN than on projection devices

Lectrascan operates directly from the stock exchange ticker wire. There is no time lag caused by projection of a moving tape.

Stop in at our office and see this amazing new innovation in action — now.

FOSTER & ADAMS

Founded 1880

109 WASHINGTON ST. WATERTOWN, N. Y.

Members New York Stock Exchange and The American Stock Exchange

Figure A–2 A LECTRASCAN display frame with 48 tubes

A.3 Other technology

The rest of the components in the clock are the latest technology, unheard of in the 1960's. The CPU that runs this clock is more powerful in many ways than the fastest computer from that era. The components are microminiature (the technical term is SMT) and the programs that run the clock, MET-PIR and the keyfob can be easily upgraded if needed (for example, to add new features).

B "Geek" stuff

This appendix contains some information that most people won't care about, but if you're interested in learning some more technical details about the clock, read on...

B.1 B-7971 Nixie tube styles

B-7971 tubes were manufactured from 1964 to 1968 in several styles. Some changes seem to have been due to improvements in the manufacturing process, while others have no known explanation. These differences are in three areas:

- Internal wiring style - large rivets and wide PCB traces on the back side vs. small rivets and narrow PCB traces on the back side. The reason for this is unknown.
- Presence of an "antenna" at the top of the tube - a small-diameter wire between the upper mica plate and the top of the tube. It is theorized that this was used on early tubes to set the depth of insertion when the tubes were being manufactured. These tubes are also slightly taller than their counterparts without antennas.
- Underscore style - The underscore segment comes in a number of styles which can be broadly categorized into narrow/steep and wide/shallow. The reason for this is also unknown.

As the Lumina is one of the first clocks to actually use the underscore segment, ideally you would like all of your tubes to have the same underscore segment style. Given the rarity of these tubes, this may be difficult and expensive to accomplish.

B.2 The MET-PIR

The MET-PIR communicates with the clock on the license-free 2.4GHz radio band. These frequencies are shared with Wi-Fi networks, cordless phones, baby monitors, and even microwave ovens. The range of the MET-PIR will vary depending on which of these are nearby. The MET-PIR can be set to any of up to 128 channels (depending on country) to avoid interference with these other gadgets - see the configuration options section. In the United States, the allowed channels are 1 through 79.

Note: Use of the MET-PIR is optional. However, some clock features such as temperature, etc. reporting and the empty room sensing function depend on a MET-PIR being present.

B.3 Environmental sensors

Displaying the temperature and optional barometric pressure / relative humidity sensor data is only possible when using the optional MET-PIR. This is because those sensors are located in the MET-PIR, not the clock itself.

B.4 Neon lamp on PSU board

In previous releases of the MOD-SIX clock, a neon lamp was provided near the front left corner of the PSU board. This was used to provide an indication that the High Voltage (HV) supply was on. The HV supply can be disabled via the "HV EN" jumper on this and all previous generations of MOD-SIX clocks.

Due to previous user comments that the orange glow of the PSU neon lamp was distracting when the clock display was off, it was omitted from the MOD-SIX Lumina. If you would like to restore this feature, obtain a small NE-2 type neon lamp and solder it to the PSU pads labeled "NE1". Orientation does not matter.

B.5 Timekeeping during power outages

The clock uses a "supercap" battery to keep track of time during power failures. It takes about an hour to charge and will maintain the correct time for approximately one day.

B.6 Service information

For information on servicing the clock, consult the MOD-6 Google Group at https://groups.google.com/group/mod-6_7971 or email badnixie@badnixie.com

Users may also find the schematics and parts placement diagrams in Appendix M helpful in understanding how the Lumina hardware functions.

C Default configuration options

This appendix lists the default configuration settings for the web-based configuration editor.

C.1 Default web-based configuration file

This is the default web-based configuration file (*cpu_config.json*).

Note: This reflects version V01-57 of the clock firmware and may change in future firmware versions.

```
{
        "CFG_DISPLAY":  {
                "time_font":    "GRUNGE",
                "disp_font":    "STNDRD",
                "xfade_rate":   20,
                "time_fmt":     "24HR",
                "time_lzs":     false,
                "time_colon":   "BLINK",
                "time_ampm":    "ON",
                "date_mod":     "1MIN",
                "date_fmt":     "MMMDD",
                "date_delay":   10,
                "date_year":    true,
                "date_dow":     true,
                "lum_brt":      95,
                "lum_dim":      30,
                "lum_ldr":      10,
                "lum_spd":      20,
                "scroll_speed": 3,
                "scroll_xfade": 8,
                "under_score":  "OFF",
                "zippy_spd":    32,
                "xfade_effect": "XFADE",
                "effect_time_a":        10,
                "effect_time_b":        10,
                "disp_order":   "DCWM",
                "disp_max":     4,
                "cal_mod":      "15MIN",
                "cal_order":    "SEQRND",
                "date_mod_dim": "SAME",
                "time_colon_dim":       "SAME",
                "under_score_dim":      "SAME",
                "cal_mod_dim":  "SAME"
        },
        "CFG_TIME":     {
                "time_src":     "SNTP",
                "time_sync":    "IMMED",
                "rtc_en":       true,
                "rtc_update_rate":      120,
                "sntp_en":      true,
                "sntp_update_rate":     121,
                "rptr_en":      false,
                "rptr_update_rate":     120,
                "tweak_ms":     0,
                "tz_offset_hh": 0,
                "tz_offset_mm": 0,
                "tz_dst":       true,
                "sntp_server":  "pool.ntp.org",
                "tz_posix":     ""
```

```
},
"CFG_SYSTEM":   {
        "hw_ver":       14,
        "clk_addr":     0,
        "web_server_en":        true,
        "debug":        0,
        "rev_major":    1,
        "rev_minor":    57,
        "device":       "cpu-esp"
},
"CFG_RFLINK":   {
        "channel":      77,
        "rate": "250K",
        "power":        2,
        "fob_mode":     "ON",
        "fob_addr":     0,
        "pir_addr":     0,
        "findable":     true,
        "beacon":       false
},
"CFG_MET":      {
        "met_mod_dim":  "SAME",
        "met_mod":      "1MIN",
        "met_delay":    15,
        "rh_units":     "ON",
        "rh_suffix":    "RH",
        "temp_units":   "F",
        "baro_units":   "HG",
        "show_trend":   "TEXT",
        "cal_tc_0":     0,
        "cal_rh_0":     0,
        "cal_baro_0":   0,
        "sta_en_mask":  1
},
"CFG_TIMERS":   {
        "tmr_mode":     "OFF",
        "pir_mode":     "ON",
        "pir_time":     5,
        "tmr1_time":    "00:00:00",
        "tmr1_action":  "ON",
        "tmr1_dow":     "TMROFF",
        "tmr2_time":    "00:00:00",
        "tmr2_action":  "ON",
        "tmr2_dow":     "TMROFF",
        "tmr3_time":    "00:00:00",
        "tmr3_action":  "ON",
        "tmr3_dow":     "TMROFF",
        "tmr4_time":    "00:00:00",
        "tmr4_action":  "ON",
        "tmr4_dow":     "TMROFF",
        "tmr5_time":    "00:00:00",
        "tmr5_action":  "ON",
        "tmr5_dow":     "TMROFF",
        "tmr6_time":    "00:00:00",
        "tmr6_action":  "ON",
        "tmr6_dow":     "TMROFF",
        "tmr7_time":    "00:00:00",
        "tmr7_action":  "ON",
        "tmr7_dow":     "TMROFF",
        "tmr8_time":    "00:00:00",
        "tmr8_action":  "ON",
        "tmr8_dow":     "TMROFF",
        "tmr9_time":    "00:00:00",
        "tmr9_action":  "ON",
        "tmr9_dow":     "TMROFF",
        "tmr10_time":   "00:00:00",
        "tmr10_action": "ON",
        "tmr10_dow":    "TMROFF",
        "tmr11_time":   "00:00:00",
        "tmr11_action": "ON",
```

```
        "tmr11_dow":    "TMROFF",
        "tmr12_time":   "00:00:00",
        "tmr12_action": "ON",
        "tmr12_dow":    "TMROFF"
    },
    "CFG_WIFI":     {
        "mdns_en":      true,
        "show_messages":        true
    },
    "CFG_WORDS":    {
        "word_mod":     "3MIN",
        "num_words":    2,
        "dirty":        false,
        "censor":       false,
        "lexicons":     "ALL",
        "effect":       "RNDRND",
        "xfade_effect": "SAME",
        "word_delay":   10,
        "letter_delay": 3,
        "segment_delay":        8,
        "bookends":     "-",
        "word_mod_dim": "SAME",
        "flw_file1":    "flw_1.txt",
        "flw_file2":    "flw_2.txt",
        "slw_file1":    "slw_1.txt",
        "slw_file2":    "slw_2.txt"
    },
    "CFG_LEDS":     {
        "led_editor":   "HSV",
        "cpu_brt_mode": "ON",
        "cpu_brt_rgb":  "RGB_1",
        "cpu_dim_mode": "SAME",
        "cpu_dim_rgb":  "RGB_2",
        "cpu_off_mode": "SAME",
        "cpu_off_rgb":  "RGB_3",
        "tdu_brt_mode": "ON",
        "tdu_brt_rgb":  "RGB_1",
        "tdu_dim_mode": "SAME",
        "tdu_dim_rgb":  "RGB_2",
        "tdu_off_mode": "SAME",
        "tdu_off_rgb":  "RGB_3",
        "aux_brt_mode": "UPDOWN",
        "aux_brt_rgb":  "RGB_1",
        "aux_dim_mode": "SAME",
        "aux_dim_rgb":  "RGB_2",
        "aux_off_mode": "SAME",
        "aux_off_rgb":  "RGB_3",
        "rgb_1":        "280500",
        "rgb_2":        "001f00",
        "rgb_3":        "00001f",
        "rgb_4":        "5CFF1E",
        "rgb_5":        "FF0000",
        "rgb_6":        "FFF800",
        "rgb_7":        "2A1F29",
        "rgb_8":        "1f0011"
    },
    "CFG_MISC":     {
        "show_messages":        true,
        "pb_press":     "TIMER",
        "pwm_map_max":  255,
        "pwm_map_min":  0
    }
}
```

D Operating multiple clocks

The normal user environment has a single Lumina clock and a single MET-PIR. In this situation, the pairing procedures described in Section 6.1.1 and Section 7.1 are sufficient to pair the clock with its MET-PIR and keyfob. More complex arrangements are possible, however, and in those cases special care should be taken to avoid interference between the two (or more) clocks. There are two ways of handling multiple Lumina clocks:

D.1 Multiple Lumina clocks, multiple MET-PIRs, multiple keyfobs

This is probably the easiest solution. Each clock will have its own MET-PIR and keyfob and will receive signals from only that MET-PIR and keyfob. To operate in this mode, simply configure each clock on a different RF channel.

Note: We recommend leaving a gap of several channels between the channels you select for each MET-PIR / clock pair - for example, 79 and 82. This will eliminate the possibility of interference between the closely-spaced channels.

Since the MET-PIR and keyfob will pair with the first clock they discover during their scans, power up only the first clock and pair the clock with its MET-PIR and keyfob. Then power that clock off and the next clock on to pair that clock with its MET-PIR and keyfob. Repeat as needed. Once each clock has been paired with its own MET-PIR and keyfob, all clocks can be powered on and will operate normally, each clock receiving data from its individual MET-PIR and controlled by its individual keyfob.

D.1.1 Additional notes for operating independent Lumina clocks on a single channel

If you want to operate all devices on the same radio channel, you will need to take additional steps to keep the various sets of devices isolated:

- Configure each of the Lumina clocks to listen to different MET-PIR PIR addresses and keyfob addresses using the **CFG_RFLINK / pir_addr** and **CFG_RFLINK / fob_addr** settings, respectively.
- Configure the MET-PIR and keyfob to corresponding addresses per the instructions in Section 6.1.3 and Section 7.2, respectively.
- Pair the MET-PIR and keyfob with the Lumina.

Note: Take care to ensure that only one set of devices is powered on when performing the pairing procedures to avoid the MET-PIR and keyfob from pairing with the first clock they find.

- Set **CFG_MET / sta_en_mask** as desired (normally *1* on the first Lumina and *4* on the second Lumina, corresponding to a station address of 1 on the first MET-PIR and 2 on the second MET-PIR, respectively.

D.2 Multiple Lumina clocks, single MET-PIR

Another possible mode uses a single MET-PIR to provide the time and temperature, etc. information to a number of clocks simultaneously. This provides some cost savings as additional MET-PIRs are not needed, but is limited to the distance at which each clock can receive a good signal from the MET-PIR. You may need to experiment with different locations for the MET-PIR to find the one that works best (or at all) for multiple clocks, powering on *only one* clock at a time while testing.

