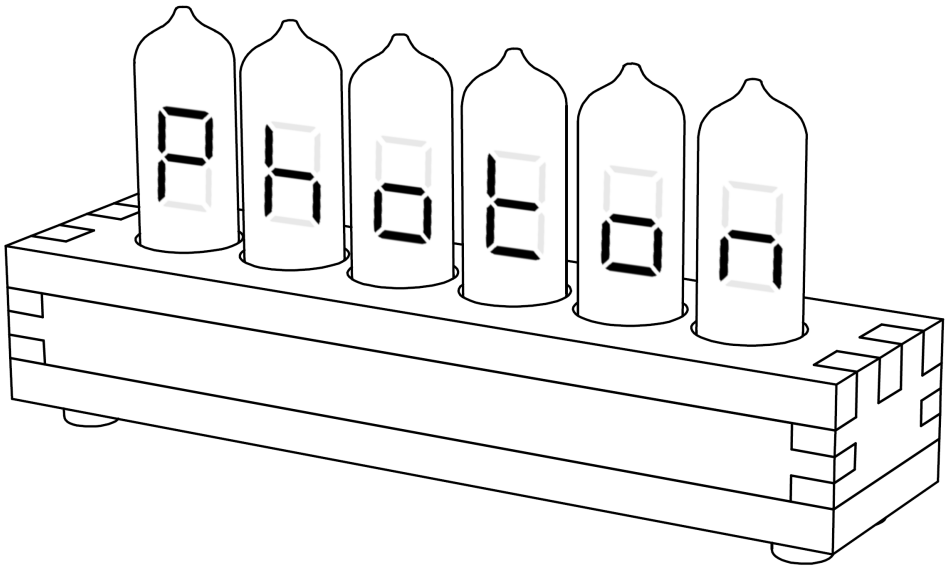
PhotoniClock
User Manual



Last Revised: 25 September 2018

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INTRODUCTION

Congratulations on choosing the PhotoniClock! It is a fusion of past and present, combining the elegance of a bygone era with the technology of today. We hope it finds a place in your life and piques the curiosity of all who encounter it.

Thank you,

The PhotonicFusion Team

FEATURES

- Handcrafted Padauk wood finished with a protective natural oil.
- Accurate timekeeping via temperature-compensated crystal oscillator (TCXO).
- RTC backup for +24hr power-loss time retention (unlike your microwave).
- Three alarms with individual day of the week settings.
- Configurable Date/Time formats and Power On/Off schedule.
- Ambient light sensing adapts display brightness to environment.
- Music database of 40+ songs.
- RGB LEDs provide colorful and unique lighting effects.
- Input voltage protection from Over/Under/Reverse conditions.
- Includes standard FTDI header for programming via Arduino IDE.
- Open-source software and hardware.

SPECIFICATIONS

Item	Specification
Input voltage range	+9V to +15V (*see note)
Typical input power	4.2W
Under/Over-voltage protection	±32V
Over-current protection	PTC Thermistor, 750mA trip current
Typical clock drift	Less than 10s per month
Operating temperature	0°C to 50°C (32°F to 122°F)
Storage Temperature	-20°C to 60°C (-44°F to 140°F)

***Note:** Use the provided power adapter or use a power supply rated for a current of at least 1A to ensure the PhotoniClock's over-current protection mechanism can function properly.

SAFETY

The PhotoniClock has basic protection against over-current, over-voltage, and under-voltage conditions, however care should be taken to prevent these conditions from occurring. Be careful not to touch or short any exposed circuit while powered, as doing so may permanently damage the clock. Do not modify the circuit in any way. Use the provided power adapter or a power supply rated for a current of at least 1A to ensure the PhotoniClock's over-current protection mechanism can function properly.

BACKGROUND

The PhotoniClock utilizes Vacuum Fluorescent Display (VFD) tubes, a specialized type of vacuum tube developed throughout the early 1960s into the late 1980s designed specifically for alphanumeric indication. The VFD tubes selected for this clock are called IV-11. They are a medium-sized, discrete, seven-segment display manufactured originally for the USSR by the Reflector plant in Saratov, Russia from the 1980s until 1993.

