

Boogie Box

Designed and Assembled by Todd Wease



Clock

Date & Time
12 or 24 Hour Time Format
Configurable Daylight Saving Time
Coin Cell Battery backup keeps time when device is unpowered

Portable with Rechargeable Lithium Ion Battery

Micro USB connection for Powering and Charging

Low Battery Indicator

Controllable Display and Lighting Brightness

Audio

Play up to 4096 songs
Dedicated Controls
- Play & Pause
- Skip Forward Tracks
- Skip Back & Rewind Tracks
Stop function for extra power savings
Direct track selection using Touch

Alarm

Wake to Beeper or Audio
Touch to Snooze
Configurable Snooze Time
Configurable Auto-Stop Timers

Timer

Up to ~100 hours
Touch to stop alerting when done
Countdown LED lighting
Toggle display between Timer / Clock

Touch

Capacitive Touch Sensing
Calibration and Tuning
Configurable Sensitivity

Night Light

Up to 4 colors
- One White
- 3 Configurable
Lighting Animations

Power

Prolong battery charge when idle
- Two low power states
- Auto-stop Audio
All idle timers configurable
Touch to force into Sleep state

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I

Enclosure & Controls

The enclosure is made of Bubinga wood with a dewaxed shellac finish. The front panel is made of aluminum.



Do not get alcohol anywhere near this. The wood finish is shellac whose solvent is alcohol. Alcohol will ruin the finish, i.e. dissolve it like turpentine will with oil based paint. So don't rest your beer bottle, glass of wine or shot of tequila on top. And to be safe, don't clean it with any kind of chemical cleaning solution. A dry or slightly damp rag, preferably microfiber, should be sufficient to get fingerprints off of the wood finish and aluminum face plate.



Before trying to disassemble the enclosure to either change the [COIN CELL BATTERY](#) or remove the [MICRO SD CARD](#) card, please read the [Disassembly](#) section.

1 Front

The FRONT is made of aluminum with cast acrylic windows for the **DISPLAY** and **LIGHTING**. It contains all of the controls and screens necessary for interacting with the device except for the **TOUCH SENSOR** which is located underneath the **TOP** of the enclosure.

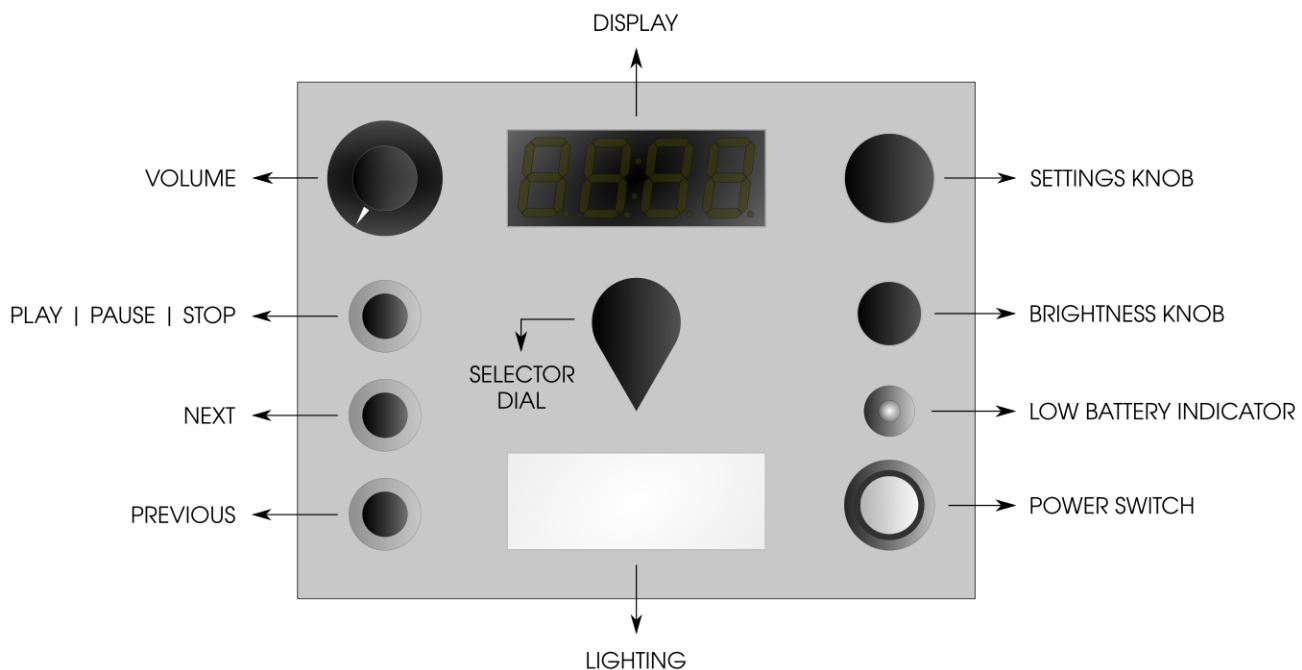


Figure 1.1: Front Panel

1.1 Power

1.1.1 Power Switch

The **POWER SWITCH** is a latching switch used to turn the device **ON** and **OFF**.

- To turn the device **ON**, press inward until you hear a mechanical click and feel it lock in place.
- To turn the device **OFF**, press inward until you hear a mechanical click and feel it release.

You can visually tell whether the switch is ON or OFF by whether or not it is lit.¹



Table 1.1: Power Switch - ON | OFF Indication

It will also be flush with the bevel when OFF and sunken in when ON.

A few items of note:

- When the device is plugged in there is no need to switch the device OFF.
- To reduce power consumption when running unplugged, instead of switching the device OFF, you can:
 - Use the **BRIGHTNESS KNOB** to blank both the **DISPLAY** and **LIGHTING**.
 - Use **PLAY | PAUSE | STOP** to **STOP** the **AUDIO**.
 - Set **NAP**, **STOP** and/or **SLEEP** timers or forcibly put the device to sleep using **TOUCH** - see **POWER SETTINGS** for configuration and usage.

1.1.2 Low Battery Indicator

The **LOW BATTERY INDICATOR** is a red LED and is used to indicate that the device needs to be recharged. When the light turns on, the battery charge is getting low.



Table 1.2: Low Battery Indicator

Note that when music is playing, the light might flicker on and off. This is because the electric current varies a great deal when playing audio and a high volume setting and/or certain sounds (usually low end sounds) can cause the voltage in the circuit to temporarily drop triggering the **LOW BATTERY INDICATOR**. Turning the volume down may get rid of the flicker. Either way, the battery should be recharged.

¹ The color of the light may vary.

1.2 Screens

1.2.1 Display

The DISPLAY is the primary means of conveying information. It is an LED [Seven-Segment Display](#) and can display the full range of numerical digits as well as the majority of letters.² It can also display a decimal point after each digit and a colon in the middle.

The brightness of the DISPLAY is controlled by the [BRIGHTNESS KNOB](#).

1.2.2 Lighting

The LIGHTING is made up of **16** RGB LEDs - 2 rows with **8** in each row. A translucent white plastic called Delrin is used to diffuse the light. Its primary use is as a night light or timer status indicator. See [CLOCK](#) and [TIMER](#) respectively for more information on its use and [SET NIGHT LIGHT](#) for instructions on setting the **3** configurable night light colors.

The brightness of the LIGHTING window is controlled by the [BRIGHTNESS KNOB](#).

1.2.3 Brightness Knob

The BRIGHTNESS KNOB is an optical rotary encoder and is used to control the brightness of both the [DISPLAY](#) and [LIGHTING](#). It does not have start or stop positions and will turn indefinitely in either direction.

- Turn *clockwise* to *increase* the brightness.
- Turn *counter-clockwise* to *decrease* the brightness.³

Continually turning in one direction or the other will eventually either:

- (1) Reach a *maximum* brightness, or
- (2) Blank both the DISPLAY and LIGHTING.



When running on battery power and not using the DISPLAY or LIGHTING - for example, if just listening to music - turn the BRIGHTNESS KNOB *counter-clockwise* until they go blank to prolong battery charge.

1.3 UI Controls

The SELECTOR DIAL and SETTINGS KNOB are the primary controls used to interact with the device and make use of its functionality.

² See [Number & Letter Display Representations](#) in the Appendix for a complete list.

³ The DISPLAY does not dim seamlessly and you will likely notice that it jumps or drops in brightness. This is normal behavior as the hardware only supports **16** brightness levels.

1.3.1 Selector Dial

The SELECTOR DIAL is a 3 position, 90 degree angle rotary switch and is used to select available operational modes.



Table 1.3: Selector Dial Positions

For information on usage, see [SELECTOR DIAL](#) in the [Operation](#) chapter.

1.3.2 Settings Knob

The SETTINGS KNOB is a combination optical rotary encoder w/ detents *and* momentary switch which can be both *turned* and *pressed*. It does *not* have start or stop positions and will turn indefinitely in either direction.

For information on usage, see [SETTINGS KNOB](#) in the [Operation](#) chapter.

1.4 Audio Controls

The left side of the front panel is devoted to the [AUDIO](#).

1.4.1 Volume

The VOLUME knob is a dual-gang potentiometer and controls the volume level of the [AUDIO](#)⁴ and has a *white arrow* indicator on the sleeve. Unlike the [SETTINGS KNOB](#) and [BRIGHTNESS KNOB](#) it does *not* turn indefinitely and has physical start and stop positions.

For usage information, see [VOLUME](#) in the [AUDIO](#) section.

1.4.2 Play | Pause | Stop

PLAY | PAUSE | STOP is a momentary push-button and is used to PLAY, PAUSE and STOP the [AUDIO](#).

For usage information, see [PLAY | PAUSE | STOP](#) in the [AUDIO](#) section.

1.4.3 Next

NEXT is a momentary push-button and is used to SKIP *forward* one or more tracks.

For usage information, see [NEXT](#) in the [AUDIO](#) section.

⁴ The VOLUME knob is not connected to the BEEPER so cannot control its volume.

1.4.4 Previous

PREVIOUS is a momentary push-button and is used to SKIP *backward* one or more tracks or *rewind* the current track.

For usage information, see [PREVIOUS](#) in the [AUDIO](#) section.

2 Top

Attached to the underside of the TOP is a TOUCH SENSOR and a COIN CELL BATTERY and holder.