To operate in this mode, configure all clocks for the same RF channel and baud rate. Next, power off all but one of the clocks and pair the MET-PIR with that clock as usual. Once paired, you may power on the remaining clocks and they should all receive data from the one MET-PIR. Do not attempt to re-pair the MET-PIR with the additional clocks. It is not necessary and will usually be unsuccessful, as multiple clocks will try to respond simultaneously which may confuse the MET-PIR.

D.2.1 Notes on the single MET-PIR configuration

There are a number of things that are important to be aware of when using multiple Lumina clocks with a single MET-PIR.

- Since all clocks are receiving environmental data (temperature, humidity, barometric pressure, etc.) from a single MET-PIR, the data displayed on all of the clocks will be the data from where the MET-PIR is located, not the data where the clock is. If this becomes confusing, you can disable the environmental data display on any of the clocks via the **CFG_MET / met_mode** or *METMNU* / *MOD* option.
- Since there is only a single MET-PIR, clocks in other rooms should have their PIR function disabled by setting **CFG_TIMERS / pir_mode** to "*OFF*". You can still use the LDR to shut down clocks in dark rooms.
- If there is a power failure or for some other reason multiple clocks are turned on at the same time, you may experience a "PING storm" where each clock reports to the others that it heard a wake-up packet from the other. The duration of this storm will vary depending on the number of clocks on the same RF channel. In tests with 5 clocks, the storm subsided in well under a minute and all clocks went back to displaying normally.

D.2.2 Using keyfobs with multiple Lumina clocks and a single MET-PIR

If you have multiple clocks all operating on the same radio channel and baud rate, you can still individually control them with separate keyfobs by setting each clock and keyfob to a different address (see **CFG_RFLINK / channel** or *LNKMNU / FOBADR*). Eight addresses are available, numbered 0 through 7. A clock will only respond to a keyfob set to the same address, even if there are other keyfobs operating on the same RF channel. Other combinations of clocks and keyfobs are possible - you can set more than one clock to the same channel, speed and fob address and control them with a single keyfob.

Note: Unless you can observe all clocks controlled by a single keyfob when using the keyfob, it is possible that one or more clocks will miss a message from the keyfob, leaving them in an inconsistent state. Therefore, we recommend a separate keyfob for each clock.

D.3 Interaction of "legacy" MOD-SIX hardware with Lumina hardware

Various combinations of legacy MOD-SIX hardware (the clock itself, as well as the GPS repeater and optional TimeLink receiver(s)) can peacefully coexist with the MOD-SIX Lumina and the MET-PIR as long as some simple procedures are observed.

In general, legacy hardware and Lumina hardware do not understand each other's communication messages. In order to avoid confusion, it is best to have each device generation on a separate radio channel. That way they will not "hear" messages from devices of the other generation.

Follow the instructions in Section D.1 to configure your Lumina hardware to use a different radio channel than your legacy hardware.

Notes: It is probably easier to set your new Lumina hardware to a different channel than to go around and reconfigure all of your legacy hardware to use a new channel.

We recommend leaving a gap of several channels between the channels you select for each set of devices - for example, 79 and 82. This will eliminate the possibility of interference between the closely-spaced channels.

Pay particular attention to the instructions regarding leaving all other clocks powered off while pairing sets of hardware - you don't want different generations reacting when devices are attempting to pair.

D.3.1 Additional notes for operating multiple hardware generations on a single channel

If you have some reason to *really* want to have both legacy and Lumina hardware operate on the same channel, this is a list of things to help you avoid some potential pitfalls.

Note: This list is provided for your convenience and may not necessarily present a complete picture of all potential issues. These combinations are not officially supported.

The only 100% protocol-compatible hardware item is the keyfob. Other than the keyfob, Lumina-generation hardware and legacy hardware do not completely understand each other's communication messages.

The Lumina can receive and display met readings from a legacy repeater operating on the same radio channel, depending on the setting of **CFG_MET / sta_en_mask**. This can be confusing as the Lumina will display two or more sets of environmental readings, one after the other, without indicating which is which.

The Lumina can supply date and time information to legacy clocks and TimeLink receivers as long as the legacy hardware is within radio range of the Lumina. You will need to manually set the LNKMNU / RFCHAN and LNKMNU / RFBAUD options on the legacy clock(s) and enable the **CFG_RFLINK / beacon** or *LNKMNU / BEACON* setting on the Lumina as there is no pairing procedure for this usage.

Notes: Currently, the Lumina only sends date and time information to legacy clocks. Sending additional information (such as the environmental data) is being considered for a future firmware update.

The signal transmitted by the MOD-SIX Lumina is not as strong as the signal from the later generations of legacy repeaters. Increasing the CFG_RFLINK / power setting to *3* on the Lumina may help. If the legacy device(s) still do not receive a reliable signal from the Lumina it will be necessary for you to continue using the legacy repeater(s). In that case, ensure that the legacy hardware uses a different radio channel and baud rate than the Lumina to avoid unwanted interactions between the different generations of clocks.

E Configuring timer mode

The MOD-SIX Lumina has twelve timers numbered 1 through 12. Each timer specifies a start time (in 24-hour format), the action to be taken at that time, and which day(s) of the week the timer is active on. This allows for a great deal of flexibility as various schedules can be configured. Let's start with a simple example.

E.1 Simple timer example - weekdays only

Assume that the Lumina occupies pride of place in an exhibition of unusual electronic devices. As such, we want the clock to be up and running when the *Museum of Fascinating Objects* opens at 9:00 AM every weekday and for the clock to continue running until the *Museum* closes at 5 PM every weekday. So, we might configure the timers as follows (all in the **CFG_TIMERS** group unless otherwise noted):

- **tmr_mode** set to "*ON*" - Enables timer mode operation.
- **tmr1_time** set to "*08:30:00*", **tmr1_action** set to "*ON*" and **tmr1_dow** set to "*MONFRI*" - turns clock on every Monday through Friday at 8:30 AM.
- **tmr2_time** set to "*17:30:00*", **tmr2_action** set to "*OFF*" and **tmr2_dow** set to "*MONFRI*" - turns clock off every Monday through Friday at 5:30 PM.

Notes: We turn on the clock display 1/2 hour before opening and 1/2 hour after closing so it isn't always one last thing to check in the opening / closing rush.

Regardless of whether the clock displays in 12 hour or 24 hour format, these times are always in 24 hour format. For example, if you wanted a timer to activate at 6 PM, you would specify "18:00:00".

E.2 Growing more popular - adding weekend hours

Let's assume that the MOD-SIX Lumina is such an attraction that the *Museum* adds additional hours on Saturdays and Sundays so people can come admire it without needing to take time off from work. The added *Museum* hours are 10:00 until 2:00 on Saturdays and 12:00 to 4:00 on Sundays. We'll use 4 more timer events, as follows:

- **tmr3_time** set to "*09:30:00*", **tmr3_action** set to "*ON*" and **tmr3_dow** set to "*SAT*" - turns clock on every Saturday at 9:30 AM.
- **tmr4_time** set to "*14:30:00*", **tmr4_action** set to "*OFF*" and **tmr4_dow** set to "*SAT*" - turns clock off every Saturday at 2:30 PM.

- **tmr5_time** set to "*11:30:00*", **tmr5_action** set to "*ON*" and **tmr5_dow** set to "*SUN*" - turns clock on every Sunday at 11:30 AM.
- **tmr6_time** set to "*16:30:00*", **tmr6_action** set to "*OFF*" and **tmr6_dow** set to "*SUN*" - turns clock off every Saturday at 16:30 PM.

E.3 Even more popular - leave on dim mode overnight

As you can see, you have only used half of the available timers, yet have configured operation throughout the week. If the Lumina is located somewhere passers-by might notice it even when the *Museum* is closed, you could assign another two timers to operate it in DIM mode during nighttime hours (assumed to be 7 PM through 6 AM in this example):

- **tmr7_time** set to "*19:00:00*", **tmr7_action** set to "*DIM*" and **tmr7_dow** set to "*EVERY*" - turns clock on in DIM mode every evening at 7:00 PM.
- **tmr8_time** set to "*06:00:00*", **tmr8_action** set to "*OFF*" and **tmr8_dow** set to "*EVERY*" - turns clock off every morning at 6:00 AM.

If you set the **CFG_MISC / pb_press** or *SYSMNU / MISC / PBPRES* option to TIMER you can override the timer function by rotating the control knob on the clock or by using the up and down buttons on the optional keyfob. When you override the timer function in this manner the timer will resume at the next scheduled timer event. In other words, it is a temporary override. You can permanently disable timer operation by changing the **CFG_TIMERS / tmr_mode** or the *TMRMNU / TMR MD* setting to OFF.

Notes: Brightness levels slowly ramp up and down to target levels, allowing time for the final brightness level to be reached.

The green PSU LED on the left side of the clock will always remain lit to show that power is still applied to the clock.

F Selecting RGB colors and modes for the LEDs

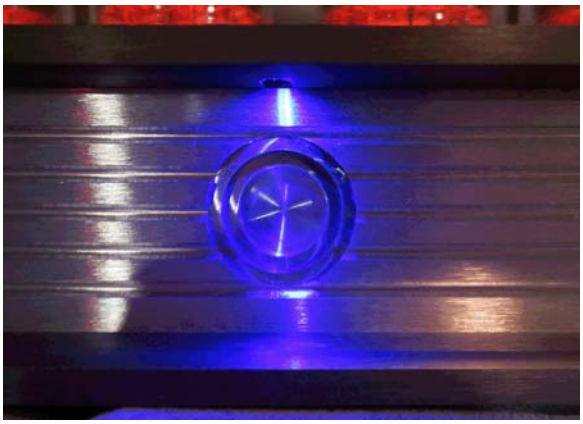
The MOD-SIX Lumina has 26 addressable RGB LEDs to provide customizable LED accents and status indication. The LEDs are grouped into three RGB "devices" that can be independently configured:

Table F–1 List of device names for LEDs

Device	Description
CPU	The single status LED on the CPU board
TDU	The set of 24 RGB LEDs, 4 under each of the six Nixie tubes on the TDU boards
AUX	The single center design RGB LED on the front of the clock base

Figure F–1 LEDs under Nixie tubes

Figure F–2 LED above the center design



For each RGB device you can select a mode that is tied to a clock illumination level (bright, dim or off) and also pick a color selected from a limited number of RGB palette slots.

There are eight RGB palette slots named rgb_1 through rgb_8 which are configurable by the user.

Note: There is only one global palette set that all devices and modes use.

There are two different methods of selecting colors.

The first is RGB (Red / Green / Blue) where you specify a brightness level for each of the three individual colors and the LED mixes them to create the desired color. Each palette slot is defined in the configuration by a sequence of RGB intensity values. Each value is a hexadecimal encoded 8-bit value ranging from 00 (completely off) to FF (brightest) for a total of 24 bits per color.

Notes: This is the same method used to select colors when creating web pages. For an example, refer to: https://www.w3schools.com/colors/colors_picker.asp

It can be a bit cumbersome to experiment with colors but is also the fastest way if you already know the specific RGB value to enter.

There is not much visible increase in brightness with higher RGB values (greater than 7F). This is likely due to a combination of nonlinear brightness perception in the human eye and the design of the LEDs themselves.

The second method is HSV (Hue / Saturation / Value). Instead of specifying a brightness for each of red, green and blue you select a color (hue), how intense the shade is (saturation) and how bright the overall color is (value). Some users feel this is a more natural way to choose colors.

F.1 RGB LED configuration via the web interface

The web-based configuration editor always works in RGB mode - HSV mode is only available via control knob or keyfob configuration.

As an example, if you want to set the TDU LEDs to bright pure red when the Nixie tubes are bright, the TDU LEDs off when the tubes are dimmed, and the TDU LEDs a dim green when the tubes are totally off, you would make the following configuration file changes:

Notes: This example uses palette slots rgb_1 and rgb_2 for convenience. Any combination of slots could be used instead, for example rgb_7 and rgb_3.

Any other devices or modes that use the selected slots will be affected by these changes.

Table F–2 Example RGB web configuration

Item	Setting	Comments
rgb_1	FF0000	Assign palette slot 1 RRGGBB a very very bright red
rgb_2	001000	Assign palette slot 2 RRGGBB a much dimmer green
tdu_brt_mode	ON	TDU mode when the tubes are bright (LED is on)
tdu_brt_rgb	RGB_1	Select palette slot 1 when the tubes are on
tdu_dim_mode	OFF	TDU mode when the tubes are dimmed (LED is off)†
tdu_off_mode	ON	TDU mode when the tubes are off (LED is on)
tdu_off_rgb	RGB_2	Select palette slot 2 when the tubes are off

† The slot selected has no effect when the mode is set to OFF, so there is no need to set tdu_dim_rgb in this example.