VFD tubes operate under the same principals of vacuum tubes. Each tube contains two very thin wires called filaments through which an electric current is passed. If you view the PhotoniClock in a dark environment and reduce the display brightness, you may see the two filaments faintly glowing. Each of the VFD tube's seven segments are electrically connected to a circuit which can toggle a high voltage on/off, +56V in this particular design. When this high voltage is applied to a segment, negatively charged electrons emitted from the filament are magnetically attracted towards the positively charged segment. Upon striking the segment, the electrons are absorbed by a phosphor coating which re-emits the energy in the form of visible light, specifically a characteristic blue-green light associated with VFDs.

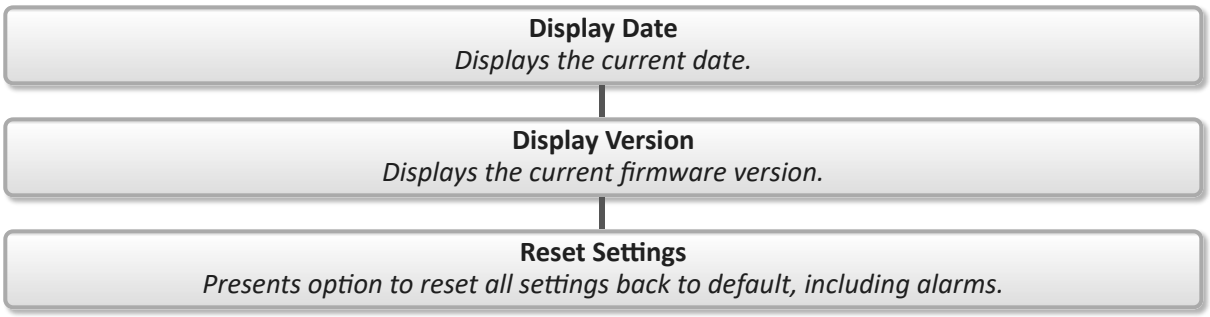
OPERATION

On the backside of the PhotoniClock is a combined rotary encoder and button knob. This knob is the sole method of input for controlling the PhotoniClock. When the PhotoniClock first turns on, it enters *Clock Mode* (displaying the current time). The *Info Menu* and the *Main Menu* are only accessible when in *Clock Mode*. All menus eventually timeout and return to *Clock Mode*. Settings will not be modified if a timeout occurs before completion.

Time is presented in this documentation using the format *HH:MM:SS* where *HH*=Hours, *MM*=Minutes, and *SS*=Seconds.

INFO MENU

Access the *Info Menu* by pressing the knob when in *Clock Mode*. The menu hierarchy is shown below. Advance to subsequent menu items by pressing the knob again.