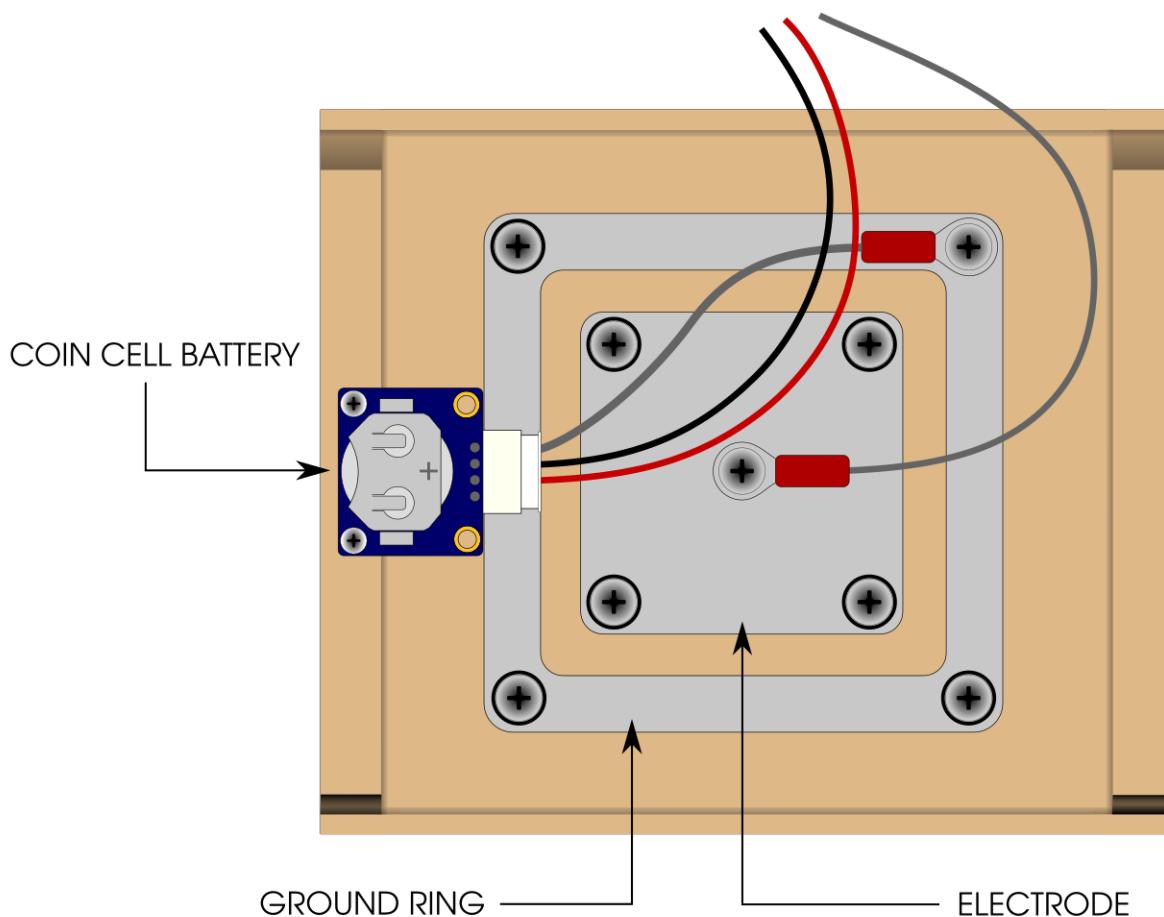


Figure 2.1: Top - Underside

2.1 Touch Sensor

The TOUCH SENSOR, also called an *electrode*, is made of a 2×2 inch square of **1/32"** thick aluminum with a wire running to the microcontroller. Around the electrode is an aluminum ground ring.

For more information, see [TOUCH SENSOR](#) in the [Operation](#) chapter and [TOUCH SETTINGS](#) for how to enable and configure the touch capability of the device.

2.2 Coin Cell Battery

The COIN CELL BATTERY is a **3V CR2032** Lithium battery and is used to keep the date and time updated when the device is switched OFF via the [POWER SWITCH](#) and otherwise unpowered. It is attached on the left side just underneath the TOP. It is *not* rechargeable, however, it should last for a number of years before needing replacement. You will know it needs replacing if the date and time are not correct when switching the device ON (assuming they were correct before switching the device OFF). For more information see [Replacing the Coin Cell Battery](#).

3 Bottom

The BOTTOM holds and secures the RECHARGEABLE BATTERY.

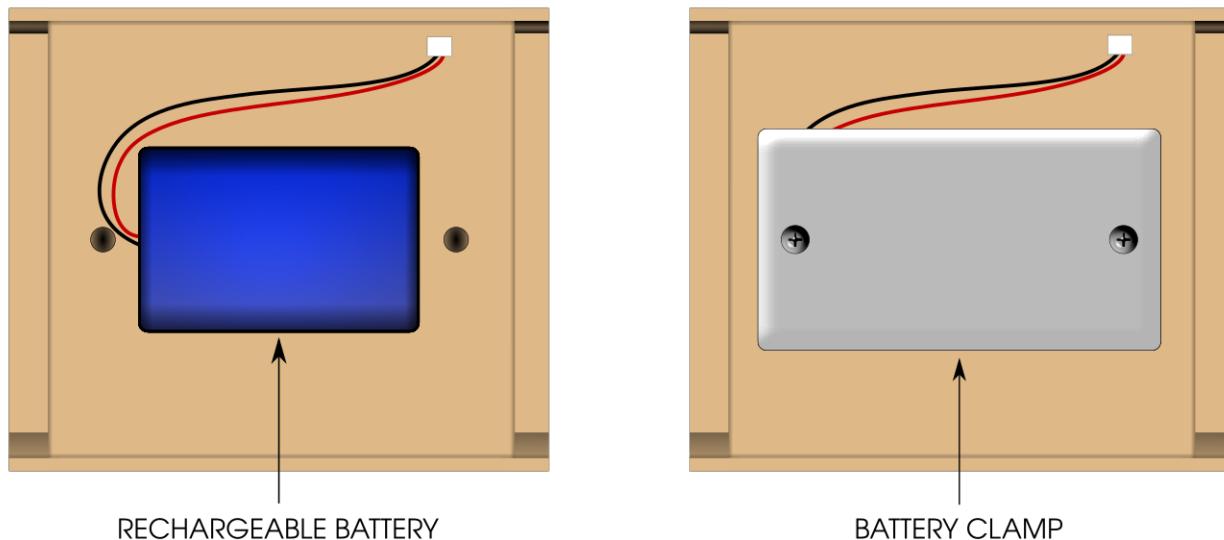


Figure 3.1: Bottom

3.1 Rechargeable Battery

The RECHARGEABLE BATTERY is a nominal **3.7 V, 6600 mAh** Lithium Ion battery pack. It is the primary power source when the device is unplugged and switched ON. With music playing, the charge should last about a day.

4 Sides

The SIDES house the speakers and are where the screws that secure the enclosure are.

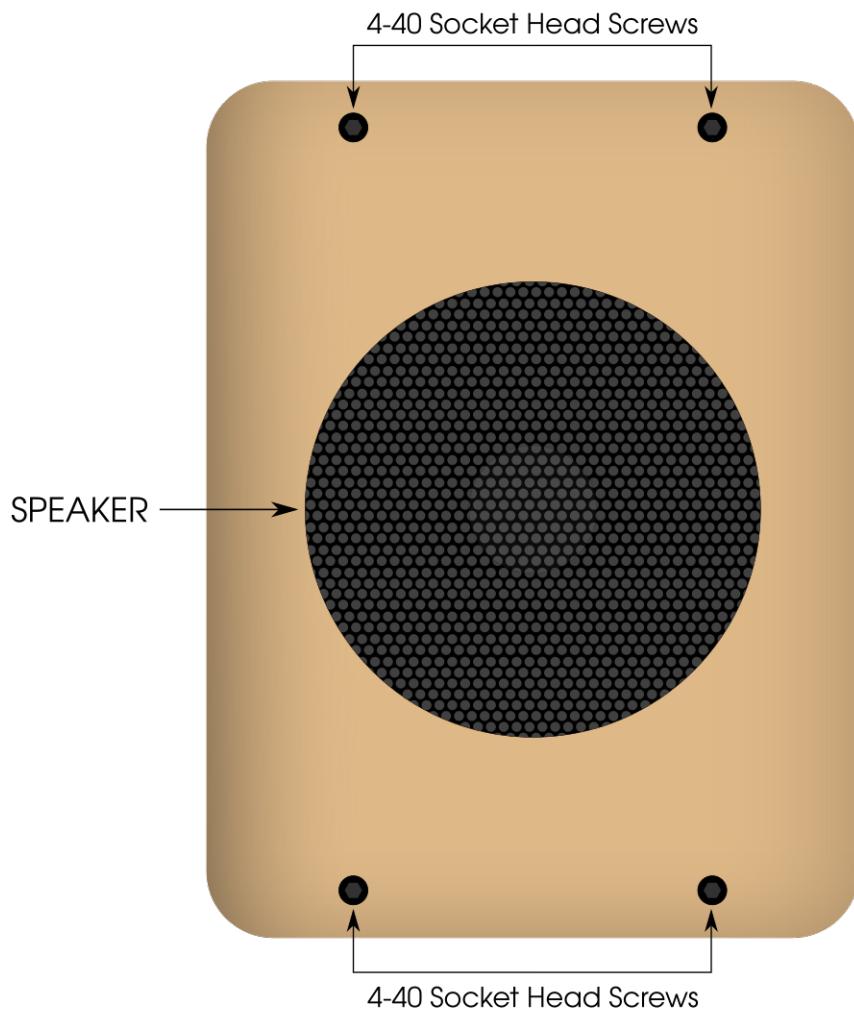


Figure 4.1: Side

4.1 Speakers

The 2 speakers, one on each side, are **8 Ω, 2W, 99 dB** with paper cone and ferrite magnet. They are used in conjunction with the [AUDIO](#). The grills are made of **1/32"** inch, **24 gauge** perforated

304 stainless steel, painted black.

4.2 Fastening Screws

The screws used to keep the enclosure together are **4-40** Socket Head screws made of Black-Oxide Alloy Steel and have a **3/32"** hex wrench drive size. There are a total of **8** screws with **4** on each side.



Before taking the enclosure apart, please refer to [Disassembly](#).