Similarly, the CPU board LED and the center design LED are configured using **CFG_LEDS** menu items with prefixes of **cpu**_ and **aux**_ instead of **tdu**_.

In addition to the simple **ON** and **OFF** settings shown in the above example, there are many other possible settings for the mode, as shown in the following table:

Table F–3 List of possible LED options

Value	Definition
"OFF"	LEDs are off
"ON"	LEDs are on
"1PPS"	LEDs will strobe once per second †
"UPDOWN"	LEDs will ramp up and down in 2 second cycles †
"RCV"	LEDs will do one UPDOWN cycle in response to any message from the MET-PIR or keyfob †

† The LEDs will light with the color and intensity configured in this appendix.

Table F–3 (Cont.) List of possible LED options

Value	Definition
"SYNC"	LEDs will do one UPDOWN cycle when the clock's internal time is updated †
"PIR"	LEDs will do one UPDOWN cycle in response to PIR events †
"WIFI"	LEDs will be on if the clock has a good WiFi connection †
"TIME"	Reserved for possible future use †
"SAME"	Use the same LED behavior as in bright mode ‡

† The LEDs will light with the color and intensity configured in this appendix.

‡ This value is only available for the dim and off settings.

F.2 LED configuration via the control knob or keyfob

You first need to decide whether you want to use RGB or HSV configuration mode. This is selected via the web configuration **CFG_LEDS / editor** setting or the *LEDMNU* / *EDITOR* control knob setting.

Once you have selected which mode you want to use, use the control knob or keyfob to navigate to the *LEDMNU* / *RGBMNU* / *RGB x* option. "*x*" selects which of the 8 palette slots (numbered 1-8) to edit. Once you have picked a palette slot, the tubes will display RRGGBB (if in RGB mode) or HHSSVV (if in HSV mode). The first 2 tubes will have their underscores lit to show which of the three values you are modifying. Rotate the control knob or use the up and down buttons on the keyfob to modify the selected value. Use a short control knob or keyfob center button press to move to the second field and enter its value. Use another press to move to the third field and enter its value. A final button press returns you to the *RGB x* menu level where you can modify the other palette slots as desired.

Note: This is one area where the control knob excels - you simply turn the knob to scroll to the desired value. If you are using the keyfob, this will require multiple button presses.

In HSV mode you may notice abrupt color or brightness level changes as you step through the values. This is due to a combination of things:

- The HSV color space is being mapped from 360 hues to the 256 the clock uses internally, and the saturation and color are being mapped from 100 values to the 256 the clock uses internally. Some rounding and truncation effects cause visible differences between certain steps.
- The human eye has varying sensitivity for different colors and the LEDs themselves also vary in brightness depending on the color being generated. You would expect that stepping through various hues while leaving saturation and brightness unchanged would appear to always have the same brightness, but due to the above factors that is not always true.

- The clock internally converts HSV settings to RGB as the LEDs only understand RGB. This also introduces some rounding effects from the conversion back and forth.

Once you have selected the colors for the palette slots, you need to assign them to the various states of each device. This is somewhat more complex to do via the control knob or keyfob, compared to the web interface. The following table explains the naming of the various settings.

Table F–4 Control knob item naming

Device	Mode	Level	Description
CP			CPU LED
TD			TDU LEDs
AX			Auxiliary (center design) LED
	M		Mode select (ON/OFF/1PPS/etc.)
	L		LED palette slot
		BRT	Applies when tubes are in bright mode
		DIM	Applies when tubes are in dim mode
		OFF	Applies when tubes are off

As the above is rather complex, here are some usage examples:

Table F–5 Naming examples

Name	Description
TDMBRT	**TD**U **M**ode when the tubes are **BR**igh**T**
CPLDIM	**CP**U **L**ED palette slot when the tubes are **DIM**med
AXMOFF	**A**u**X**iliary (center design) **M**ode when the tubes are **OFF**

To replicate the same LED configuration as shown in the web menu example, use the following control knob settings. All of these are in the *LEDNMU* part of the menu tree.

Table F–6 Example RGB knob configuration

Item	Setting	Comments
EDITOR	RGB	Select RGB color entry mode
RGBMNU/RGB 1	FF0000	Assign palette slot 1 RRGGBB a very very bright red
RGBMNU/RGB 2	001000	Assign palette slot 2 RRGGBB a much dimmer green
TDUMNU/TDMBRT	ON	TDU mode when the tubes are bright (LED is on)
TDUMNU/TDLBRT	RGB 1	Select palette slot 1 when the tubes are on
TDUMNU/TDMDIM	OFF	TDU mode when the tubes are dimmed (LED is off)†
TDUMNU/TDMOFF	ON	TDU mode when the tubes are off (LED is on)

† The slot selected has no effect when the mode is set to OFF, so there is no need to set TDLDIM in this example.

Table F–6 (Cont.) Example RGB knob configuration

Item	Setting	Comments
TDUMNU/TDLOFF	RGB 2	Select palette slot 2 when the tubes are off

G The calendar function

The MOD-SIX Lumina has a sophisticated calendar feature to display text messages on a specific date. A sample calendar file with the dates of New York City's Ticker Tape Parades as well as various "fortune cookie" type messages is provided with the Lumina, but users should feel free to modify it or replace it with their own events.

Notes: We welcome calendar file submissions from users. If there is sufficient interest we will develop a way to share them with other users.

The calendar functions are still evolving and additional features may be added in a future release.

Lumina firmware updates do not include the *calendar.txt* file. If an update to the calendar file is provided in a future update, it will be an individual file the user will need to upload to the clock.

G.1 Calendar file configuration settings

The clock's configuration file contains settings to control calendar display. These are described in detail in Chapter 4 but are summarized here for your convenience.

CFG_DISPLAY / cal_mod controls how often calendar events are displayed and whether at the top or bottom of the minute.

CFG_DISPLAY / cal_mod_dim determines the display interval (or off) when the tubes are dimmed.

CFG_DISPLAY / cal_order selects the order to display matching events if there is more than one.

CFG_DISPLAY / disp_order controls the sequence in which items are displayed. The items available are the date, calendar event(s), met data and random word(s).

Note: A particular display cycle might not include all events.

As with all other configuration options, we encourage users to experiment and discover what settings work best for them. One thing to be aware of is that calendar messages can be quite long (up to 150 characters) and can "monopolize" the clock's display. This is discussed in further detail in Appendix H.

G.2 Calendar file format

Calendar entries are one per line. They start with an @ symbol, then a 2-digit month, a / delimiter and a 2-digit day. This is followed by a space character. The month and/or day can be set to *00* to specify "any month" or "any day", respectively.

Next is 0 or more optional modifiers, discussed below. Each modifier is followed by a space character.

The actual calendar text begins with a " character, up to 150 characters for the message and ends with a closing " character.

Notes: If any modifiers are used, the number of available message characters is reduced accordingly.

Due to inherent limitations from the segmented nature of the tubes some characters (even those you would expect to be available) will not display as expected. One of the more prominent examples is the exclamation point symbol.

Any line not beginning with an @ symbol is ignored. By convention, a *;* symbol is used to indicate that the following text is a comment.

Note: All other characters are reserved for potential future use.

The sample calendar provided with the clock contains a handy "ruler" so you can see how long each message is:

```
;       0         0         0         0         0         0         0...
;       0         1         2         3         4         5         6...
;       12345678901234567890123456789012345678901234567890123456789012345678901...
```

Here are some example calendar entries:

```
@04/01 "It is April Fool's Day"
@00/01 "First day of the month - time to pay bills"
; This is a comment. Maybe we don't know why March is special.
@03/00 "March is special"
```

G.3 Calendar file display modifiers

The default calendar display uses the STNDRD font and scrolls at the speed set by **CFG_DISPLAY / scroll_speed**. These can be modified on an entry-by-entry basis.

The **#F:[font]** modifier changes the font for this entry to the specified font. Any of the fonts listed in **CFG_DISPLAY / disp_font** may be selected. For example:

```
@00/00 #F:STNDRD "Boring 1234567890"
@00/00 #F:ALIEN "Aliens are coming 1234567890"
@00/00 #F:TIME_F "Match the time font 1234567890"
```

Note: Fonts only change the display of numbers. Additional alphabetic fonts are being considered for a future release. However, the segmented nature of the tubes limits what can be done.

The **#S:[speed]** modifier is used to control how rapidly calendar events scroll across the tubes. You can speed up or slow down the scrolling with this modifier. The speed is in milliseconds (1/1000 of a second) so a speed value of 100 would be 1/10 of a second. The lowest speed value (fastest display scroll) is 100 and the highest speed value (slowest display scroll) is 2500. This allows a scroll speed between 1/10 and 2.5 seconds per character. Here are some examples:

```
@00/00 #S:100 "Mosquitos are coming"
@00/00 #S:300 "Default scroll speed"
@00/00 #S:750 "Stuck in molasses"
```

The **#R:** modifier is used to specify that the following message is a random "fortune cookie" type message. Normally these would be specified with a date of *@00/00* so they have an equal chance of appearing on any given day. However, you can use specific month and/or day values. For example, the following message would only appear randomly in April:

```
@04/00 #R: "April showers bring May flowers"
```

Note: While #R: ends with a colon, no additional value is used after the colon.

Modifiers can be combined in any order for various effects:

```
@00/00 #F:ALIEN #S:150 "Run quick - the aliens are coming 1234567890"
@00/00 #S:750 #F:MIRROR "Time to admire the mirror font 1234567890"
@00/00 #R: #F:ALIEN "Cloudy with a 30% chance of aliens today"
```

Note: All other modifier letters are reserved for future use.

The logic for calendar entries and random words is somewhat complex.

There are 2 pools, one for calendar entries and one for random messages. The calendar pool holds 16 lines and the random message pool holds 512 lines. The calendar entry pool is filled by (up to) the first 16 calendar entries with a matching date (specific or wildcard), in the order they appear in the *calendar.txt* file. If one or more entries with a random message *#R:* modifier is found, a single entry in the calendar pool is used to flag this fact. If there are more matching entries than lines in the pool, the rest are ignored. The random message pool is then filled with up to 512 random messages with a matching date (also specific or wildcard).

Once the pools are filled, the display routine selects one or more lines from the calendar pool, as determined by **CFG_DISPLAY / cal_order**. If a selected entry has the random message flag, the display routine selects an entry at random from the random message pool and displays it.

Note: Based on the above, you can see that while up to 16 matching calendar entries may be displayed, only a single random message will be displayed. However, that one random message will itself be selected randomly from the random message pool.

G.4 Modifying the calendar file

The calendar is stored in the file *calendar.txt*. There are two ways to modify or replace it. The first way is to use the built-in editor via the "Calendar Editor" link on the clock's home page. Your browser's usual select / cut / paste operations are available for editing. You can even delete the entire contents and paste in new events. The alternative is deleting the *calendar.txt* file from the clock's home page using the Delete button and then uploading a new file with the Browse... and Upload buttons. If you forget to delete the old *calendar.txt* file, you will get a *File already exists* message when you upload the new calendar file.

G.5 The calendar in operation

The clock displays calendar entries that match the current date or via wildcard. While testing entries, particularly ones with modifiers, you probably want to use *@00/00* and a 1-minute display interval in order to see how your entry appears with the desired effects. You can then change both the calendar entry and display frequency as desired.

You may want to acknowledge a displayed calendar entry and prevent it from reappearing. For example, you might have a calendar entry like this to remind you of someone's birthday:

```
@01/27 "Amanda's birthday"
```

Once you have seen that message, you may want it to stop appearing until next year. A short press on the center keyfob button or control knob while a calendar entry is displaying will cause the clock to prompt you with *REMOVE*. You can confirm the removal with another keyfob or knob short press, which will display *DONE*. If you do not confirm the removal, the *REMOVE* message will time out and the clock will resume the normal display cycle.

IMPORTANT: While the clock offers this feature, it does not have an audible alarm, so you should *NOT* rely on this function as the only reminder - "Woe betides the person who forgets their anniversary".

A fob or knob press works in the same manner to remove random messages. However, if a random message is removed, it will prevent display of **all** random messages for the remainder of the day.

Notes: Any operation that causes the calendar file to be reloaded (editing, uploading a new *calendar.txt*, etc.) will cause the temporarily removed calendar entry to resume displaying.

Removed events are only removed from the clock's working memory. The saved *calendar.txt* file is not modified. Edit the calendar if you want to permanently remove a calendar or random message entry.