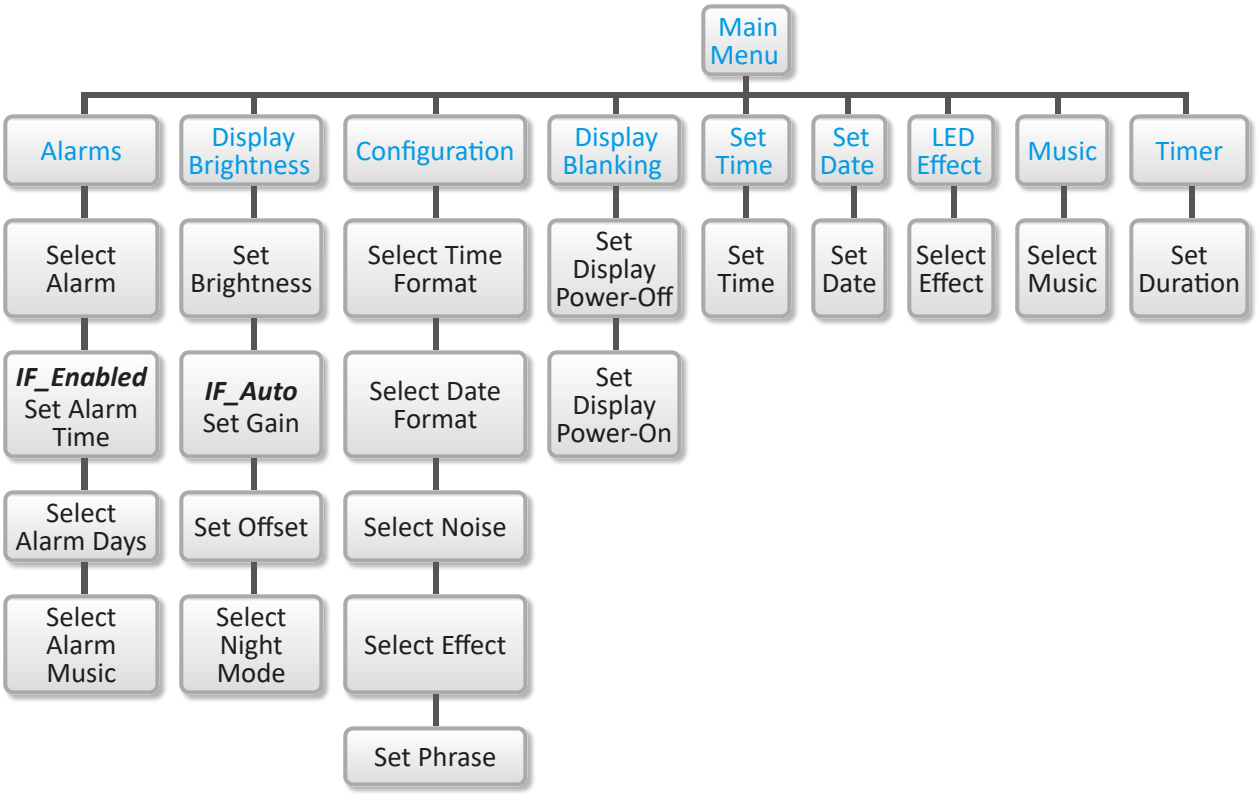


DISABLE DISPLAY

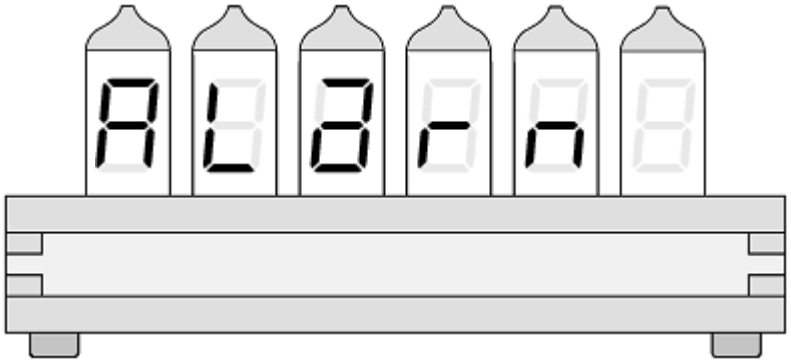
The display can be turned off by pressing and holding the knob for at least 3 seconds when entering the *Info Menu*. The display will remain off until user input is received, an alarm occurs, or the display blanking *Power-On* time matches the current time.

MAIN MENU

Access the *Main Menu* by rotating the knob in any direction when in *Clock Mode*. The menu hierarchy is shown below. Detailed information on each menu item is described in the sections that follow.



ALARMS



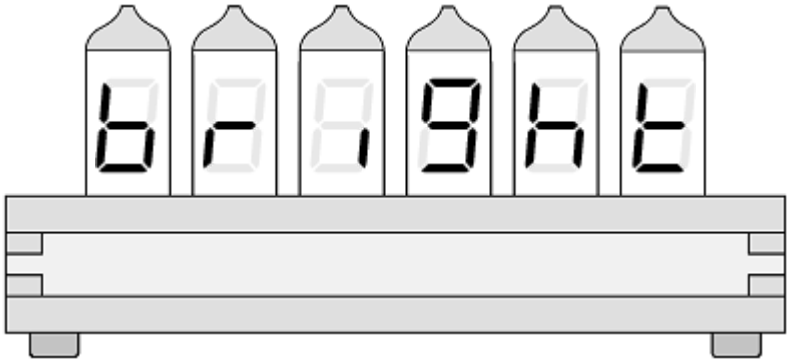
The PhotoniClock features three individual alarms. Each alarm may be set for a specific time and day(s) of the week for which it shall be active. The decimal of the leftmost VFD tube indicates whether an alarm is armed within the next 24 hours. If an alarm is armed, the decimal will be illuminated.

When an alarm time and day matches the current time and day, an alarm event will occur. An alarm event will cause the display to turn on (if it was previously off) and the alarm music selection to sound. The alarm will sound for at least 2 minutes or until interrupted. Any user input will interrupt the alarm.