5 Back

On the BACK of the device is the POWER / CHARGE PORT that is used to both power the device and charge the [RECHARGEABLE BATTERY](#) inside.

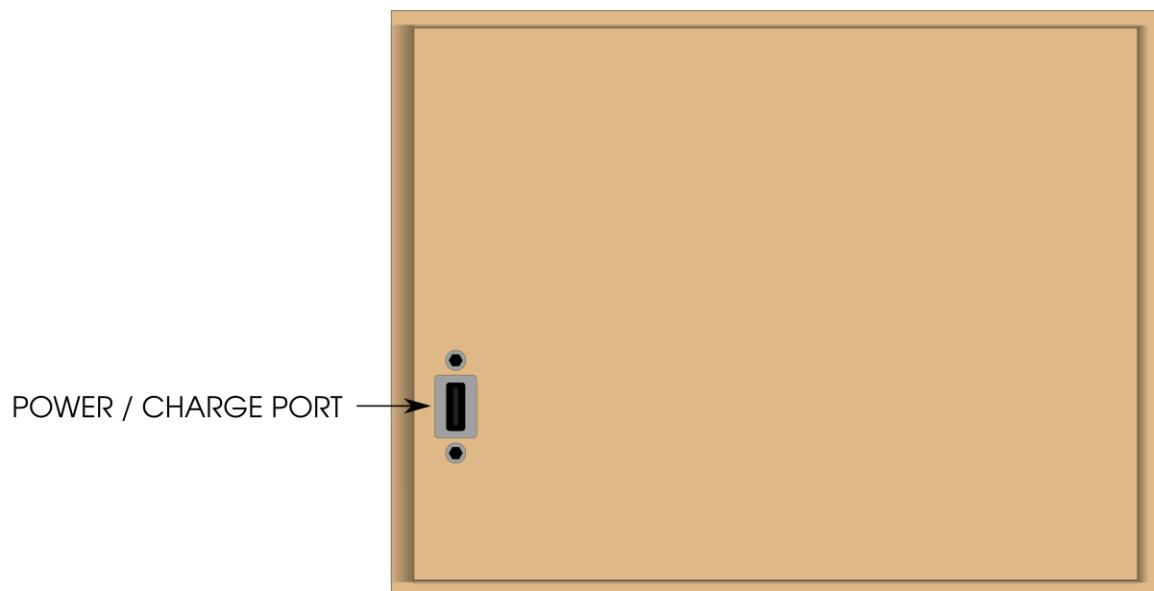


Figure 5.1: Back

The main circuit board is attached on the inside. Of interest are the BEEPER and removable MICRO SD CARD.

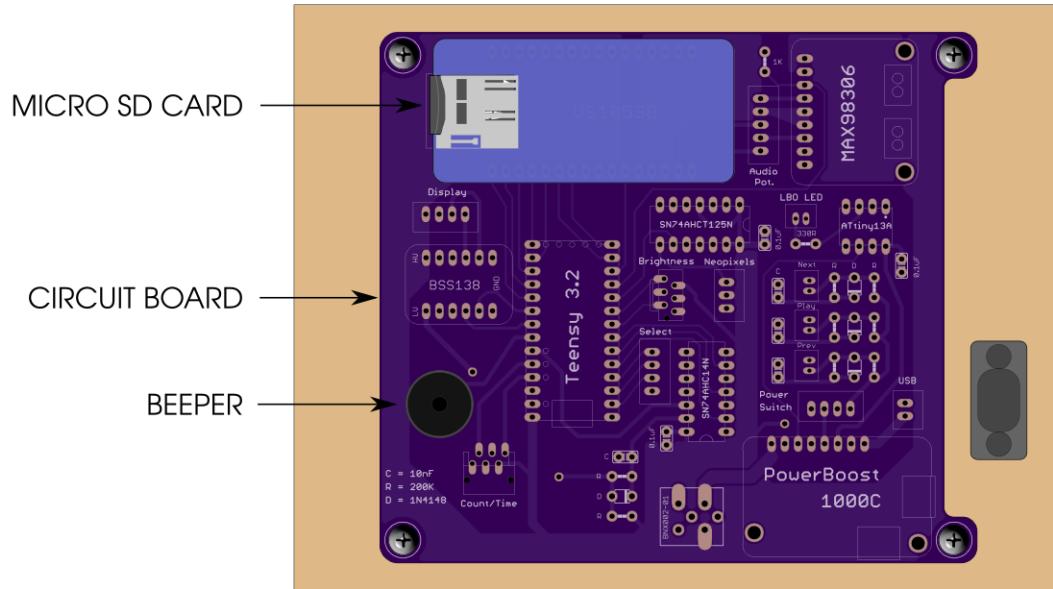


Figure 5.2: Back - Circuit Board

5.1 Power / Charge Port

The POWER / CHARGE PORT is a USB 2.0 MICRO-B port.

A few items of note:

- The device can be ON or OFF when plugging or unplugging the [POWER ADAPTER](#) or other USB cable.
- The device can be ON or OFF while charging.
- The device is fully functional while charging.
- The device never has to be unplugged.

See [Powering & Recharging](#) for more information.

5.2 Beeper

The BEEPER is a **2.3 kHz** magnetic single tone buzzer and is used with the [ALARM](#), [TIMER](#) and [TOUCH SETTINGS](#). Note, it will always sound at the same volume since the VOLUME control is not connected to it and can *not* adjust it.

There are two symbols used to reference the BEEPER that are used in later sections.

<i>Symbol</i>	<i>Meaning</i>
	The BEEPER is making sound, i.e. beeping.
	The BEEPER is mute, i.e. <i>not</i> beeping.

5.3 Micro SD Card

The MICRO SD CARD is used as storage for the songs on the device. The MICRO SD CARD that comes preinstalled with the device has a read speed of at least **90 MB/sec** and is formatted with the **FAT32** filesystem using **512** bytes per sector.

6 Accessories

6.1 Power Adapter

The one accessory included is the POWER ADAPTER that is used to both power the device and charge the [RECHARGEABLE BATTERY](#). It is a **5.25 V, 2.4 A** switching AC/DC power adapter that terminates with a USB 2.0 MICRO-B connector that plugs into the [POWER / CHARGE PORT](#). It can accept either **110** or **240 VAC** mains so works in the US as well as other countries.

If this needs to be replaced, the replacement *must* be a **5 V** AC/DC adapter (or **5.25 V** if you can find one).



An adapter that is **6 V, 9 V, 12 V** or above *will* damage the device.



An adapter that is less than **5 V** will not be able to power the device and it *will* malfunction.

The adapter should be rated for at least **1 A** and no more than **2.5 A**.

7 Powering & Recharging

The device can be both powered and charged using either the supplied [POWER ADAPTER](#) or a *USB 2.0 Standard Type-A Male to Micro Type-B Male* cable.

USB 2.0 MICRO-B is asymmetric and can only be plugged in one way.



Figure 7.1: USB 2.0 Micro-B

The figure below indicates how the USB 2.0 Micro-B plug should be oriented when *facing* the [POWER / CHARGE PORT](#).

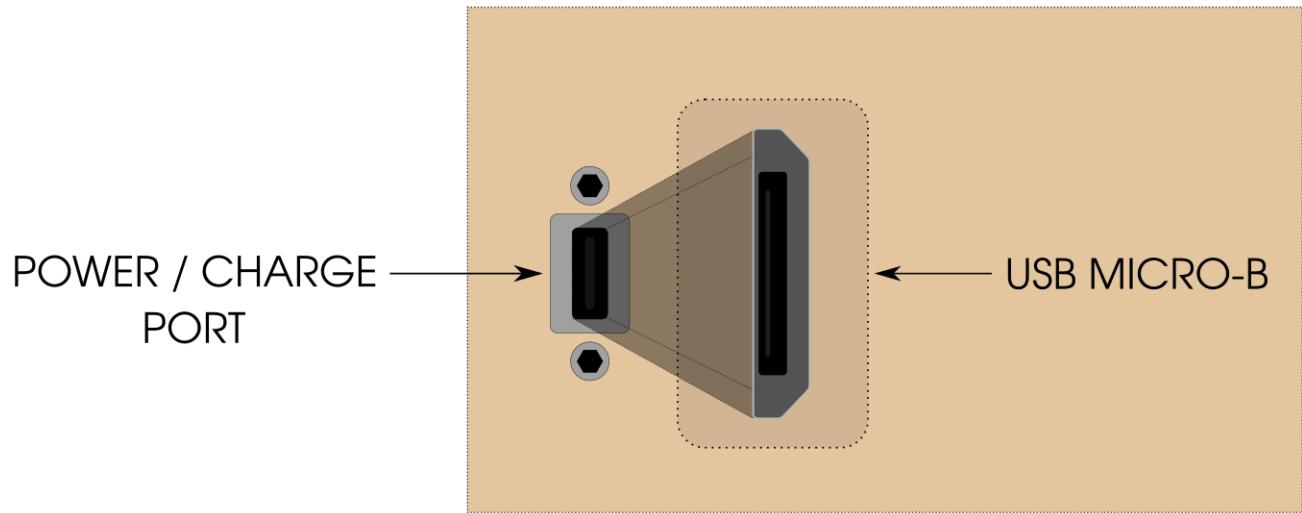


Figure 7.2: USB 2.0 Micro-B → Power / Charge Port Orientation

Using the supplied POWER ADAPTER, plug the USB 2.0 MICRO-B end into the POWER / CHARGE PORT on the BACK of the device and the 2-prong end into a wall or power strip receptacle.

If a *USB 2.0 Standard Type-A Male to Micro Type-B Male* cable is used, connect the Micro-B end into the POWER / CHARGE PORT and the Standard Type-A end into the USB port on a computer or USB hub.

7.1 Recharging

The **LOW BATTERY INDICATOR** will light up when the device needs to be recharged. Unfortunately there is no way to indicate that the battery has finished charging. Using the supplied **POWER ADAPTER**, it should take about 8 hours to charge if the LOW BATTERY INDICATOR is signaling - plug it in before going to bed and it should be charged by the time you wake up. When using a *USB 2.0 Standard Type-A Male to Micro Type-B Male* cable, charging may take longer since USB ports on a computer generally do not supply as much current as the POWER ADAPTER will.