H A note about display sequence and overcrowding

It is possible to "overcrowd" the display to the extent that the time is only visible for a short period, if at all. When enabling display options, the user should be mindful of the amount of time each item will be displayed. There are many settings that control the duration of various options. This appendix concentrates on the effects of enabling, disabling or limiting the various display options. The major option groups are:

- Date (**CFG_DISPLAY** settings **date_mod**, **date_year** and **date_dow**)
- Environment (**CFG_MET** settings **met_mod** and **show_trend**)
- Words (**CFG_WORDS** settings **word_mod** and **num_words**)
- Calendar (**CFG_DISPLAY** settings **cal_mod** and **cal_order**)

The **CFG_DISPLAY / disp_order** setting controls the order in which the various effects display. It supports all combinations of D (Date), C (Calendar), M (Metrology) and W (Words). For example, a setting of "*WMCD*" will display one or more random words, then the metrology data, then any matching calendar entries and ending with the date.

The **CFG_DISPLAY / disp_max** setting limits the overall number of effects (date, calendar, metrology and words and calendar) displayed during each display cycle.

While it can be tempting to "turn everything on" to see all of the interesting data that is displayed, it can become somewhat overwhelming to the casual observer (who probably just wants to know what time it is). Experiment with enabling options selectively in order to see what works best for you.

Each of the various displays can be suppressed when the clock is in dim mode to avoid distraction in low-light / nighttime environments.

The effects can be individually configured to display at the top or bottom (30 second point) of the minute. For example, you might configure things as shown in the following list (related settings not listed presumed to be set to default values):

- **CFG_DISPLAY / disp_order** to **"DMWC"**
- **CFG_DISPLAY / date_mod** to **"1MIN"**
- **CFG_DISPLAY / met_mod** to **"1MIN"**
- **CFG_DISPLAY / word_mod** to **"1MINB"**
- **CFG_DISPLAY / cal_mod** to **"15MINB"**
- **CFG_DISPLAY / word_mod_dim** to **"OFF"**
- **CFG_DISPLAY / cal_mod_dim** to **"OFF"**

This configures the clock to display the date and metrology data at the top of the minute every minute, random word(s) at the bottom of the minute every minute, and calendar event(s) at the bottom of the minute every 15 minutes. Since calendar events can be quite long, this limits how frequently they display. When the tubes are in dim mode due to the room being dark, the clock will continue to display the date and metrology data, but will not display words or calendar events.

Notes: The above is only a basic example to show you how these features can be configured. Feel free to experiment to find the settings that work best for you.

If the word or calendar event displays are enabled it is not possible to determine exactly how long a complete display cycle will take.

If an effect takes long enough to display that another effect would start late, that additional effect will be skipped. This is to prevent a perpetual cycle of the clock getting further and further behind.

Maintaining a subset configuration file

Note: This is an advanced topic. Most users will probably never have a need for this material. It is included for completeness and for the few users who might need it.

If you change configurations regularly or frequently switch between different firmware versions, you may want to maintain a file containing only your changes and have the clock fill in everything else. This can be particularly useful when switching between different firmware versions as a mismatched config will display **REVERR** at each boot to warn you about the configuration version mismatch. It also lets you keep track of your changes without having to find them in the whole configuration file. A file with only your changes is called a "subset configuration file".

Subset configuration files follow the same syntax rules as full configuration files. Refer to the beginning of Chapter 4 for a refresher on these rules if necessary.

Create your subset configuration via any convenient method. You can start with a full configuration file and delete all of the lines you haven't changed from their default value, or you can copy the lines you have changed into an empty file - whichever is more convenient for you.

Note: This is a file you maintain on your computer or other device, as the whole point of saving subset configuration files is to have them available when needed.

The following example shows a subset configuration file:

```
{
        "CFG_DISPLAY":  {
                "time_font":    "STNDRD",
                "time_colon":   "ON",
                "lum_brt":      40,
                "lum_dim":      15,
                "lum_ldr":      10,
                "disp_order":   "DMCW",
                "cal_mod_dim":  "OFF"
        },
        "CFG_TIME":     {
                "tz_offset_hh": -5,
                "tz_posix":     "EST5EDT"
        },
        "CFG_SYSTEM":   {
                "clk_addr":     1
        },
        "CFG_MET":      {
                "met_delay":    10,
                "rh_suffix":    "%H",
                "show_trend":   "COMPCT",
                "cal_tc_0":     8,
                "cal_rh_0":     0,
                "cal_baro_0":   -8
        },
        "CFG_TIMERS":   {
                "pir_time":     30
        },
```

```
        "CFG_WORDS":    {
                "word_mod":     "1MINB",
                "num_words":    1,
                "dirty":        true,
                "censor":       true,
                "effect":       "RNDSEG",
                "word_delay":   20,
                "letter_delay": 2,
                "segment_delay":        2,
                "bookends":     "OFF",
                "word_mod_dim": "OFF"
        },
        "CFG_LEDS":     {
                "cpu_brt_mode": "UPDOWN",
                "cpu_brt_rgb":  "RGB_2",
                "cpu_off_rgb":  "RGB_2",
                "tdu_brt_rgb":  "RGB_8",
                "tdu_dim_rgb":  "RGB_8",
                "tdu_off_rgb":  "RGB_8",
                "aux_brt_mode": "ON",
                "aux_brt_rgb":  "RGB_3",
                "aux_dim_rgb":  "RGB_3",
                "rgb_2":        "000100",
                "rgb_3":        "000001",
                "rgb_8":        "040000"
        }
}
```

Note: We do not suggest that the above are useful changes - they are just provided as an example.

Once you have created your subset configuration file, install it in the clock via the following steps:

1 Use your browser to navigate to the clock's configuration file editor and delete the entire contents of the configuration file in the edit box.

2 Copy your subset configuration from your computer or other device and use your browser to paste it into the now-empty configuration box.

3 Use the [Save all edits to config file] button to save your changes and return to the clock's home page.

4 If your web browser validates JSON, do so now using the procedure described in Section 3.4.1 to make sure it is valid JSON.

5 Click the [Reload config file into CPU] button. If the clock returns you to the main menu, the configuration was successfully loaded. If it reports "RELOAD ERR", it means that there is a structural error in your configuration.

Note: The "RELOAD ERR" message just means that the clock determined that there was a JSON format error. It does NOT mean that the configuration is valid. For example, using "APPLE" as a time interval would not be detected on a reload.

6 Return to the clock's config file editor.

7 Using the keyfob or control knob, navigate to SYSMNU / MISC / F-SAVE and perform the F-SAVE operation. Exit the keyfob / knob menu tree with RETURN / RETURN / CANCEL.

8 Using your browser, do a "Reload" of the configuration editor page. You should now see all of the default settings filled in, leaving your customizations unchanged.

9 Return to the clock's home page using the Discard edits. Return to main. button to exit the editor and return to the clock's home page.

Note: Needing to use both the web-based menus *and* the keyfob or control knob is a bit of a kerfluffle. We expect to make this process easier in a future firmware release.

J Battery Replacement Procedures

This appendix describes the procedures to replace the batteries in the MET-PIR and keyfob.

J.1 Replacing the MET-PIR batteries

The batteries in the MET-PIR are located on the underside of the circuit board. You will need a *non-conductive* item such as a wooden toothpick to push each battery out of the holder.

Caution: Ensure that any item you use to move the battery is non-conductive. Metal objects such as screwdrivers can short out the battery and damage it or the MET-PIR circuit board.

Turn the MET-PIR upside down to expose the battery holder. Remove both of the AAA batteries and recycle or discard them as appropriate.

Figure J–1 MET-PIR battery location

Remove the new batteries from any packaging they came in. Using the makings on the battery holder, install each battery in the appropriate orientation.

Caution: Make certain that the batteries are oriented correctly.

With both batteries installed correctly, the RGB LED on the front of the MET-PIR will blink its firmware version. The sequence starts with a blue blink. One or more red blinks indicate the major version and zero or more green blinks indicate the minor firmware version. For example, a blink pattern of blue red green green green green green would indicate firmware version 15.

Note: Do not be confused by extraneous green flashes caused by PIR motion detection events.

Note: It should not be necessary to re-pair the MET-PIR after replacing the battery.

J.2 Replacing the keyfob battery

To replace the battery in the keyfob, carefully pry the two halves of the keyfob "clamshell" apart using your fingernail. Start near any of the 5 corners of the keyfob and work your way around the keyfob until both halves separate completely. If the halves do not separate easily, you can gently use a thin piece of plastic (such as the edge of a credit card) to get things started.

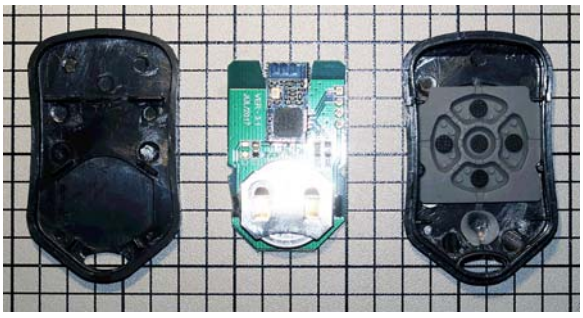
Caution: The plastic case of the clamshell is relatively soft and can be damaged by sharp objects such as screwdrivers.

Once you have the two halves separated, you will have:

- Bottom half of clamshell
- Keyfob circuit board
- Membrane button assembly
- Top half of clamshell

Note: The membrane button assembly may remain in the top half of the clamshell. If so, there is no need to separate it.

Figure J–2 Keyfob battery location



Hold the keyfob circuit board with the battery and other components facing you. Using your finger, gently slide the battery out of the holder, moving it toward the edge of the board closest to the battery holder. Then grasp the rim of the battery at the edge of the board and continue sliding it out of the holder until it is completely free. If you have any difficulty moving the battery, you may use a *non-conductive* item such as a wooden toothpick to push the battery.

Caution: Ensure that any item you use to move the battery is non-conductive. Metal objects such as screwdrivers can short out the battery and damage it or the keyfob circuit board.

Remove the new battery from any packaging it came in. Determine the positive side of the battery (usually marked "+" and the larger of the two sides) and insert the battery into the edge of the battery holder with the positive / + side facing up (away from the circuit board). Slide the battery all of the way in until it hits the end stops in the battery holder.

Caution: Make certain that battery is oriented correctly. Installing it backwards will damage the keyfob.

Reassemble the keyfob, starting with the bottom half of the clamshell. Place the circuit board on top of the clamshell with the battery facing the clamshell. You should feel it drop into position when you have it oriented correctly. Next, ensure that the membrane button assembly is still attached to the top half of the clamshell. If not, place it in the clamshell. While it appears that it could be installed in any one of four possible orientations, there is only one way where the various tabs and slots all line up. Place the top half of the clamshell on the bottom half and gently push the two halves together. There should be a click as the catches engage.

Test the keyfob function by pressing any of the 5 buttons. You should see a flash from the LED on the keyfob.

Note: It should not be necessary to re-pair the keyfob after replacing the battery.

K Recovery mode

The MOD-SIX Lumina has a special recovery mode. This mode is entered by pressing the control knob while the clock is doing the power-on segment test on the Nixie tubes during power-up or reboot. Continue pressing the control knob until the clock displays **RCVERY** on the tubes. At that time, you can release the control knob. Rotating the control knob will scroll through the various recovery options, one per detent of the knob.

Note: You must wait until the clock is doing the segment test on the tubes, then press and hold the control knob until the RCVERY message appears. If you press the button too early or late, or release it too soon, the clock will proceed with its normal power-on sequence.

K.1 Individual recovery functions

The individual recovery functions are described below. After selecting a recovery function and pressing the control knob, the clock will display **CONFIRM / LONGPB**. To perform the selected action, press and hold the control knob until the display reports **EXEC**. After releasing the control knob, the clock will generally display **++++++** and **- - - - - -** to indicate the recovery function has started and completed. Some recovery functions take longer than others to complete. To skip the selected action, rotate the knob one detent in either direction. The clock will display **ABORT / DONE** and return you to the main recovery menu.

K.1.1 CLRNET

This option will clear the IP and WiFi information on the clock. The next time the clock boots, it will again function as an access point as described in Section 2.6 and you will need to select which WiFi network to use. You may need to use this option if you move the clock to a different network.

Note: This just clears the WiFi and associated information - the configuration, etc. will remain unchanged.

K.1.2 CLRCFG

This option erases the user configuration file (the configuration file you edit from the clock's web interface). This is useful if you've lost track of your changes, or if one of your changes breaks parsing of the configuration file. The next time the clock boots, a new default configuration will be created.

Notes: This configuration is just in the clock's "running memory". You will need to save it once the clock boots by going to the "Config File Editor" page and using the Save all edits to config file. **button.**

While the configuration parser can detect several common types of user error, it is definitely possible to confuse the parser to an extent where the clock does not work properly. Clearing the config is the easiest way out of this type of issue.