Setting an alarm:

1. Select `ALArn` from the *Main Menu*.
2. Select one of the three alarms `A1`, `A2`, or `A3` from the list. The current state of the alarm is displayed beside it as `On` if at least one day of the week is enabled, otherwise `OFF` will be displayed.
3. Select `EnAbLE` to continue configuring the alarm, or `dISAbLE` to disable the alarm and exit.
4. `SEt` Set the time of day when the alarm should sound.
5. The day selection menu will cycle through all days of the week. You may skip to any day by rotating the knob. Select a day to choose whether the alarm should be armed (`EnAbLE`) or disarmed (`dISAbLE`) for that day. The menu will automatically advance to the next day after a selection is made. Exit the menu by selecting `-donE-` from the menu.
6. `Audio` Select the music that will play when the alarm sounds.

DISPLAY BRIGHTNESS

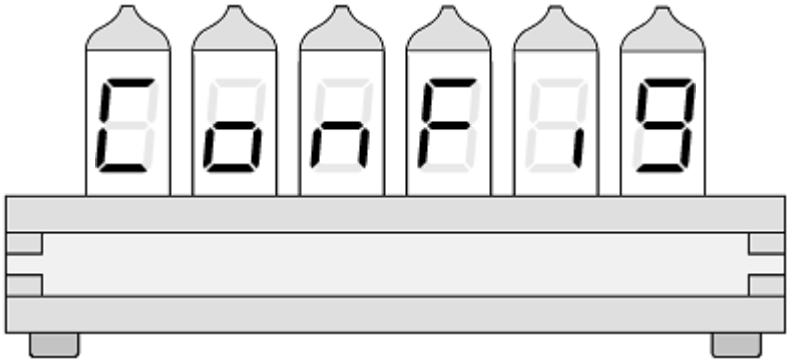


The PhotoniClock has 8 brightness levels for the display. In addition, there in an *Auto Mode* that will adjust the display brightness according to the ambient lighting conditions. After selecting *Auto Mode*, there in an option to enable *Night Mode* which will use minimum display brightness and turn off the LEDs when dark ambient conditions are present. This provides an acceptable brightness level to avoid being bothersome at night.

Setting the display brightness:

1. Select `bright` from the *Main Menu*.
2. Select one of the 8 brightness settings or select `Auto` to enable automatic brightness. If *Auto Mode* is selected, follow the remaining steps.
3. `gain` Select the sensor gain. This value adjusts the sensitivity of the light sensor.
4. `OFFSEt` Select the sensor offset. This value adjusts the minimum value measured by the light sensor.
5. `night` Select whether to enable (`EnAbLE`) or disable (`dISAbLE`) *Night Mode*. When enabled and dark ambient conditions are present, minimum display brightness will be used and the LEDs will be disabled.

CONFIGURATION

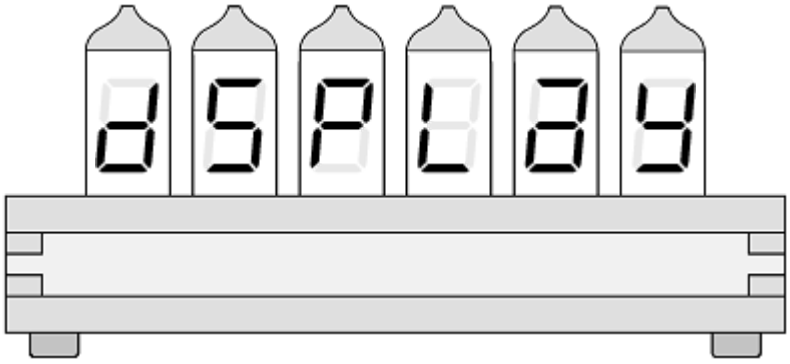


The PhotoniClock is customizable and can be configured to user preference. Configuration settings include time and date format, knob noise generation, display effects, and custom phrase.