II

Operation

8 Modules

8.1 Introduction

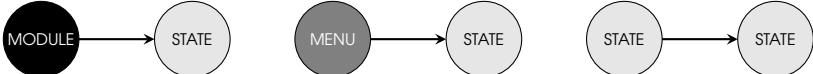
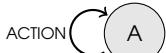
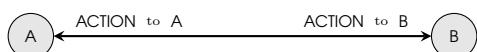
There are a number of functions that the device performs. Each set of functionality will be called a *module*. There are some modules that are always active and some that can only be active at one time. Those that are always active will be called *components*. Those that can only be active at one time will be called *modes*.

<i>Components</i>	AUDIO ALARM POWER CLOCK SET ALARM TIMER
<i>Modes</i>	SET CLOCK POWER SETTINGS TOUCH SETTINGS SET NIGHT LIGHT

Table 8.1: Modules

8.2 State Diagrams

At the end of each module section will be a diagram showing the states it can be in and the movement from one state to another and actions triggering the movement. The following table shows and describes the diagram elements.

<i>Symbol</i>	<i>Meaning</i>
	An element that is a MODULE , i.e. a MODE or COMPONENT .
	An element that is a MENU option available in certain modes. A menu state will contain a number options that will branch to different states.
	An element that is a STATE that a mode or component can be in.
	<p>A <i>unidirectional</i> or one-way path or flow from one element to the same or different element.</p>  <p>One or more actions may be associated with the path, i.e. will trigger the movement from one element to another. Either a symbol or text may be located next to or near the path line indicating the action that triggers the movement.</p> 
	<p>A state can have a path that points to itself. There may be output or effects due to the action but the state does not change.</p>  <p>A <i>bidirectional</i> or two-way path or flow between two elements.</p> <p>One or more actions may be associated with the path, i.e. will trigger the movement between the two elements. Either an action symbol or text will be located next to or near the path line indicating the action that triggers the movement.</p> 
	<p>If there is more than one action associated with the path, the action <i>nearest the arrow</i> is what determines the path or flow <i>in the direction of the arrow</i>.</p> 

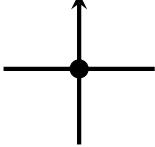
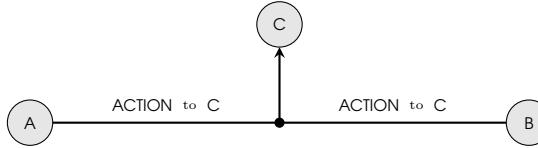
	<p>A <i>node</i> that combines two or more unidirectional paths from two or more states into one unidirectional path to one state.</p> <p>Each path leading into the node will have an action associated with it. The actions may be the same or different, but the resulting state will be the same.</p>  <pre> graph LR A((A)) -- ACTION to C --> Node(()) B((B)) -- ACTION to C --> Node Node --> C((C)) </pre>
---	--

Table 8.2: State Diagram Symbols

8.3 Components

A component is a module that is enabled and running at all times unless explicitly disabled. Components all run and function concurrently and are independent of any mode the device might be in.

There are **3** components each described in individual sections.

<i>Component</i>	<i>Description</i>
AUDIO	Provides the functionality related to track selection and playback.
ALARM	Contains the functionality related to alarm waking, snoozing and stopping and remains active in all power states.
POWER	Governs device power states and when the device should nap, sleep or auto-stop the audio.

8.4 Modes

A mode is a device state containing specific functionality. The device can be in *one and only one* mode at a time. There are **7** modes each described in individual sections.

<i>Mode</i>	<i>Description</i>
CLOCK	Displays the time. Can display the date and current track. Provides direct selection of a track for playback. Is the only mode where the night light can be turned on and off.
SET ALARM	Set a time of day alarm that is used by the ALARM component.
TIMER	Set and run a timer.
SET CLOCK	Set the time and date.
POWER SETTINGS	Settings related to power consumption that are used by the POWER component.
TOUCH SETTINGS	Settings related to the touch sensing capability of the device.
SET NIGHT LIGHT	Set any of the 3 configurable night light colors.

Modes are selected using the SELECTOR DIAL and the SETTINGS KNOB. They are partitioned into PRIMARY, SECONDARY and TERTIARY.

PRIMARY	CLOCK SET ALARM TIMER
SECONDARY	SET CLOCK POWER SETTINGS
TERTIARY	TOUCH SETTINGS SET NIGHT LIGHT

Table 8.3: Modes

The position of the SELECTOR DIAL avails a subset of modes. When the SELECTOR DIAL is turned, the PRIMARY mode is automatically selected. The SETTINGS KNOB is then used to select SECONDARY and TERTIARY modes.

8.4.1 Settings Modes

Settings that can change value will be *blinking* on the DISPLAY. If there is more than one setting to configure on the DISPLAY at a time as in the case of setting a time or date, the one currently being set will be *blinking* on the DISPLAY.

8.4.2 Modes Diagram

The following diagram illustrates the modes of operation and the actions using the SELECTOR DIAL and SETTINGS KNOB that lead to and from each mode.

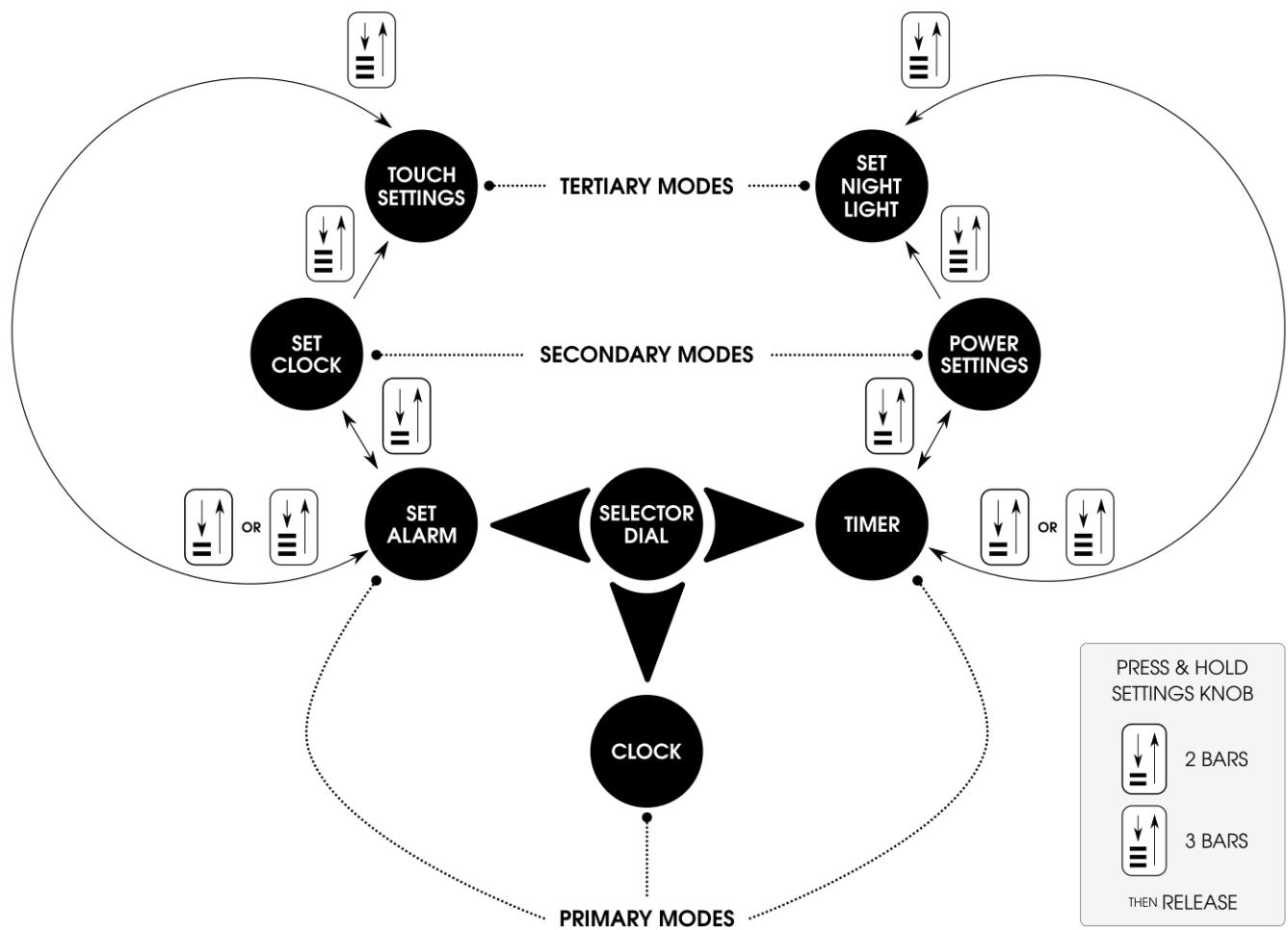


Figure 8.1: Modes Diagram

9 Selector Dial

The SELECTOR DIAL is used to select a subset of available modes. The position determines which modes are available.

<i>Position</i>	<i>Modes</i>		
	PRIMARY	SECONDARY	TERTIARY
	SET ALARM	SET CLOCK	TOUCH SETTINGS
	CLOCK	—	—
	TIMER	POWER SETTINGS	SET NIGHT LIGHT

Table 9.1: Selector Dial - Positions & Modes

Turning the SELECTOR DIAL will automatically set the mode to the PRIMARY mode for the given position. The **SETTINGS KNOB** is then used to select SECONDARY and TERTIARY modes.

There are a number of symbols used to indicate turning actions.

<i>Symbol</i>	<i>Meaning</i>
	Turn from MIDDLE to LEFT.
	Turn from LEFT to MIDDLE.
	Turn from MIDDLE to RIGHT.
	Turn from RIGHT to MIDDLE.
	Turn from LEFT to RIGHT.
	Turn from RIGHT to LEFT.

10 Settings Knob

The SETTINGS KNOB is the primary control for interacting with the device. It can be *turned* and *pressed*.

10.1 Turning

There are *no* start or stop positions when turning and it will turn indefinitely in either direction. While turning, you will notice bumps - termed *detents* - that provide a tactile feel for turning progression.

In general, when setting values:

- Turning *clockwise* will *increase* a value.
- Turning *counter-clockwise* will *decrease* a value.
- Values will *change* at each *detent*.

If you turn past a *minimum* or *maximum*, the value will usually wrap or cycle.