In future firmware releases, we expect that more user errors will be detected during input, leading to reduced need for the CLRCFG function.

K.1.3 CLRNVS

This function clears the entire non-volatile storage (NVS) area of the clock. Consider it a superset of the **CLRNET** function.

Note: The clock's user configuration and other filesystem data are not stored in this dedicated NVS area and will not be affected.

K.1.4 CLROTA

Selecting this function will cause the clock to boot the firmware loaded at the factory and not either of the Over-The-Air (OTA) partitions. Useful if the OTA partition(s) have corrupted firmware or firmware with software bugs. Both OTA partitions are fully erased and ready for re-use.

K.1.5 CLRDAT

This function erases all data from the file system partition. This includes the lexicons (refer to Appendix L), the configuration, calendar and run_ times files (as well as their backup copies, if present). The next time the clock boots, a new default configuration will be created.

Notes: The new default configuration is just in the clock's "running memory". You will need to save it once the clock boots by going to the "Config File Editor" page and using the Save all edits to config file. **button.**

No other files will be installed, but can be manually installed by the user. You may find the RESTOR function more useful.

K.1.6 CLRALL

This is a macro function that performs **CLRNVS**, **CLROTA** and **CLRDAT** in that sequence.

K.1.7 RESTOR

This function restores the contents of the file system partition with copies saved in a hidden backup partition. Useful for restoring the file system partition to a known good state.

Note: Any user-uploaded files or user-modified files will be deleted by the RESTOR function and replaced by the factory version. This can produce unexpected results such as the removal of the calendar file as some files may have been added or modified since the factory programming of your Lumina. The latest factory default files will be available from http://badnixie.com/MOD-SIX_Info_Page.html (be sure to select the appropriate files for your clock).

K.1.8 FACTRY

This macro resets the clock to the factory defaults by performing a **CLRALL** followed by a **RESTOR**. This is used as the last step in assembly and testing before clocks are shipped to customers, in order for them to be in a known state.

K.1.9 REBOOT

This provides a quick way of rebooting the clock when you are done with recovery procedures.

K.1.10 -EXIT-

This exits the recovery menu and the clock continues with its normal startup after confirming the exit request by displaying **-OK-**.

K.2 Additional recovery methods

There are three additional recovery methods which are mentioned here for completeness, although the vast majority of owners will never need to use them. They are for unusual cases where the clock startup does not progress to the point where the normal recovery mode can be entered. Should you encounter an issue which seems to indicate the need for any of these, contact us via one of the methods listed in Section B.6 for further assistance with diagnosing the issue and getting your Lumina working again.

K.2.1 Reset jumper

Pins on the CPU board can be jumpered to force the clock to start from the factory partition. At that point it should be possible to enter the usual recovery mode and use it to perform any needed recovery operations.

K.2.2 Reprogramming via a flash cable

Normal firmware updates are performed via the web interface and configuration changes for most items are performed via the web interface and/or control knob. While prior editions of the clock required special firmware updating dongles which were pre-programmed with specific updates, the MOD-SIX Lumina has a much more user-friendly update process. However, situations can arise where a programming cable might be needed. These would be made available on a "loan and return" basis if necessary. We do not foresee any need for this type of updating but mention it for completeness.

K.2.3 CPU swap

As a last resort, the CPU module can be swapped out and returned for repair. Should this be needed, the appropriate tools, anti-static bag, and instructions will be provided.

L Updating the lexicon (random word) files

The clock firmware includes a preinstalled list of over 23,000 words which can be selected at random and displayed by the clock. Most Lumina owners will probably not modify this list. This appendix is provided for owners who have an interest in adding or removing words, such as those in a foreign language.

L.1 Back up the original Lumina lexicon files

The first thing you should do is navigate to the clock's main web page and save each of the *flw_1.txt, flw_2.txt, slw_1.txt* and *slw2.txt* files to your computer or other device. We suggest you save them with a different suffix (for example, *.orig* instead of *.txt*). In most web browsers you can do this by right-clicking on the filename and selecting "*Save link as...*". That way you always have the original files to refer to if necessary.

Note: Lumina firmware updates do not include the lexicon files. If updates to the lexicon files are provided in a future update, they will be individual files the user will need to upload to the clock.

L.2 Lexicon file naming

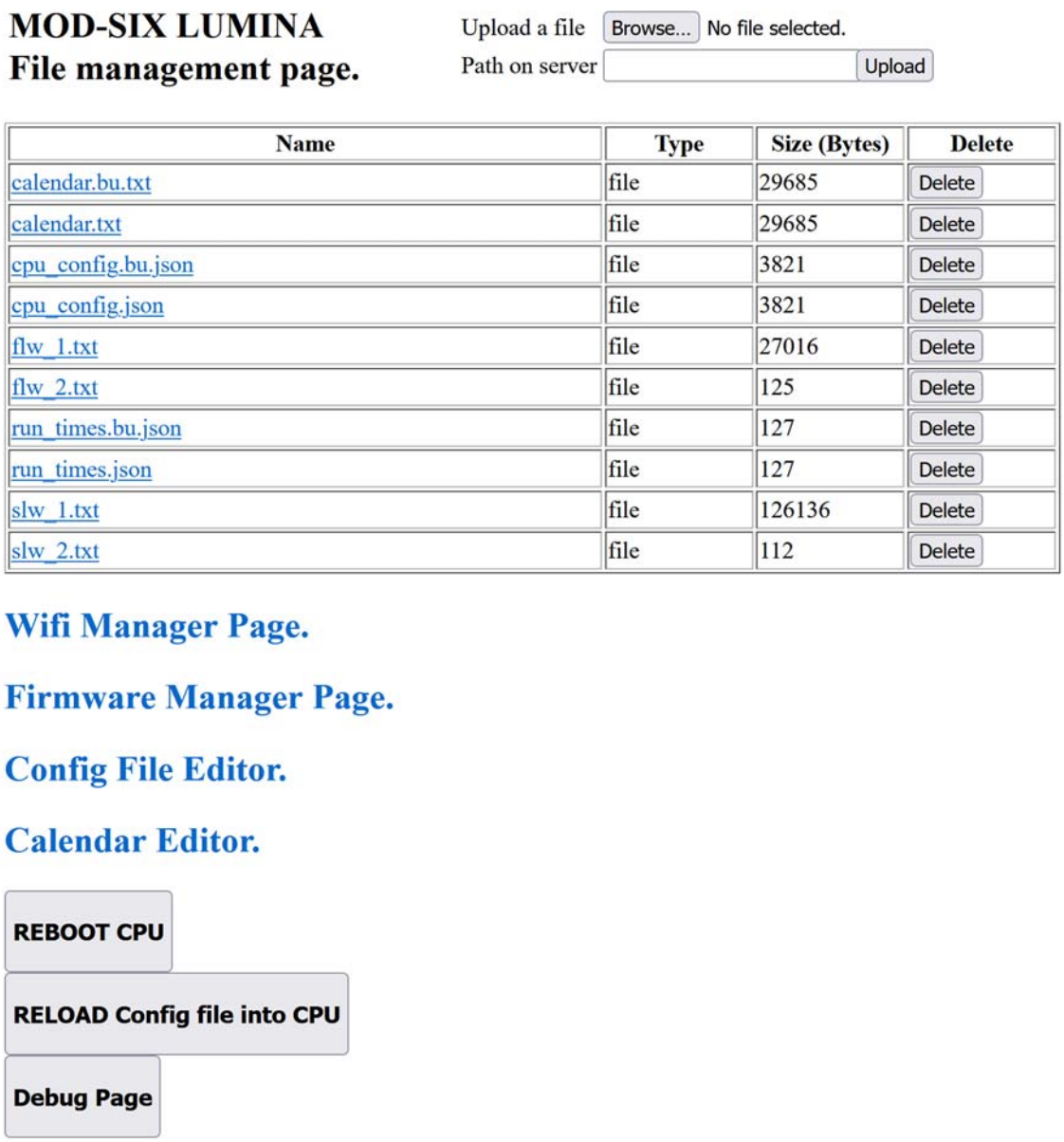
The lexicon files used by the clock are named as follows, with the contents following these conventions:

Table L–1 List of lexicon files

File name	Contents
flw_1.txt	Random word lexicon, four-letter "clean" words
flw_2.txt	Random word lexicon, four-letter "dirty" words
slw_1.txt	Random word lexicon, six-letter "clean" words
slw_2.txt	Random word lexicon, six-letter "dirty" words

Note: The names of the files used by the clock can be changed in the CFG_WORDS menu section if desired. Normally there is no need to change them.

Figure L–1 Clock web page showing file directory



The format of the lexicon files is described below.

L.3 Lexicon file format

The word files used by the clock have a simple format: 4 or 6 letters followed by either a space or the end of a line. The following sample shows the first few lines of the *flw_1.txt* file:

```
aani aaru abac abas abba abby abed abel
abet abey abie abir able ably abox absi
abut acca acer ache achy acid acis acle
```

Similarly, this sample shows the first few lines of the *slw_1.txt* file:

```
ababua abacay abacus abanic abaris abased
abaser abasgi abasia abasic abater abatis abaton abator
abatua abbacy abbasi abbess abdest abdiel abduce abduct
```

When marking a word as "dirty", move it to the appropriate **_2.txt* file, then simply capitalize one or more letters of the word. For example, to mark the word "abacus" as dirty, move it to the *slw_2.txt* and change any character in the word to uppercase.

You could use ABACUS, Abacus, aBaCuS or any other combination of capital and lowercase letters - as long as there is at least one capital letter, the word will be considered dirty.

Hint: Uppercase letters are considered for replacement with the censoring character "*" when the menu option CENSOR is set to TRUE. Lowercase letters will not be censored.

L.4 Suggestions for managing custom lexicons

We suggest that you create a new .txt file by copying it from one of the four files you saved in Section L.1 and then modifying it as desired. Future updates to the clock may include new lexicon files for installation by the user. This way you will have backups of both the original lexicon files and your changed files on your computer. You can then compare those with the new lexicon files and merge any of your changes as desired.

You may add foreign words to the lexicon files if you so desire. However, those words should be modified (if necessary) to contain only the English letters A through Z as the tubes in the clock can only display English letters.

The clock does not check for words which are duplicated in the input lexicons. You can use this to make one or words more likely to appear on the clock by simply adding additional copies of the word to your custom lexicon file. For example, if you wanted to have the word 'abacus' appear more often, you could add lines like this to your custom lexicon file:

```
abacus abacus abacus abacus abacus abacus abacus abacus abacus abacus
abacus abacus abacus abacus abacus abacus abacus abacus abacus abacus
```

This will make the word 'abacus' approximately 20 times more likely to appear. Most lexicons have tens of thousands of words, so even 20 times does not guarantee that a word will appear frequently.

L.5 Uploading your lexicon files to the clock

You will first need to delete any lexicon files that you wish to replace. Attempting to upload a file when there is already one with the same name will result in the error message *File already exists*. In that case, simply use the Delete button to the right of any files you wish to delete. You will be prompted to confirm the file deletion or to cancel the delete operation.

Select the appropriate *flw_1.txt, flw_2.txt, slw_1.txt* or *slw2.txt* file by using the Choose Files button which will launch your browser's file chooser. Select the appropriate file and click the Upload button. The selected file will be uploaded and the clock's directory listing will refresh and show the new file. Repeat as needed for additional files.

M Lumina schematics and parts placement diagrams

The following pages provide schematics and parts placement diagrams for the various circuit boards in the MOD-SIX Lumina. Readers with a more technical background may find these of interest.

Note: Some of the following pages are larger than standard letter size paper. If you are printing this manual, you might want to omit these pages from your printout (and possibly print them separately on larger paper).