Configuring the PhotoniClock:

1. Select ConF ig from the *Main Menu*.
2. Hour Select the hour format to be *12-hour* (12 hr) or *24-hour* (24 hr) mode.
3. dAtE Select the date format to be *Y-M-D* (Y-M-d), *M-D-Y* (M-d-Y), or *D-M-Y* (d-M-Y) where *D*=Day, *M*=Month, and *Y*=Year.
4. Noi SE Select whether an audible blip is enabled (EnAbLE) or disabled (dISAbLE) when the rotary encoder knob is turned.
5. EFFEct Select whether an effect should be displayed during normal clock display. Options include:
   - NonE No effect will be displayed.
   - SPirAL A spiral effect will be displayed when the seconds reach 0.
   - dAtE The current date will be displayed when the seconds reach 30.
   - PhrASE The user configured phrase will be displayed when the seconds reach 30.
6. PhrASE Input a custom phrase to display during alarms and display effects.

DISPLAY BLANKING



The PhotoniClock includes a display blanking feature which allows for scheduled times when the display should turn off/on. This feature is useful if you want to turn off the clock at night (alternatively see *Night Mode*), or prolong the lifespan of the VFD tubes.

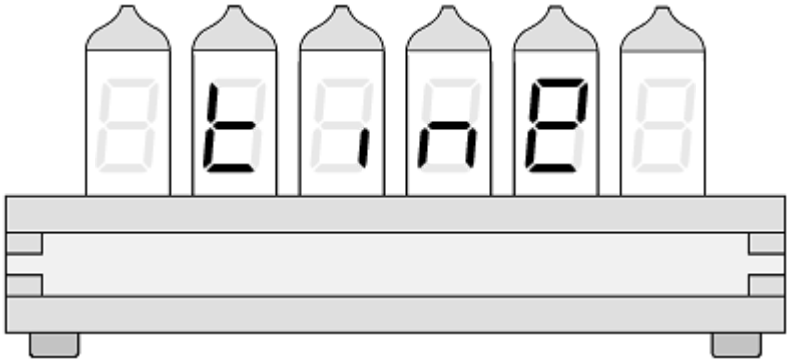
Setting the display blanking schedule:

1. Select dSPLAY from the *Main Menu*.
2. P-OFF Input the time in *HH:MM* when the display should power-off.
3. P-On Input the time in *HH:MM* when the display should power-on.

Disable display blanking:

To disable display blanking, simply set the *P-Off* and *P-On* times to be equal. This prevents display blanking from occurring.

SET TIME

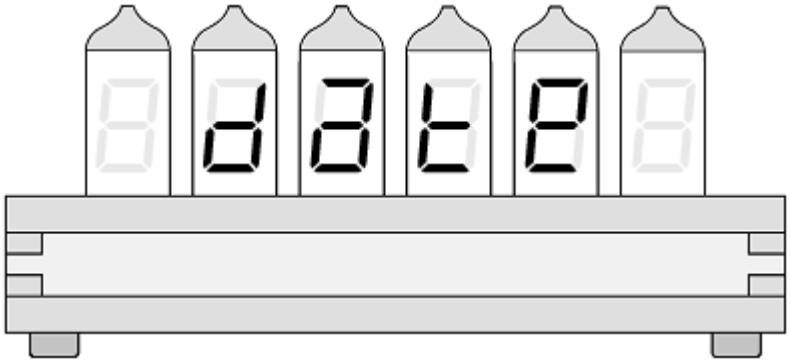


The PhotoniClock utilizes an RTC with a temperature-compensated crystal oscillator (TCXO). This particular RTC has a very low clock drift, specified less than 10s per month. In addition, an on-board supercapacitor maintains RTC time and date during a power-loss event for over 24 hours.

Setting the time:

1. Select `t inE` from the *Main Menu*.
2. `t inP` Input the time in *HH:MM:SS* to set the clock.
3. `CYcLE` If the *Hour Format* is configured to *12-hour* mode, there will be an additional selection asking for current cycle. Choose between *AM* (`AM`) and *PM* (`PM`). The decimal of the rightmost VFD tube indicates the current cycle. It will illuminate when the cycle is *PM*.