- If a value is at a *maximum*, a *clockwise* turn will circle to the *minimum*.
- If a value is at a *minimum*, a *counter-clockwise* turn will circle to the *maximum*.

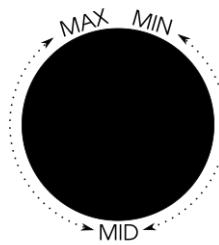
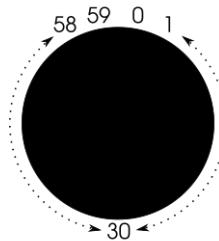


Figure 10.1: Settings Knob Turning

Note that the above figure is not a literal representation of where values will lie in relation to the SETTINGS KNOB. You may have to turn the knob for only a couple of detents to reach a midpoint value or cycle through all of the allowable values. Or you may have to turn for many revolutions. It is meant to show that values are arranged circularly as opposed to linearly.

Consider, for example, setting a minute or second value, where the allowable range is **0-59**. If the current value is **59**, a clockwise turn will cycle to **0**. Likewise if the current value is **0**, a counter-clockwise turn will cycle to **59**.



It can often be quicker to turn in the opposite direction to get to a value.

There are a number of symbols that will be used indicating direction, number of times, not to turn or a failure to turn within a specified amount of time.

<i>Symbol</i>	<i>Meaning</i>
\circlearrowleft	Turn in <i>any</i> direction.
\circlearrowright	Turn <i>clockwise</i> .
\circlearrowleft	Turn <i>counter-clockwise</i> .
\circlearrowleft_N	Turn for at least N detents in any direction. $\circlearrowleft_3 \rightarrow$ Turn until at least 3 detents are felt.
\circlearrowleft_{Ns}	Turn <i>within</i> N seconds. $\circlearrowleft_{3s} \rightarrow$ Turn within 3 seconds.
\otimes	Do <i>not</i> turn.
\otimes_{Ns}	Failure to turn <i>within</i> N seconds. $\otimes_{15s} \rightarrow$ Failure to turn within 15 seconds.

Table 10.1: Settings Knob - Turn Symbols

When the SETTINGS KNOB is turned, you will feel bumps. These are called *detents*. When it is specified to turn N times, it means detents and *not* full rotations. So \textcircled{U}^3 means to turn for at least 3 bumps/detents.

10.2 Pressing

There are 3 main pressing actions.

Action	Abbr.	Description
PRESS & RELEASE	P&R	A relatively quick press & release similar to a computer mouse click.
DOUBLE-CCLICK	DC	Press & release <i>twice</i> in quick succession, similar to a computer mouse double-click.
PRESS & HOLD	P&H	Press and hold for some amount of time, then release.

Table 10.2: Settings Knob Pressing Actions

10.2.1 Press & Release

What action this performs will be dependent on context.

In settings modes, it generally caches a setting and moves to the next setting or if at the last setting, sets and saves all cached settings and finishes.

In other cases, it may turn the alarm off, show the date or pause the timer.

There are a number of symbols that will be used indicating number of times, not to press or a failure to press within a specified amount of time.

<i>Symbol</i>	<i>Meaning</i>
$\downarrow\uparrow$	Press & release <i>once</i> .
$\downarrow\uparrow_N$	Press & release <i>N</i> times. $\downarrow\uparrow_4$ → Press & release 4 times.
$\downarrow\uparrow_{Ns}$	Press & release <i>within N</i> seconds. $\downarrow\uparrow_{4s}$ → Press & release within 4 seconds.
\times	Do <i>not</i> press & release.
\times_{Ns}	Failure to press & release <i>within N</i> seconds. \times_{3s} → Failure to press & release within 3 seconds.

Table 10.3: Settings Knob - Press & Release Symbols

10.2.2 Double-Click

This is currently only used in **SET NIGHT LIGHT** and has one associated symbol.

<i>Symbol</i>	<i>Meaning</i>
$\downarrow\uparrow$	Press & release <i>twice</i> in quick succession.

Table 10.4: Settings Knob - Double-Click Symbol

It is distinguished from $\downarrow\uparrow_N$ in that the second press & release *must* be done very quickly - within **300ms** which is a little less than $\frac{1}{3}$ of a second.

10.2.3 Press & Hold

This pressing action will, in general, do one of the following:

- RESET a settings mode, i.e. allow starting over from the beginning or some origin state.
- Go to SECONDARY or TERTIARY modes - see **SELECTOR DIAL**.
- If currently in a SECONDARY or TERTIARY mode, go back to the PRIMARY mode.

In every mode except CLOCK mode, bars / dashes will be shown and blink on the DISPLAY providing a visual indication to release.

<i>Display</i>	<i>Hold Time</i>	<i>Effect</i>
	1.5 seconds	RESET
	4.0 seconds	CHANGE MODE
	6.5 seconds	

Table 10.5: Settings Knob - Press & Hold

The following table shows the mode changes when the SETTINGS KNOB is pressed and held for two or three bars.

<i>Mode</i>	<i>Display</i>	<i>Next</i>
PRIMARY		SECONDARY
		TERTIARY
SECONDARY		PRIMARY
		TERTIARY
TERTIARY		PRIMARY

Table 10.6: Settings Knob - Press & Hold Modes

For example, to go to **TOUCH SETTINGS** which is a TERTIARY mode and assuming the SELECTOR DIAL is *not* already pointing to the LEFT:

- (1) TURN the SELECTOR DIAL to the LEFT.

(2) PRESS & HOLD the SETTINGS KNOB until you see  blink on the DISPLAY.

(3) RELEASE the SETTINGS KNOB.

To go back to **SET ALARM** which is a PRIMARY mode:

(1) PRESS & HOLD the SETTINGS KNOB until you see  or  blink on the DISPLAY.

(2) RELEASE the SETTINGS KNOB.

There are a number of symbols that will be used indicating press type and duration.

<i>Symbol</i>	<i>Meaning</i>
 N_s	Press & hold for N seconds then release.  $6s$ → Press & hold for 6 seconds then release.
 	Press & hold until  is displayed, then release.
 	Press & hold until  is displayed, then release.
 	Press & hold until  is displayed, then release.

Table 10.7: Settings Knob - Press & Hold Symbols

11 Touch Sensor

The TOUCH SENSOR utilizes [Capacitive Touch Sensing](#) which measures changes in capacitance of an *electrode* to detect touch events. There are a number of functions that the TOUCH SENSOR provides.

Function	Module
Snooze alarm.	ALARM
Show current track number.	CLOCK
Stop timer alerting.	TIMER
Wake the device from nap or sleep.	POWER
Toggle timer lighting on/off.	TIMER
Forcibly put the device to sleep.	POWER

All of the above, except for the last two, can also be done using the SETTINGS KNOB, so if you want or need to disable the TOUCH SENSOR you will not lose much functionality.

When using the touch functionality, it is not enough to simply tap the top with your index finger. You *must* place your *hand* or the majority of your fingers, palm down on the TOP of the enclosure. The figure below shows the general amount of coverage.



Figure 11.1: Touch Sensor - Hand Coverage

See [TOUCH SETTINGS](#) for more information on configuring and calibrating the TOUCH SENSOR.

There are a number of symbols that will be used indicating touch, touch duration, not to touch and failure to touch within some amount of time.¹

<i>Symbol</i>	<i>Meaning</i>
	Touch the top of the enclosure with palm of hand.
	Touch for <i>N</i> seconds.  → Touch for 5 seconds.
	Do <i>not</i> touch.
	Failure to touch <i>within N</i> seconds.  → Failure to touch within 3 seconds.

Table 11.1: Touch Sensor Symbols

¹ Though an outstretched index finger is used in the symbol, the palm of the hand or a majority of the fingers must be used.

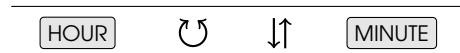
12 Symbols

In addition to expository language, symbols will often be used to describe actions and effects so that one can quickly surmise an action and outcome.

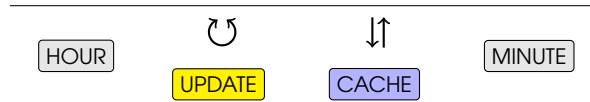
For example, the following steps used in SET CLOCK:

- (1) From the HOUR state, TURN the SETTINGS KNOB to select an hour.
- (2) PRESS & RELEASE the SETTINGS KNOB to cache the selected hour and proceed to the MINUTE state.

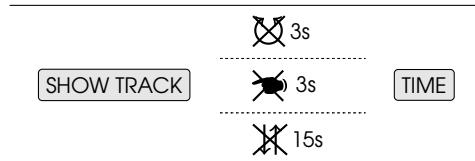
can be summed up using the following sequence of symbols:



Often, an *effect* will be grouped with the *action*:



And sometimes multiple actions will be grouped into one column indicating that *any* one of the actions can bring about the change. For example, the following is used in CLOCK to indicate any of three actions, or rather inactions, that will cause the SHOW TRACK state to go back to the TIME state.



The table below sums up all of the symbols described in the previous sections.

SELECTOR DIAL

<i>Symbol</i>	<i>Meaning</i>
	Turn from MIDDLE to LEFT.
	Turn from LEFT to MIDDLE.
	Turn from MIDDLE to RIGHT.
	Turn from RIGHT to MIDDLE.
	Turn from LEFT to RIGHT.
	Turn from RIGHT to LEFT.

SETTINGS KNOB

<i>Symbol</i>	<i>Meaning</i>
	Turn in <i>any</i> direction.
	Turn <i>clockwise</i> .
	Turn <i>counter-clockwise</i> .
	Turn for at least <i>N</i> detents in <i>any</i> direction.
	$\circlearrowright_3 \rightarrow$ Turn until at least 3 detents are felt.

	Do <i>not</i> turn.
N_s	Failure to turn <i>within N</i> seconds. $\cancel{\otimes}^{15s}$ → Failure to turn within 15 seconds.
$\downarrow\uparrow$	Press & release <i>once</i> .
$\downarrow\uparrow_N$	Press & release <i>N</i> times. $\downarrow\uparrow^4$ → Press & release 4 times.
	Do <i>not</i> press & release.
N_s	Failure to press & release <i>within N</i> seconds. $\cancel{\otimes}^{3s}$ → Failure to press & release within 3 seconds.
$\downarrow\uparrow\uparrow$	Press & release <i>twice</i> in quick succession.
$\downarrow__Ns$	Press & hold for <i>N</i> seconds then release. $\downarrow__6s$ → Press & hold for 6 seconds then release.
$\downarrow__\uparrow$	Press & hold until --- is displayed, then release.
$\downarrow__\uparrow\uparrow$	Press & hold until ==== is displayed, then release.
$\downarrow__\uparrow\uparrow\uparrow$	Press & hold until ===== is displayed, then release.