§ *Terminat hora diem, terminat auctor opus*

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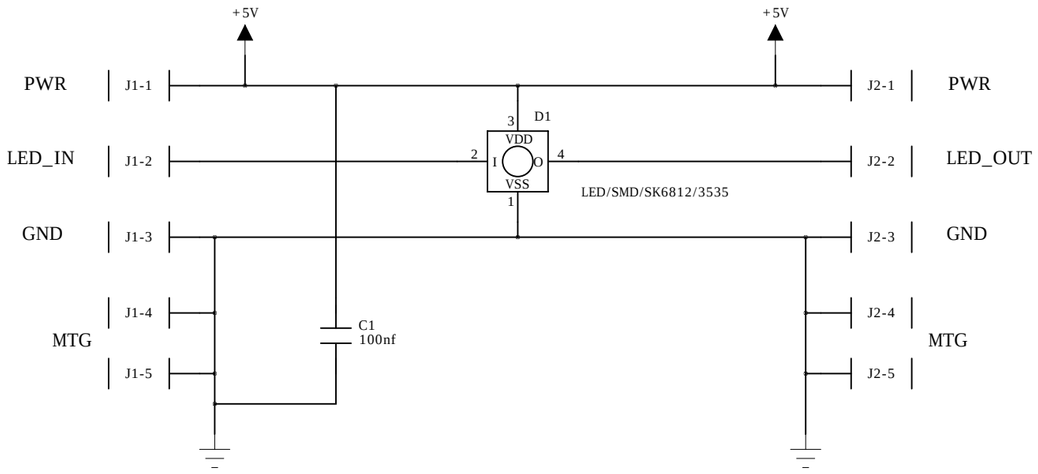

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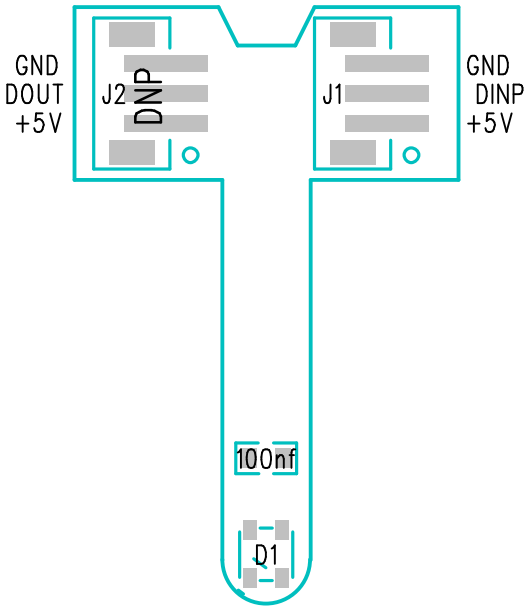

AUX LED PARTS PLACEMENT BOTTOM

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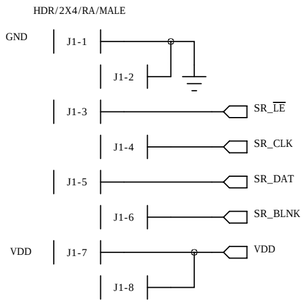

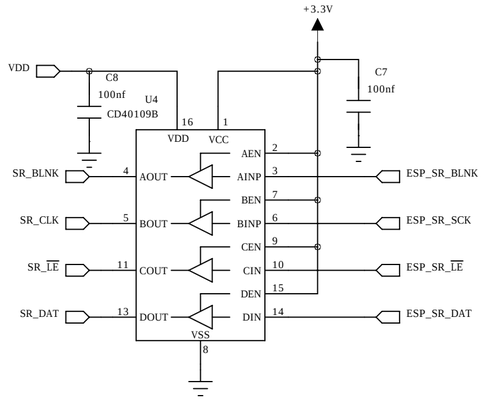

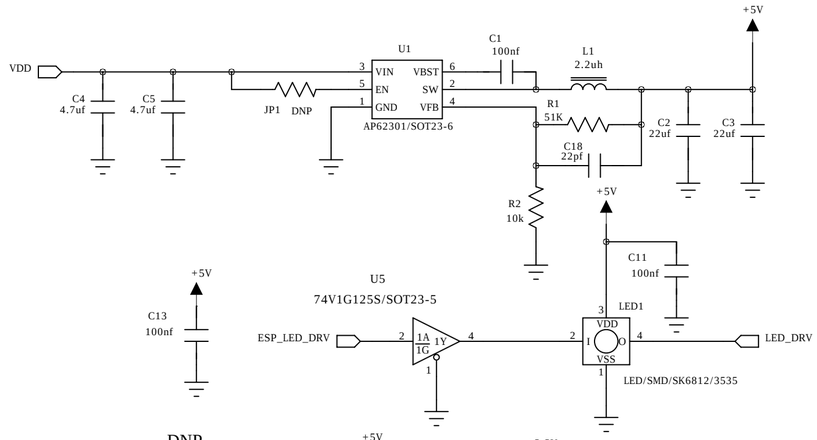

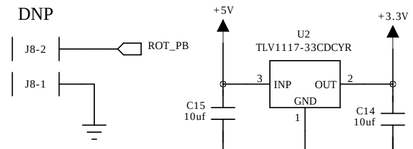

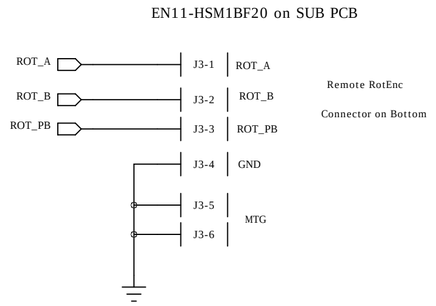

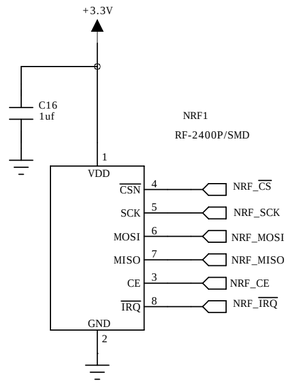

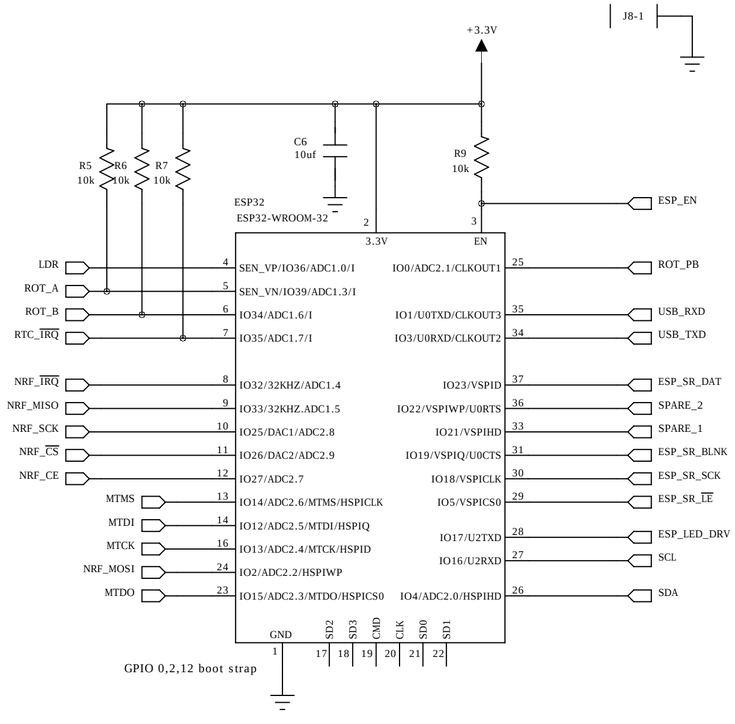

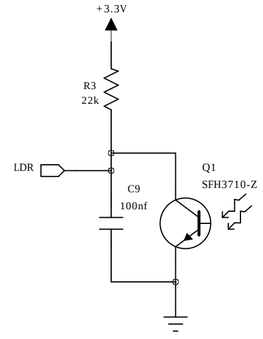

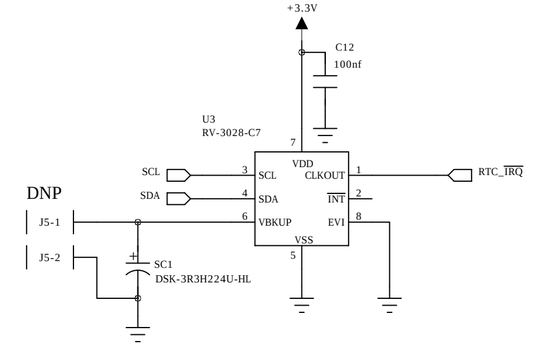

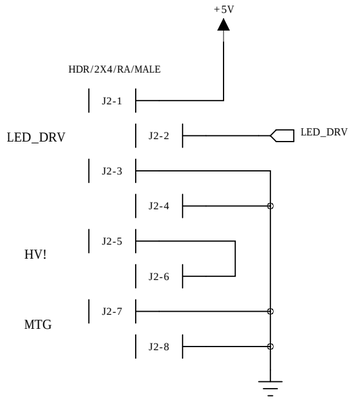

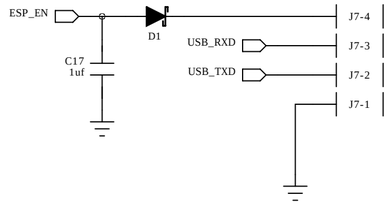

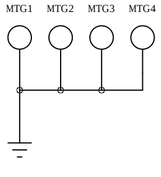

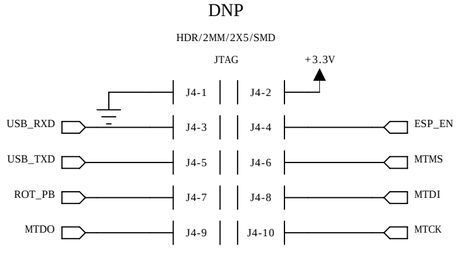

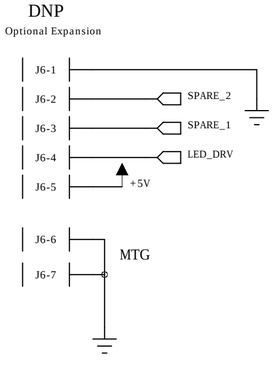

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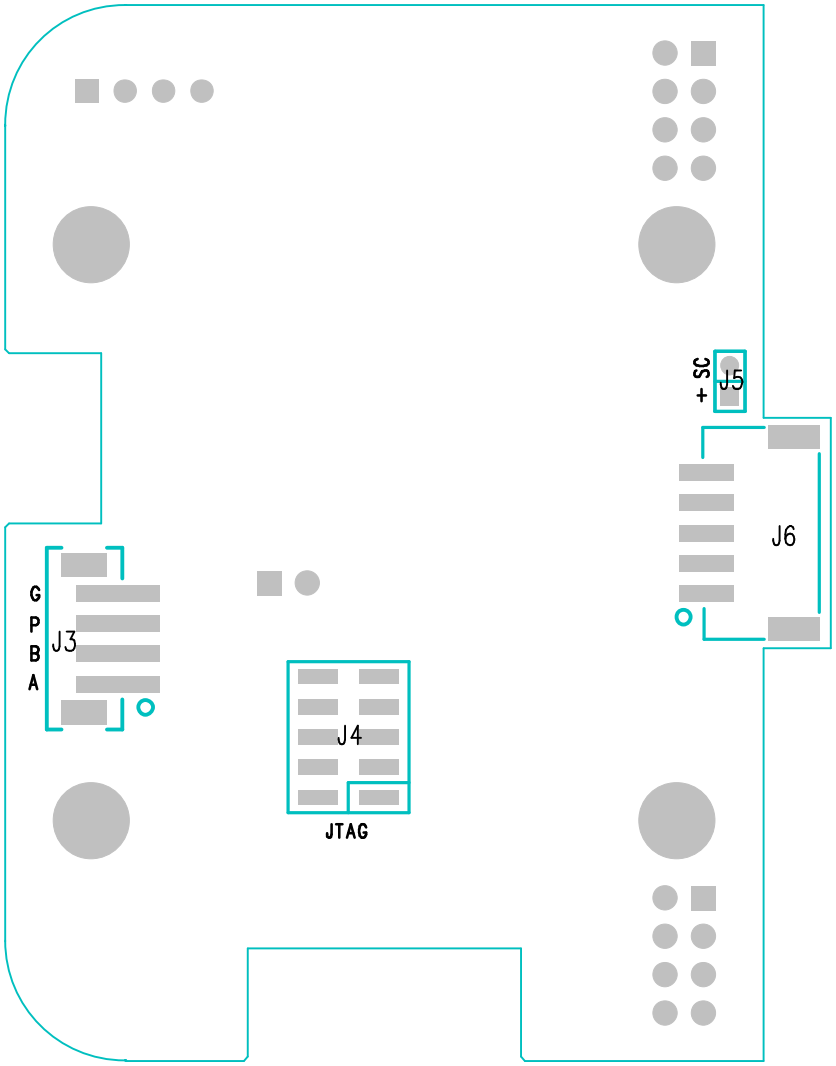
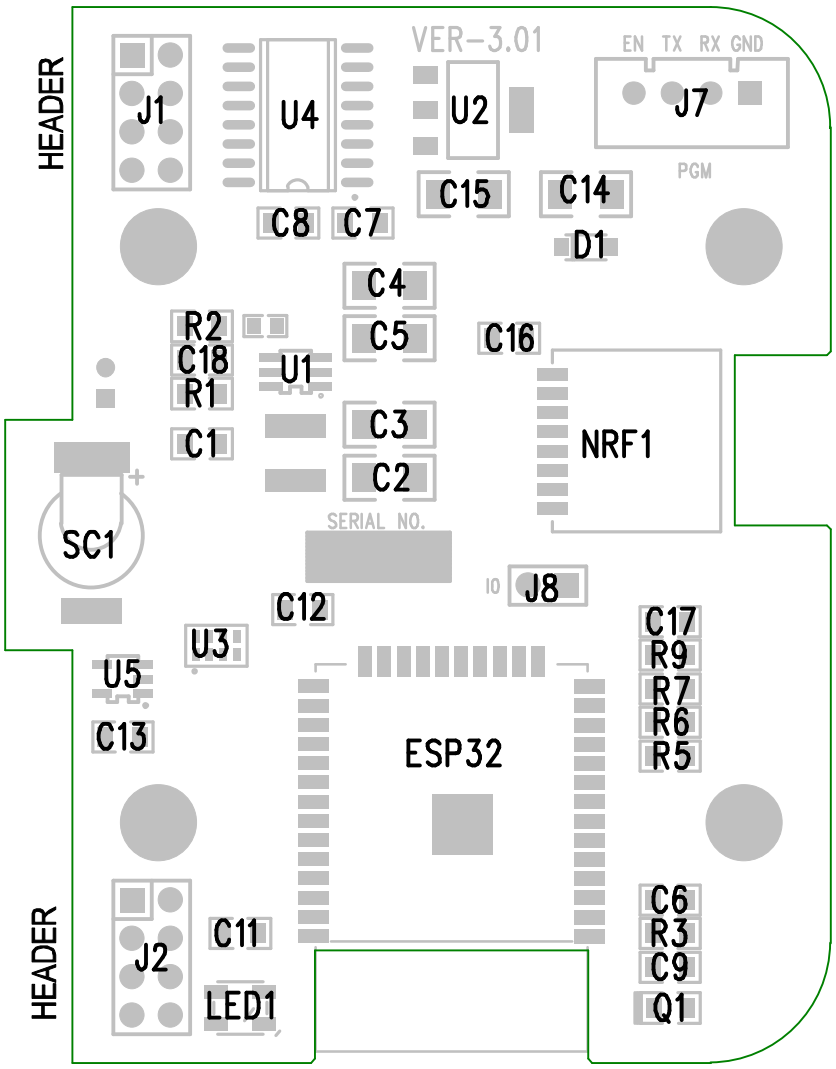