SET DATE

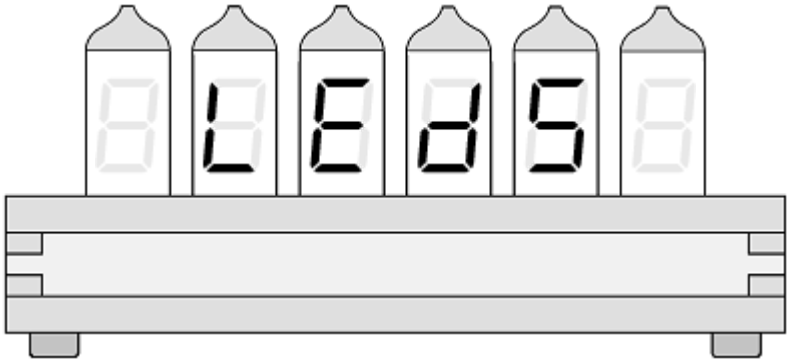


The PhotoniClock RTC automatically adjusts for leap years and accepts dates from 01-January-2000, to 31-December-2099.

Setting the date:

1. Select dAtE from the *Main Menu*.
2. dAtE Input the date to set the clock. The format used will be *Y-M-D*, *M-D-Y*, or *D-M-Y* where *D*=Day, *M*=Month, and *Y*=Year depending on which *Date Format* is configured.

LED EFFECT

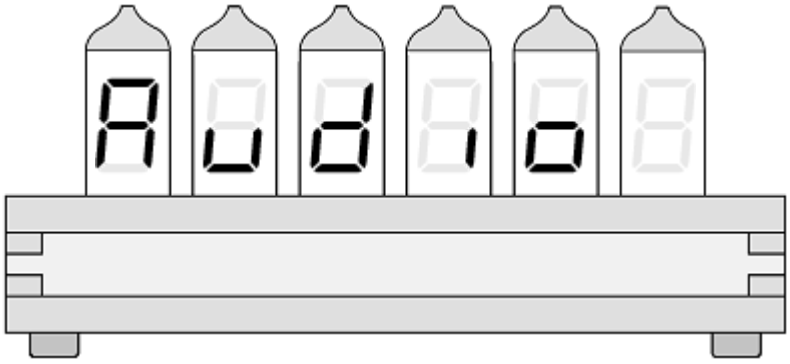


Beneath each VFD tube is an RGB LED. This array of LEDs can be configured to display effects listed in the description below. LED brightness is automatically adjusted to match the display brightness. In the event that *Night Mode* is triggered, the LEDs will be disabled.

Setting the LED effect:

1. Select `LEdS` from the *Main Menu*.
2. `EFFEct` Select the LED effect desired. Options include:
   - `Stat cc` Static color choice.
   - `PuLSE` Slow pulsing color choice.
   - `F crE` Fire effect of color choice.
   - `1982` Knight Rider effect of color choice.
   - `Pon9` Color-changing bounce.
   - `FadE` Slow color-changing transitions.
   - `Fa cnbo` LEDs cycle through hue in unison.
   - `CSh cFt` LEDs cycle through hue in sequence.
   - `9hoSt` Slow color orbs.
   - `droPS` Colors drop and combine every second.
   - `d c9 ct` Hours, Minutes, Seconds translate to colors.
   - `tEtr cS` Colors "fall" and collect.
   - `CycLE` Cycle through all effects except Static and Disable.
   - `dSabLE` No effect will be displayed.

MUSIC (AUDIO)



The PhotoniClock features two miniature transducers capable of square-wave generation. Included in an on-board EEPROM is a library of music listed in the description below. Cycle through the music library to experience a retro interpretation of iconic and modern songs. Users may optionally upload their own music following the procedure documented in section Custom Music.

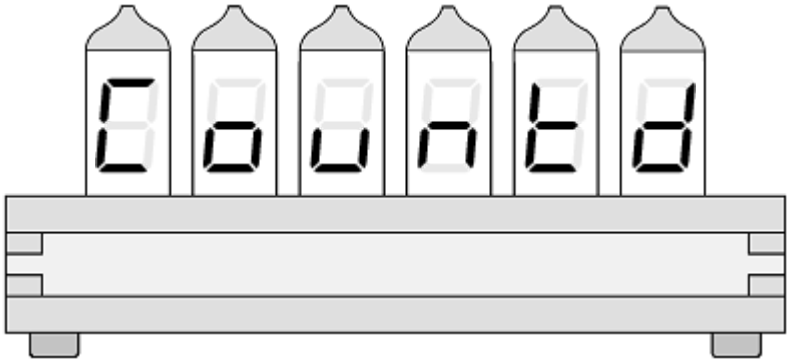
Browsing the music library:

1. Select Audio from the *Main Menu*.
2. Audio Select the music for Alarm/Countdown events. Music list:

Entries 00-24		Entries 25+	
00	Alarm, Slow Beep	25	Morrisons_Jig
01	Alarm, Fast Beep	26	Mortal_Kombat_Theme
02	Ave_Maria	27	PacMan_Intro
03	Bach_Prelude	28	Pallet_Town
04	Back_To_The_Future_Theme	29	Pokemon_Battle
05	Cave_Story_Moonsong	30	Portal_Halls_of_Science
06	Fantaisie_Impromptu	31	Portal_Still_Alive
07	Far_Off_Promise	32	Song_of_Storms
08	Fortitude	33	Sonic_the_Hedgehog
09	G&W_Gallery_2_Parachute	34	SquareWave
10	Game_of_Thrones	35	Super_Mario_3_Overworld_2
11	God_Save_The_Queen	36	Super_Mario_Bros_Overworld
12	Hall_of_the_Mountain_King	37	Tanzunite
13	Harry_Potter_Hedwigs_Theme	38	Tetris_A_Theme
14	He_is_a_pirate	39	The_Star_Spangled_Banner
15	Jurassic_Park_Theme	40	Undertale_Spider_Dance
16	Kalinka	41	Under_the_Sea
17	Katyusha	42	

Entries 00-24		Entries 25+
18	Kirby_Gourmet_Race	43
19	Knight_Rider	44
20	Legend_of_Zelda_Overworld	45
21	Stone_Tower_Temple	46
22	Marriage_D_Amour	47
23	Metroid_Kraids_Hideout	48
24	Mission_Impossible_Theme	49

TIMER (COUNTDOWN)



The PhotoniClock includes a timer feature with a configurable countdown duration up to 1 day. Use the timer to easily set a single-use alarm for reminders, timing, and cases where a periodic alarm isn't needed. When the timer countdown reaches 0, an alarm will sound for at least 2 minutes or until interrupted.

Setting the timer:

1. Select Countd from the *Main Menu*.
2. SEt Input the duration in *HH:MM:SS* to set the timer.

OPEN-SOURCE HARDWARE & SOFTWARE

The PhotoniClock project is open-source and available on GitHub from the following link:

https://github.com/photonicfusion/photoniclock

FLASHING FIRMWARE

To flash firmware to the PhotoniClock, follow the procedure below.

1. Download the latest firmware and utilities from GitHub.
2. Use the provided Makefile or Arduino IDE to compile the source to binary.
3. Use the provided python script PhotoniClock/Utilities/FlashProduction.py or Arduino IDE to upload the binary to the PhotoniClock using an FTDI cable.

CUSTOM MUSIC

Custom music can be added to the PhotoniClock. Follow the procedure below.

1. Download the latest firmware and utilities from GitHub.
2. Install Python and the required modules (run PhotoniClock/Utilities/FlashProduction.py to determine missing modules).
3. Prepare music in MIDI format. For best results, choose MIDI files with few channels and note/rest durations no smaller than triplet sixteenth. Place MIDI files into the PhotoniClock/Utilities/MIDI directory.
4. Follow the steps provided in section Flashing Firmware and use "-e" flag with PhotoniClock/Utilities/FlashProduction.py to invoke EEPROM upload.

REVISION HISTORY

Date	Description
30 August 2018	Initial Release
25 September 2018	Updated Music list. Updated URLs.

CONTACT INFORMATION

If you have a warranty claim or need support, please contact us at:
support@photonicfusion.io

The PhotoniClock and accessories can be purchased at https://photonicfusion.io

WARRANTY

The PhotoniClock is warranted to be free from defects in materials and workmanship for a period of one year from the date of purchase. If within the warranty period your unit should become inoperative from such defects, the unit will be repaired or replaced at the option of PhotonicFusion. This warranty covers normal use and does not cover damage which occurs in shipment or failure which results from alteration, tampering, hacking, accident, misuse, abuse, neglect or improper maintenance.

Any implied warranties, including but not limited to implied warranties of merchantability and fitness for a purpose, are limited to the express warranty. PhotonicFusion shall not be liable for loss of use of the unit or other incidental or consequential damages, expenses, or economic loss, or for any claim or claims for such damage, expenses or economic loss. A purchase receipt or other proof of original purchase date will be required before warranty repairs or replacement will be rendered.