TOUCH SENSOR

<i>Symbol</i>	<i>Description</i>
	Touch the top of the enclosure with palm of hand.
	Touch for <i>N</i> seconds.  5s → Touch for 5 seconds.
	Do <i>not</i> touch.
	Failure to touch <i>within N</i> seconds.  3s → Failure to touch within 3 seconds.

Table 12.1: Symbols - Reference

III

Components

13 Audio

AUDIO

13.1 Introduction

The left side of the front panel is devoted to AUDIO playback and control. Its functionality is available at all times independent of any mode the device may be in.¹

- It can PLAY and PAUSE the audio files stored on the removable MICRO SD CARD attached to the circuit board.
- You can STOP it for extra power savings when running unplugged.
- It can SKIP forward or backward tracks or rewind the current track.



The DISPLAY is *not* capable of displaying the track *name* being played so track *numbers*^a are displayed instead when applicable.

^a The numbers represent the order on disk and not any kind of album track order.

There is an auto-stop feature that can be enabled via [POWER SETTINGS](#). If in the PAUSE state for a configurable amount of time, the AUDIO will automatically turn off and go into the STOP state.

13.2 Volume

The VOLUME knob controls the volume level of the AUDIO² and has a *white arrow* indicator on the sleeve. Unlike the SETTINGS KNOB and BRIGHTNESS KNOB it does *not* turn indefinitely and stops at the *minimum* and *maximum* positions as indicated below.

- Turn *clockwise* to *increase* the volume.
- Turn *counter-clockwise* to *decrease* the volume.

¹ One exception is during touch calibration - see [TOUCH SETTINGS](#).

² The VOLUME is not connected to the BEEPER so cannot control its volume.



Table 13.1: Volume Control

13.3 Symbols

There are a number of symbols that will be used in the next sections to describe the controls and actions that can be performed.

Controls

<i>Symbol</i>	<i>Description</i>
▶ ■	PLAY PAUSE STOP push-button.
▶	NEXT push-button.
◀	PREVIOUS push-button.

Actions

<i>Symbol</i>	<i>Description</i>
(▶)	Press & Release ▶ ■ to PLAY the AUDIO when it is in the PAUSE or STOP states.
()	Press & Release ▶ ■ to PAUSE the AUDIO when it is in the PLAY state.
(■)	Press & Hold ▶ ■ until STOP is displayed then release to STOP the AUDIO when it is in the PLAY or PAUSE states.
(▶)	Press & Release or Press & Hold ▶ to SKIP forward tracks.



Press & Release or Press & Hold **◀** to REWIND the current track or SKIP backward tracks.

Table 13.2: Audio Symbols

13.4 Play | Pause | Stop

The **▶||■** push-button can PLAY, PAUSE or STOP the AUDIO.

The AUDIO starts in the STOP state when the device is initially switched ON via the POWER SWITCH. To start playback, PRESS & RELEASE.



To PAUSE, PRESS & RELEASE when in the PLAY state.



To resume playback, PRESS & RELEASE when in the PAUSE state.



To STOP the AUDIO when in PLAY or PAUSE states, PRESS & HOLD for **2** seconds and RELEASE when the DISPLAY shows

STOP



Besides the power savings that STOP provides over PAUSE, there is another difference between PAUSE and STOP.

- When resuming from PAUSE, the track will resume playing from the same place as when it was paused.
- When resuming from STOP, the track will start playing from the beginning.

13.5 Next

The ► push-button is used to SKIP forward one or more tracks.

- PRESS & RELEASE to SKIP to the *next* track.
 - The next track number will *not* be shown on the DISPLAY.
- PRESS & HOLD to SKIP *forward* one or more tracks.
 - The longer the push-button is held, the faster tracks will progress.
 - The track numbers *will* be shown on the DISPLAY, for example:



Track #22

- RELEASE when you get to the track you want.



<i>Hold Time</i>	<i>Tracks per Second</i>
First 5 Tracks	1
Next 10 Tracks	2
Next 20 Tracks	4
Next 40 Tracks	8
Next 80 Tracks	16
Next <i>N</i> Tracks	32

Table 13.3: Audio - Next Hold Times



When the device is in the SLEEP power state, ► can *not* wake it - see [POWER](#) for more information and controls that can wake the device from SLEEP.

13.6 Previous

The **◀** push-button is used to SKIP *backward* one or more tracks or REWIND the current track.

- PRESS & RELEASE
 - REWIND the current track if more than $\frac{1}{4}$ of the track has played.
 - Otherwise, SKIP to the *previous* track.
 - The track number will *not* be shown on the DISPLAY.
- PRESS & HOLD to SKIP *backward* one or more tracks.
 - The longer the push-button is held, the faster tracks will progress.
 - The track numbers *will* be shown on the DISPLAY, for example:



Track #8

- RELEASE when you get to the track you want.



<i>Hold Time</i>	<i>Tracks per Second</i>
First 5 Tracks	1
Next 10 Tracks	2
Next 20 Tracks	4
Next 40 Tracks	8
Next 80 Tracks	16
Next <i>N</i> Tracks	32

Table 13.4: Audio - Previous Hold Times



When the device is in the SLEEP power state, **◀** can *not* wake it - see [POWER](#) for more information and controls that can wake the device from SLEEP.

13.7 Track Selection

In addition to using the NEXT and PREVIOUS controls to SKIP forward and backward in order to select a track for playback, there also exists the capability to select a track more quickly and directly when in **CLOCK** mode. The SETTINGS KNOB can be used alone or in combination with TOUCH to do so. Refer to [Show Track](#) and [Set Track](#) in that section for more information.

13.8 Reference

<i>State</i>	<i>Action</i>	<i>Control</i>	<i>Effect</i>	<i>Next</i>
STOP			PLAY AUDIO	PLAY
			SKIP FORWARD	SKIP
			SKIP BACKWARD	
PLAY			PAUSE AUDIO	PAUSE
			SKIP FORWARD	SKIP
			SKIP BACKWARD	
PAUSE			STOP AUDIO	STOP
			RESUME AUDIO	PLAY
			SKIP FORWARD	SKIP
INACTIVITY			SKIP BACKWARD	
		—	STOP AUDIO	STOP

SKIP				
RELEASE				

Table 13.5: Audio - Reference

13.9 State Diagram

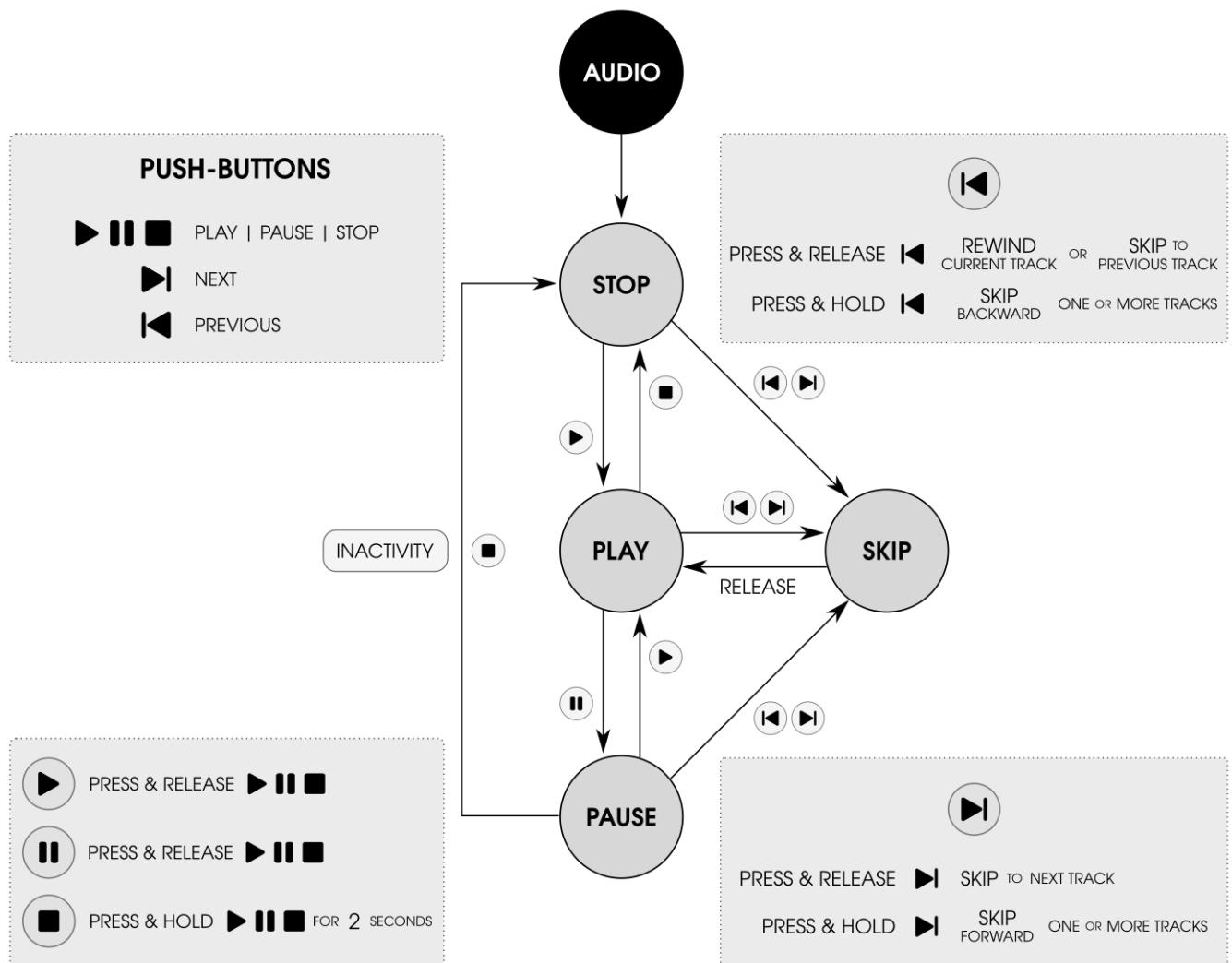


Figure 13.1: Audio - State Diagram

14 Alarm

ALARM

14.1 Introduction

The ALARM is a *time of day* alarm. It runs independent of any mode and can wake the device from any power state. Both the BEEPER and AUDIO can be used as wakeup sources. Refer to [SET ALARM](#) for configuration.