CPU PARTS PLACEMENT BOTTOM



CPU PARTS PLACEMENT TOP

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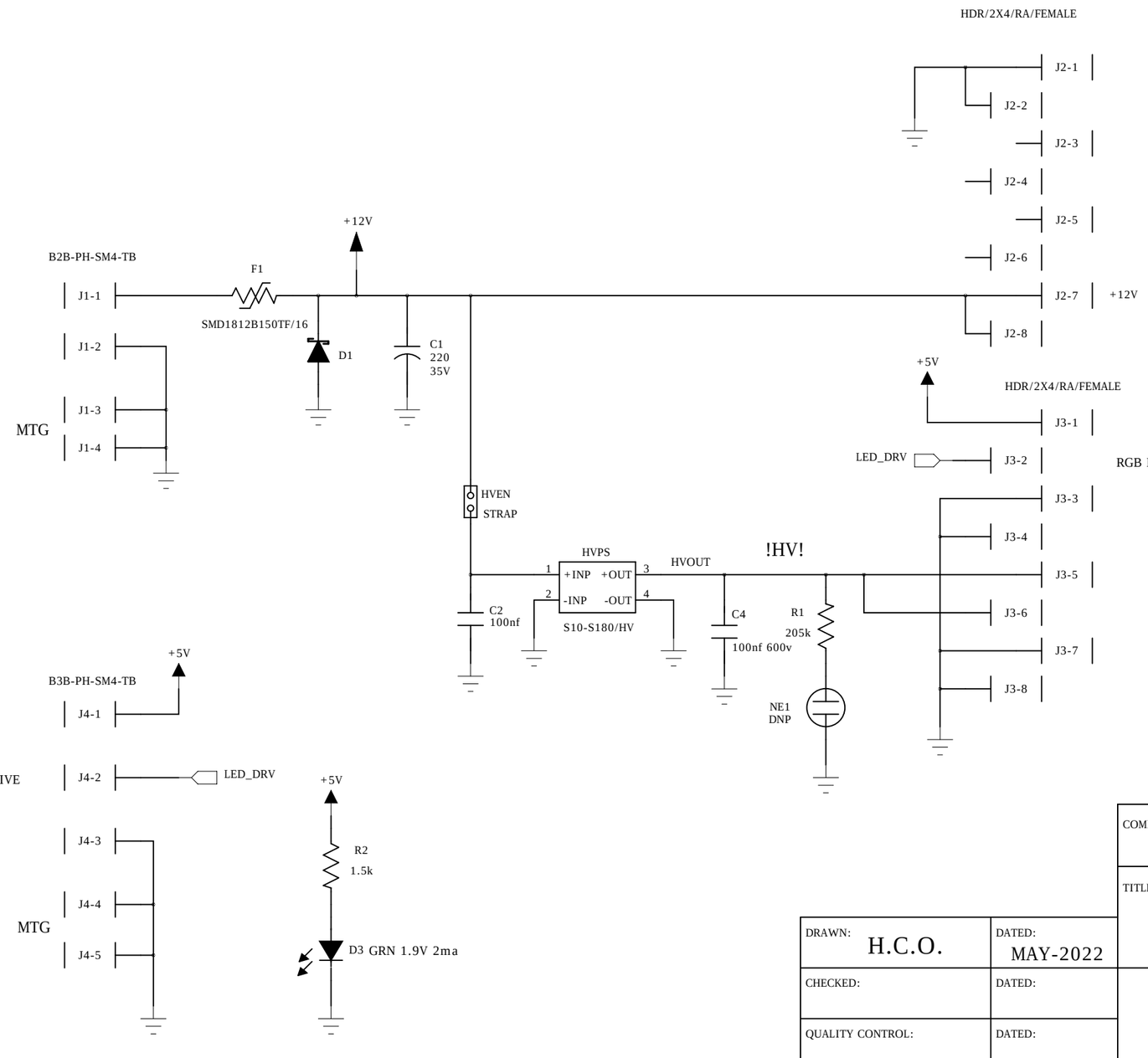

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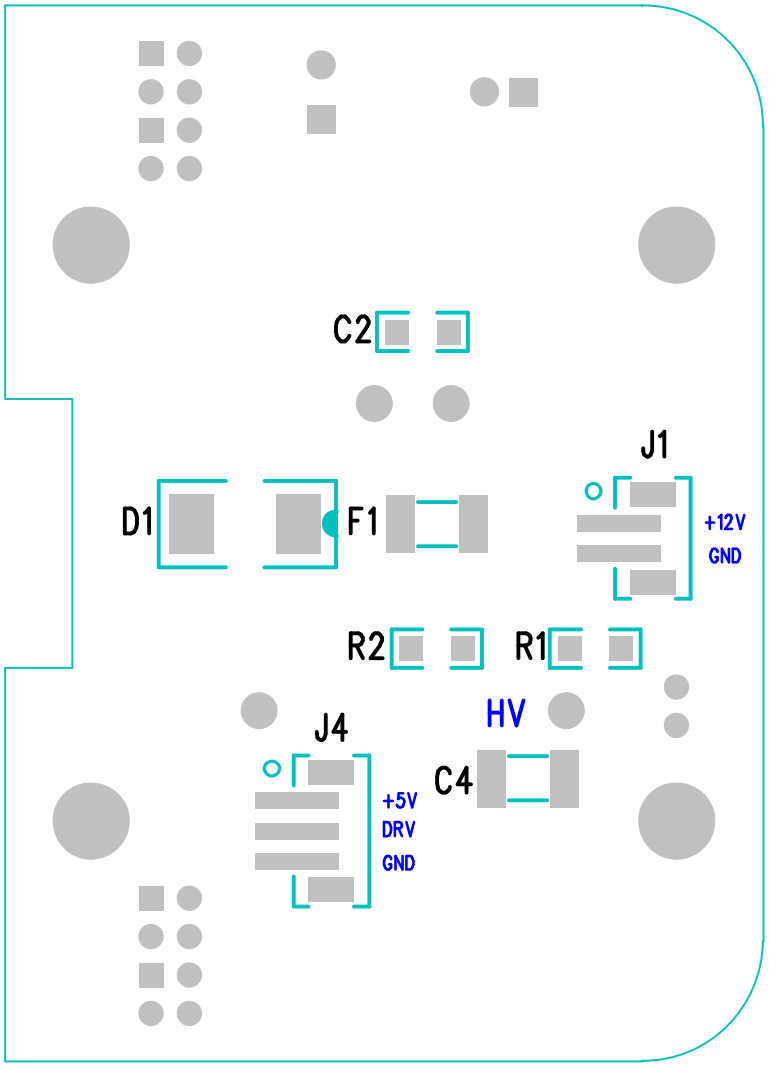

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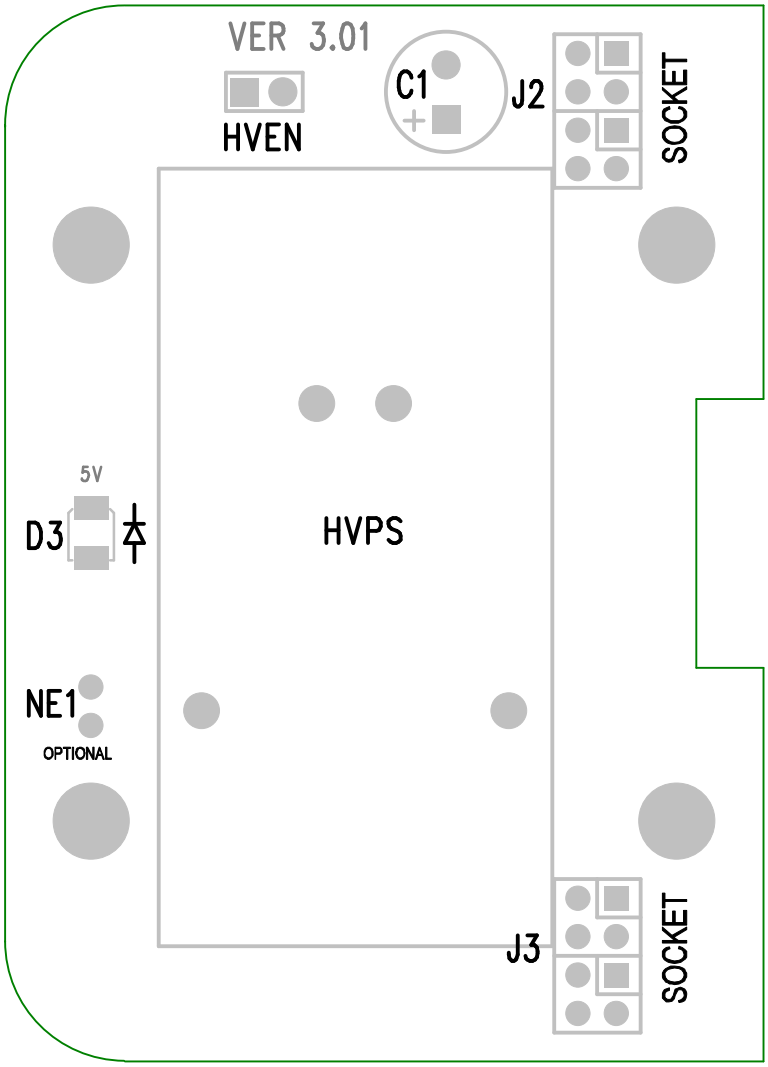