14.2 Disabled

DISABLED

If the alarm is DISABLED, it will stay in the DISABLED state until enabled via [SET ALARM](#).

14.3 Off

OFF

This is the initial and final state if the alarm is enabled. When the current time equals the alarm time, the alarm will start, and either

- (1) Start playing an AUDIO track, or
- (2) Start alerting with the BEEPER

depending on which was configured in SET ALARM. It will then enter the WAKE state.



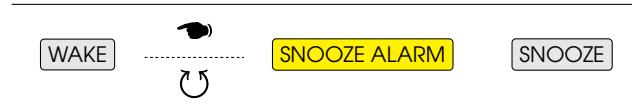
If a track is currently playing when the alarm starts, the beeper will be used regardless of setting - this is so you know that the alarm has started.

14.4 Wake

WAKE

In this state, the BEEPER will alert or the AUDIO will play a track. To SNOOZE the alarm, do one of the following:

- TOUCH the TOP of the enclosure.¹
- TURN the SETTINGS KNOB.



The DISPLAY will show

Snoo

when either of the two above actions are taken.

If a WAKE TIME has been configured and the alarm has been in the WAKE state for longer than that time, the alarm will stop and go to the OFF state.



14.5 Snooze

SNOOZE

The AUDIO will be paused or the BEEPER will stop when the alarm is snoozed. It will resume when the configured SNOOZE TIME has elapsed.



14.6 In Progress

IN PROGRESS

This includes both the WAKE and SNOOZE states. To stop the alarm, PRESS & RELEASE the SETTINGS KNOB.

The DISPLAY will show

OFF

¹ This assumes that touch has been enabled via [TOUCH SETTINGS](#).

when the above action is taken.



If a TOTAL ALARM TIME has been configured and the alarm has been IN PROGRESS for more than this time, it will turn off and go to the OFF state.



In either case, the alarm will automatically reset for the next day.

14.7 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
DISABLED	—	—	—
OFF	TIME = ALARM TIME	START ALARM	WAKE
WAKE	⌚ ⟳ ↓ WAKE TIME EXCEEDED TOTAL ALARM TIME EXCEEDED	SNOOZE ALARM STOP ALARM	SNOOZE OFF
SNOOZE	SNOOZE TIME EXPIRED ↓ TOTAL ALARM TIME EXCEEDED	WAKE ALARM STOP ALARM	WAKE OFF

Table 14.1: Alarm - Reference

14.8 State Diagram

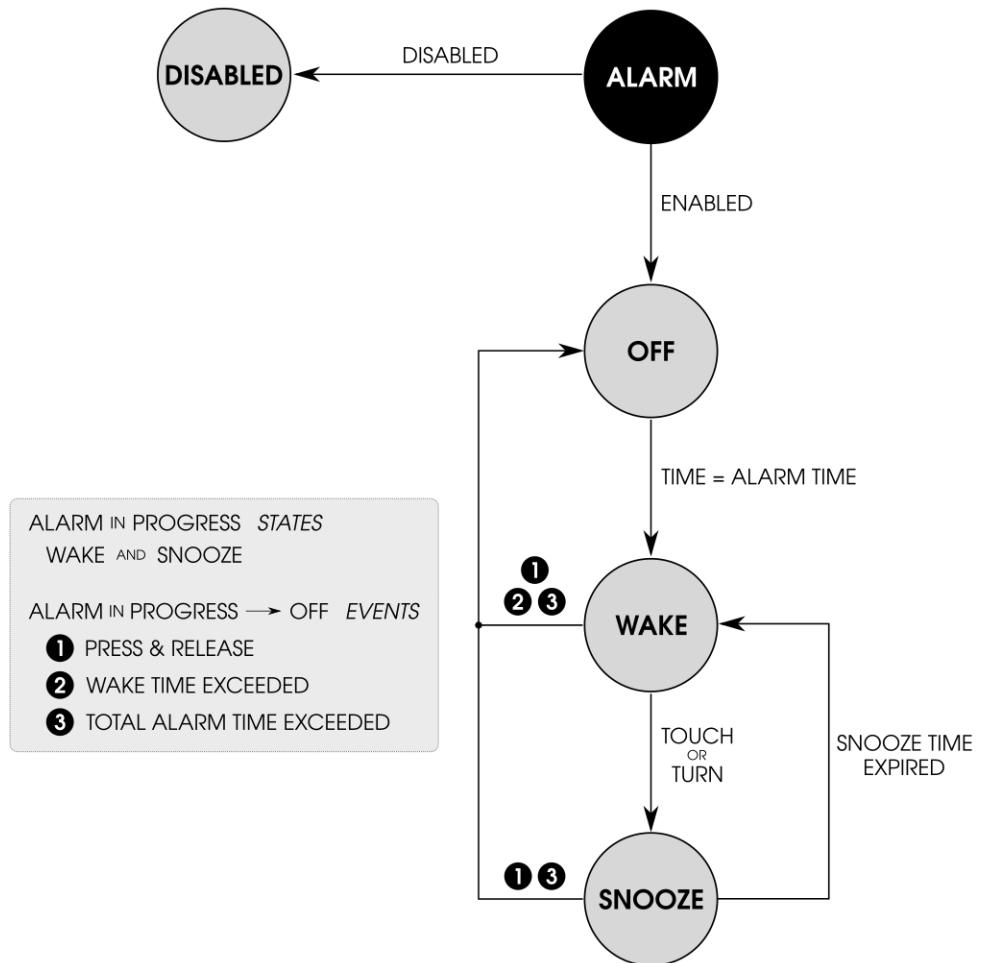


Figure 14.1: Alarm - State Diagram

15 Power

POWER

15.1 Introduction

In order to prolong battery charge, the DISPLAY and LIGHTING can, depending on mode, turn OFF or DIM after a configurable period of inactivity. The device can also enter a low power SLEEP state to further reduce power consumption and auto-stop the AUDIO if it isn't being used. See [POWER SETTINGS](#) for configuration.

15.2 Wake

WAKE

This is the normal operating state and also is the most power consumptive. The DISPLAY is ON and the LIGHTING window is potentially lit, both at the brightness level as determined by the BRIGHTNESS KNOB.

Any kind of activity or interaction with the controls of the device will either wake it or keep it awake.

- TOUCH the TOP of the device.¹.
- TURN the SELECTOR DIAL.
- TURN or PRESS the SETTINGS KNOB.
- TURN the BRIGHTNESS KNOB.
- PRESS the PLAY | PAUSE | STOP, NEXT or PREVIOUS push-buttons.



If in the SLEEP state, neither the NEXT nor the PREVIOUS push-buttons can wake it though they will keep it from going into a SLEEP state.



When in TOUCH SETTINGS mode and the power state is NAP, TOUCH will not wake it.

¹ Assumes touch capability has been enabled via [TOUCH SETTINGS](#).

Action	Control
TURN	SELECTOR DIAL
	SETTINGS KNOB
	BRIGHTNESS KNOB
PRESS	SETTINGS KNOB
	PLAY PAUSE STOP
	NEXT ²
TOUCH	PREVIOUS ³
	TOUCH SENSOR ⁴

Table 15.1: Power - Waking Control Actions

Additionally, the ALARM will wake the device from any power state. It will also keep it from entering a SLEEP state as long as it is in the WAKE state and actively alerting or playing music or IN PROGRESS and the wakeup source is the AUDIO.

15.3 Nap

NAP

The device will NAP if a nap timer has been enabled via [POWER SETTINGS](#) and the following conditions are met:

- You are *not* actively using the device, i.e. not interacting with it or fiddling with the controls.
- The nap timer is enabled and the configured nap timer has elapsed.

The nap timer is started from the last time the device was interacted with. For example, if the SETTINGS KNOB was just turned, the timer will start from that point. As long as you are interacting with the device, it will *not* NAP.

The screens will either DIM or turn OFF depending on the current mode and state.

² The NEXT push-button will *not* wake if sleeping.

³ The PREVIOUS push-button will *not* wake if sleeping.

⁴ Touch will *not* wake when napping and in TOUCH SETTINGS mode.

<i>Mode</i>	<i>State</i>	<i>Screens</i>
CLOCK	ANY	DIM
TIMER	RUN	DIM
	ALERT	
TOUCH SETTINGS	ALL OTHER STATES	OFF
	BASELINE RUN	
	TOUCH RUN	DIM
	TOUCH & READ	
	TEST & ADJUST	
ALL OTHER MODES	ALL OTHER STATES	OFF
	ANY	OFF

Table 15.2: Power - Nap Action per Mode

15.4 Sleep

SLEEP

When the device sleeps, the screens will turn OFF, the AUDIO will go into the STOP state and all processing stops affording more power savings over NAP.

The device will SLEEP if a sleep timer has been enabled via [POWER SETTINGS](#) and *all* of the following conditions are met:

- You are not actively using the device, i.e. not interacting with it or fiddling with the controls.
- The AUDIO is *not* in the PLAY state.
- The ALARM is *not* in the WAKE state.
- The ALARM is *not* IN PROGRESS when the wakeup source is AUDIO.
- The current state in the current mode allows SLEEP.
- The sleep timer is enabled and the configured sleep timer has elapsed.

The sleep timer is started from the last time the device was interacted with. For example, if the NEXT push-button is being pressed, the timer will start from that point. As long as you are interacting with the device, it will *not* SLEEP.

The timer is also restarted if the AUDIO is playing or the ALARM is alerting. As long as the AUDIO is in the PLAY state or the ALARM is in the WAKE state, the device will *not* SLEEP.

Additionally, if the ALARM is IN PROGRESS, i.e. in the WAKE or SNOOZE states *and* the wakeup source is the AUDIO, the device will *not* SLEEP. When the wakeup source is the AUDIO and the ALARM is snoozed, the AUDIO is *not* stopped, but paused. Since the SLEEP state will STOP the AUDIO, the device will *not* SLEEP in this situation.



Though the NEXT and PREVIOUS push-buttons can keep the device from entering a SLEEP state, they can *not* wake the device from SLEEP.