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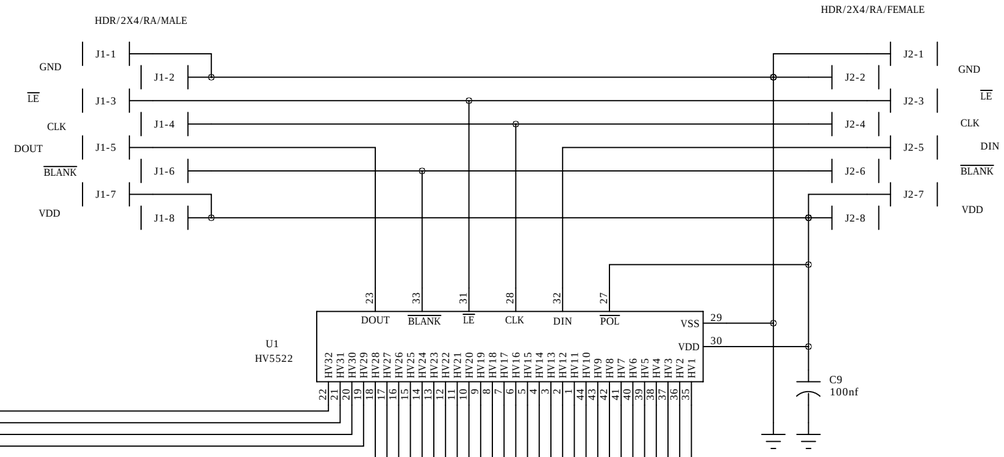
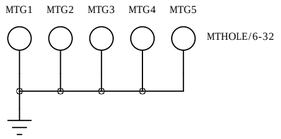
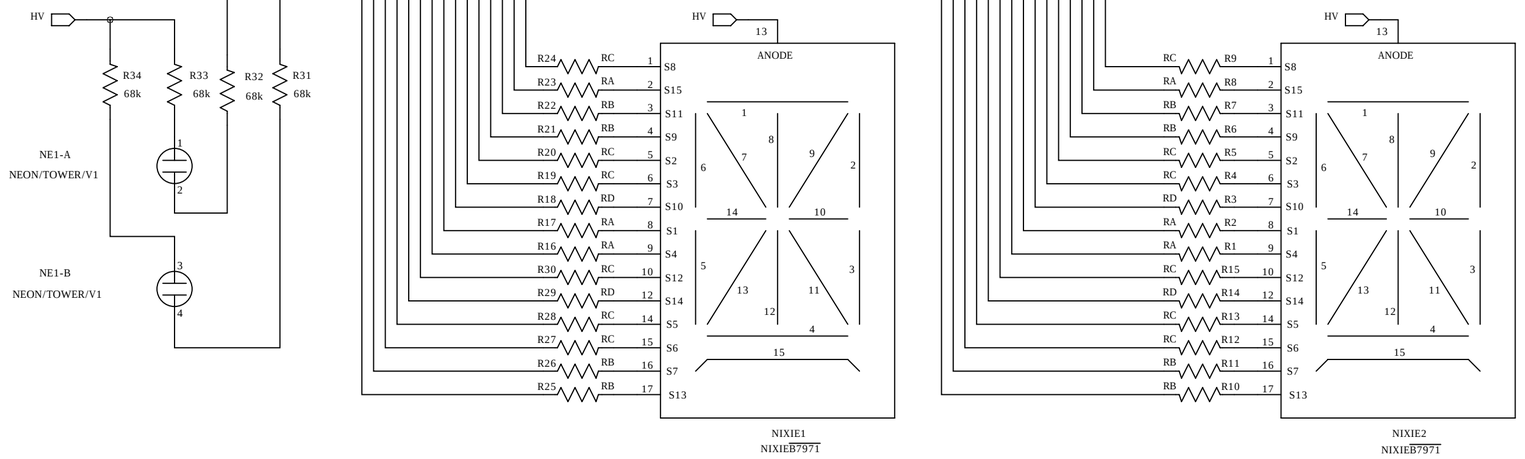
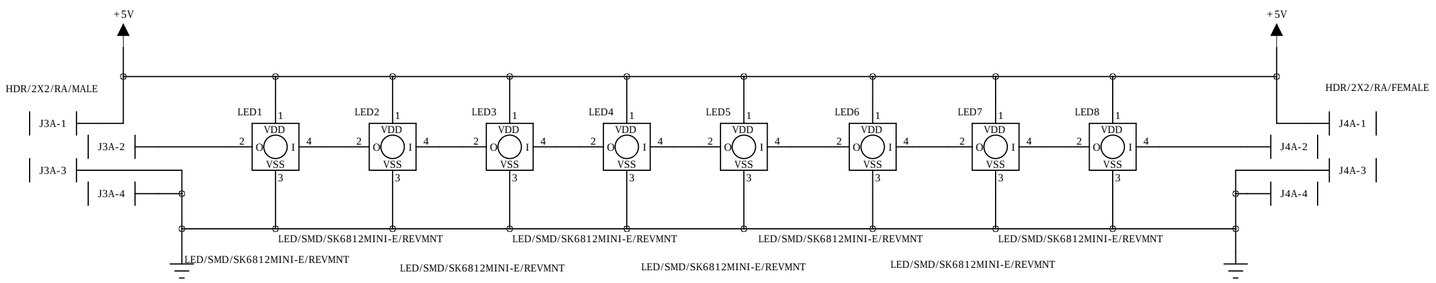


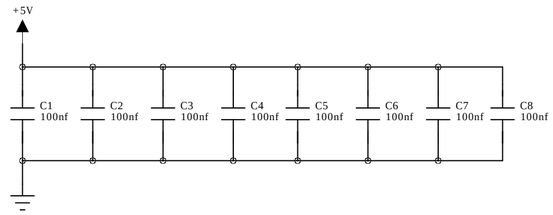




Different Nixie segment lengths require different current limiting resistors.

RA = 22k
RB = 24k
RC = 27k
RD = 33k





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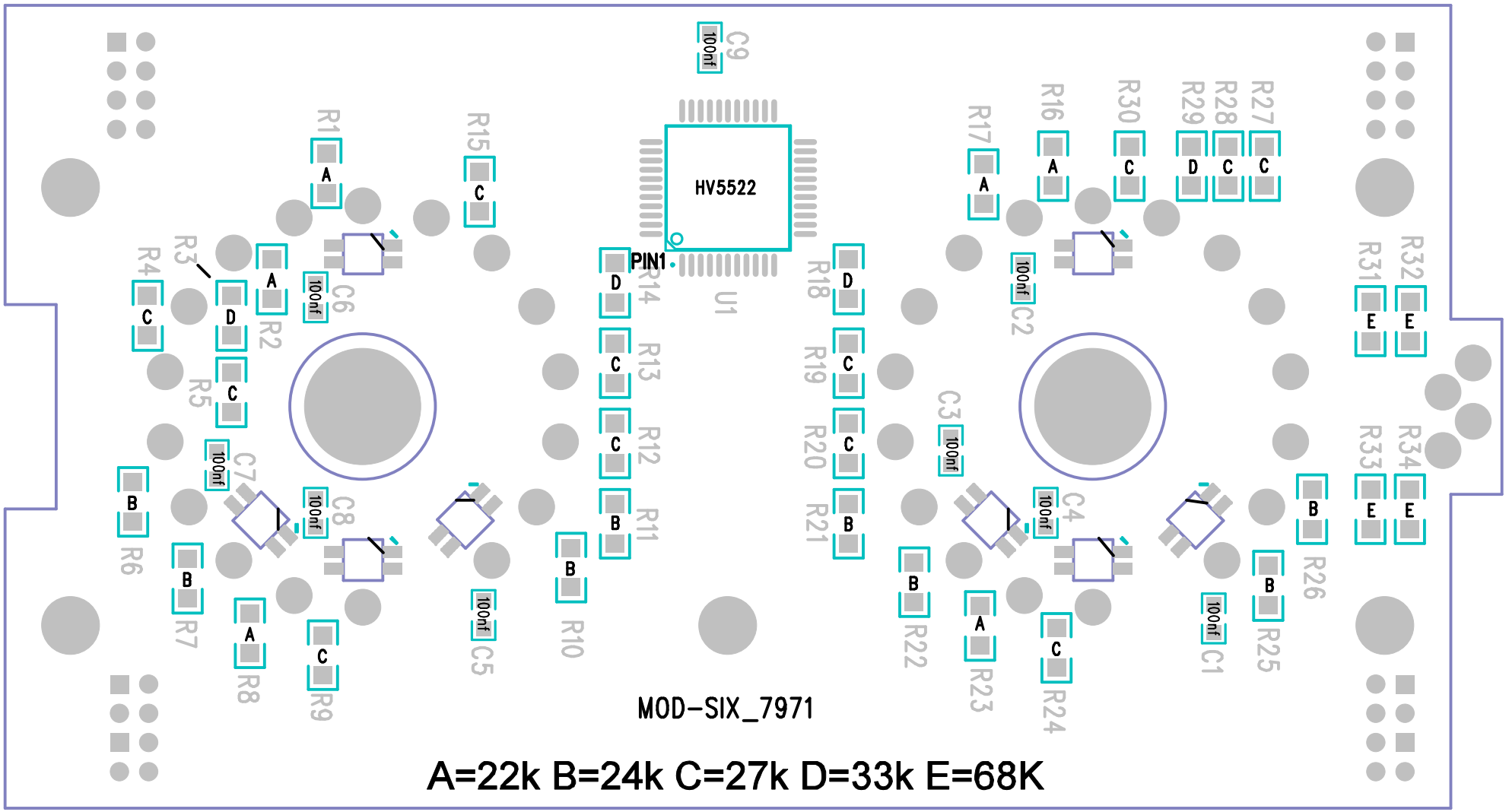
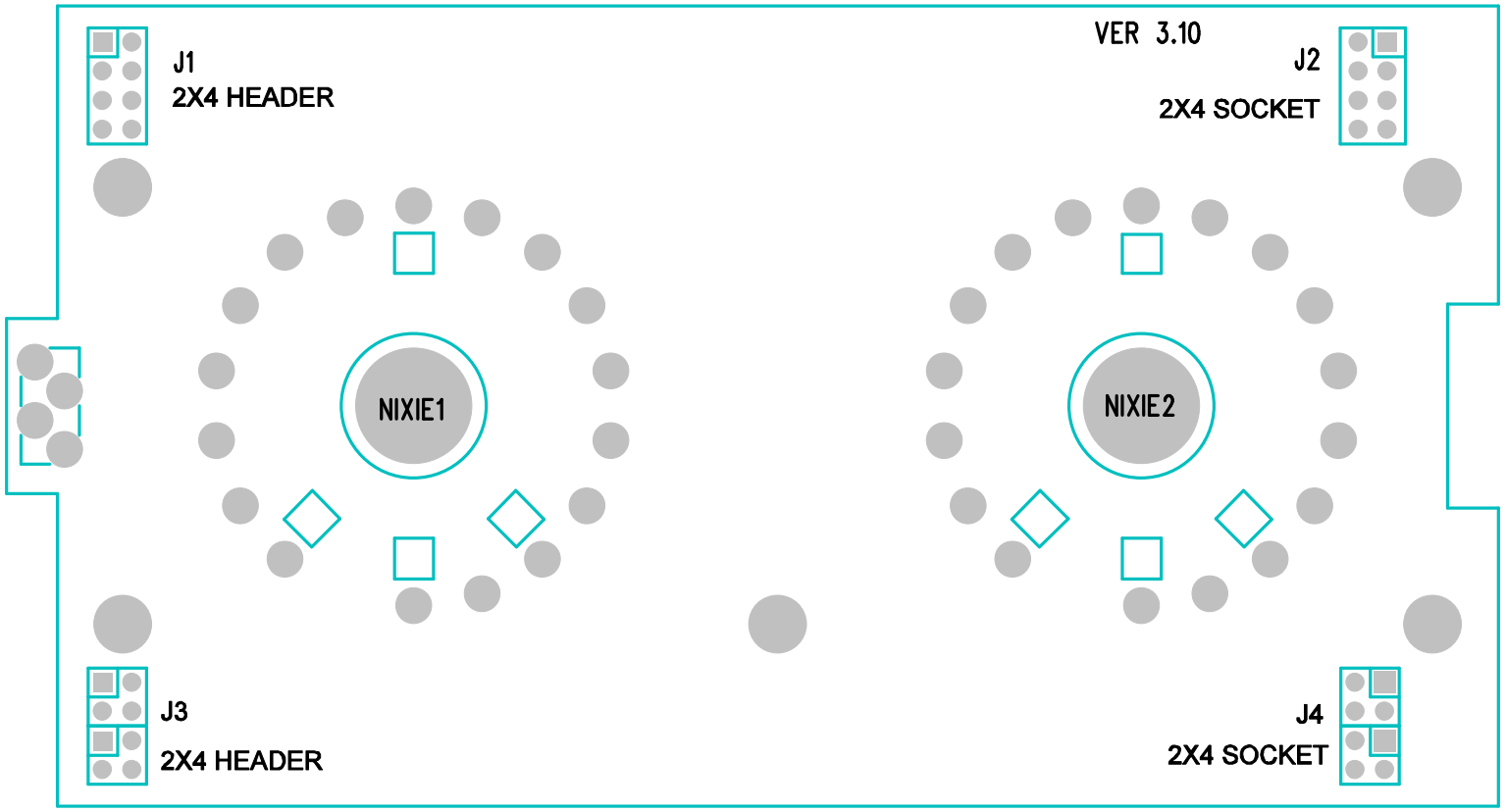


A=22k B=24k C=27k D=33k E=68K

TDU PARTS PLACEMENT BOTTOM



TDU PARTS PLACEMENT TOP