Some modes can be in states that do *not* allow the device to enter a SLEEP state. The following table shows which modes and states can and cannot enter a SLEEP state.

<i>Mode</i>	<i>State</i>	<i>Can Sleep?</i>
TIMER	RUN	NO
	ALERT	
	ALL OTHER STATES	YES
TOUCH SETTINGS	BASELINE RUN	
	TOUCH RUN	NO
	TOUCH & READ	
	TEST & ADJUST	
	ALL OTHER STATES	YES
ALL OTHER MODES	ANY	YES

Table 15.3: Power - Sleep per Mode & State

Any mode or state that can not SLEEP will instead NAP and DIM the screens.

<i>Mode</i>	<i>State</i>	<i>Action</i>
TIMER	RUN	
	ALERT	
TOUCH SETTINGS	BASELINE RUN	SLEEP → NAP
	TOUCH RUN	
	TOUCH & READ	
	TEST & ADJUST	

Table 15.4: Power - Sleep to Nap

15.4.1 Touch Sleep

The device can be *forced* into a SLEEP state by *continuously* touching the TOP of the device for a configurable amount of time set via [POWER SETTINGS](#). Though the sleep timer is reset when touched, it is irrelevant if this touch time is exceeded. Since the device is forced into a SLEEP state, the AUDIO will be *forced* into the STOP state.



For touch induced sleep to work, TOUCH must be enabled via [TOUCH SETTINGS](#) and the palm of your hand or most of your fingers must lay on TOP of the enclosure.

15.5 Audio Auto-Stop

The AUDIO component will automatically STOP if a stop timer has been enabled via [POWER SETTINGS](#) and *all* of the following conditions are met:

- You are not actively using the device, i.e. not interacting with it or fiddling with the controls.
- The AUDIO is in the PAUSE state.
- The ALARM is *not* IN PROGRESS *or* is *not* using the AUDIO as the wakeup source.
- The stop timer is enabled and the configured stop timer has elapsed.

The stop timer is started from the last time the device was interacted with. For example, if the BRIGHTNESS KNOB was just turned, the timer will start from that point. As long as you are interacting with the device, the AUDIO will *not* be auto-stopped.

The timer is also restarted if the AUDIO is playing or the ALARM is IN PROGRESS, i.e. in the WAKE or SNOOZE states *and* the wakeup source is the AUDIO. As long as these conditions are true, the device will *not* auto-stop the AUDIO.

15.6 State Diagram

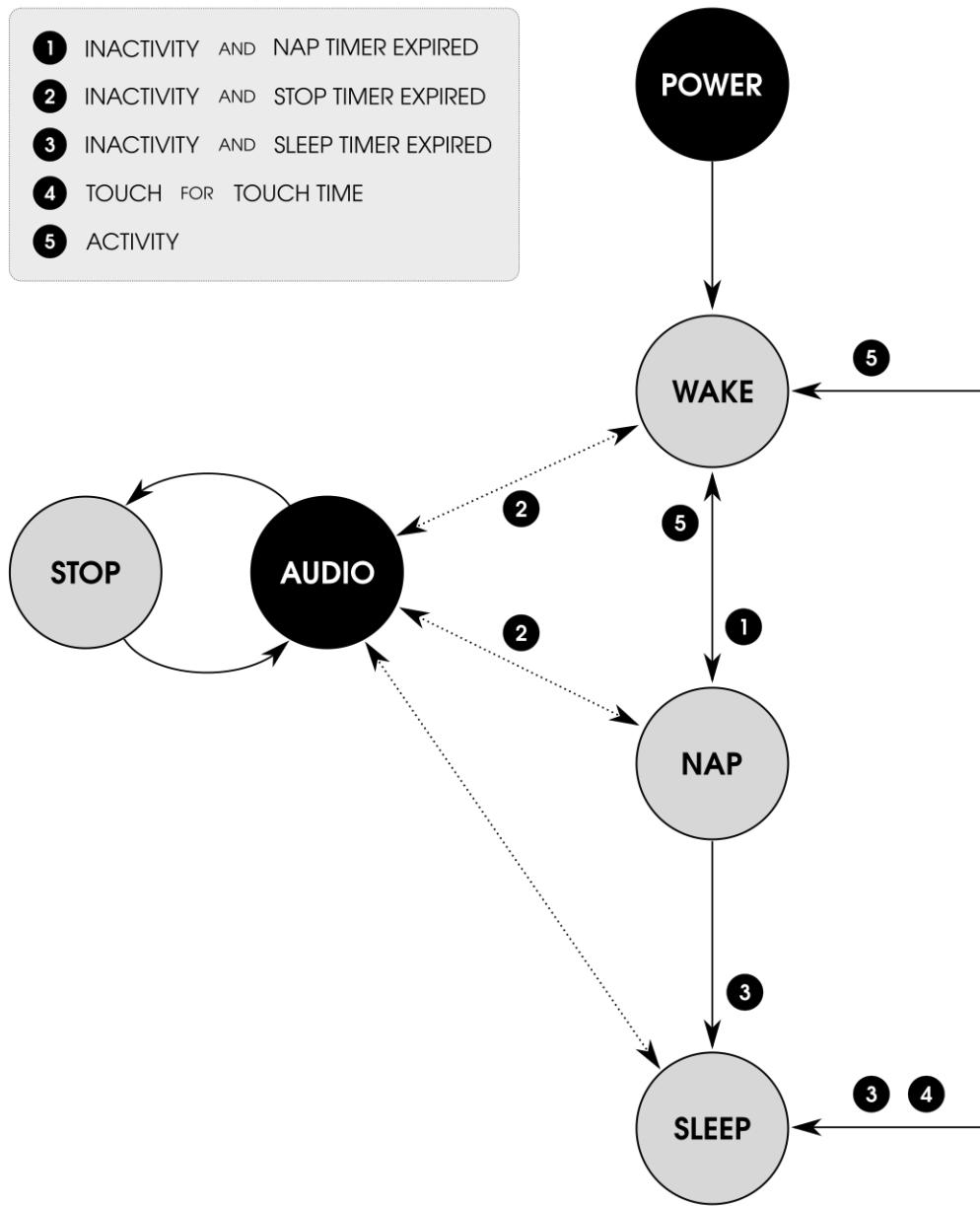


Figure 15.1: Power - State Diagram

IV

Primary Modes

16 Clock

CLOCK

16.1 Introduction

This is the mode the device will likely be in a majority of the time. It displays the current time and can display the date and current track number and provides the capability to directly select a track for playback. It is also the only mode where you can turn the night light on and off.

It is the PRIMARY and *only* mode when the SELECTOR DIAL is in the MIDDLE position.

To get to CLOCK mode simply TURN the SELECTOR DIAL to the MIDDLE.

<i>Position</i>	<i>Mode</i>	<i>Action</i>
	ANY	
		
	CLOCK	—

Table 16.1: Clock - Mode

16.2 Overview

There are a number of states the CLOCK can be in and are explained in the following sections.

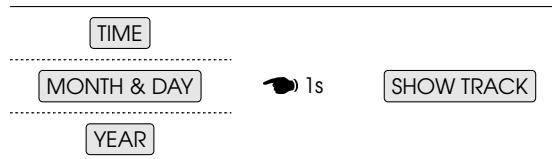
<i>State</i>	<i>Description</i>
TIME	Display the current time.
MONTH & DAY	Display the month & day.
YEAR	Display the year.
SHOW TRACK	Display the current track.
SET TRACK	Select a track for playback.

Table 16.2: Clock - States

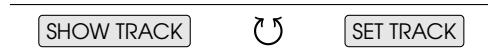
To progress through the states, **PRESS & RELEASE** the SETTINGS KNOB. The basic progression from TIME back to TIME is:



TOUCH can also be used to show the current track. From TIME, MONTH & DAY or YEAR, you will TOUCH the TOP of the enclosure for 1 second to show the current track.¹

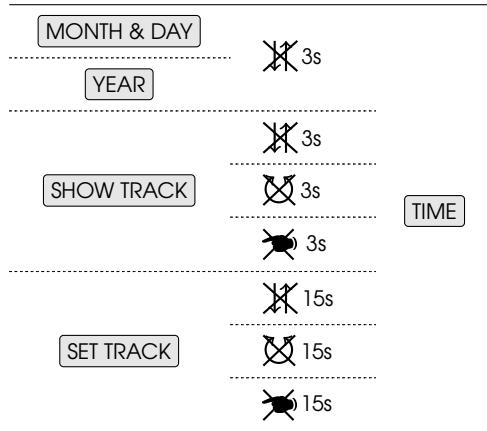


At SHOW TRACK, if you TURN the SETTINGS KNOB, the state will change to SET TRACK and from there you can select a track for playback.



If no action is taken, states other than TIME will only display their values for so many seconds before redisplaying the time.

¹ Touch must be enabled and configured for this to work - see [TOUCH SETTINGS](#) for more information.



16.3 Time

TIME

Displays the current time in either **12** or **24** hour format, depending on which was configured via **SET CLOCK**. For **12** hour format, a *decimal* at the *bottom right* of the DISPLAY is used to designate **PM**.

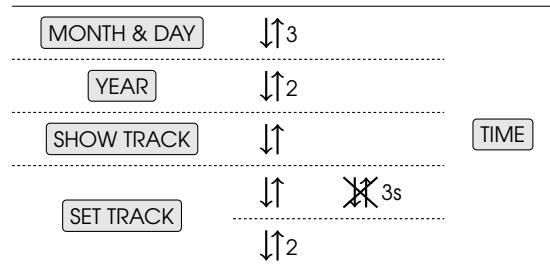
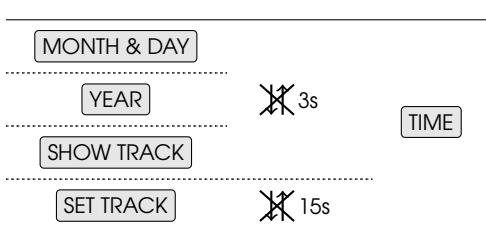
11:00

11 AM

11:00.

11 PM

This is the base state of **CLOCK** mode and will be the first when **CLOCK** mode is selected. If you go to any other state, you will either need to wait some amount of time, either **3** or **15** seconds, or **PRESS & RELEASE** the **SETTINGS KNOB** one or more times. If in **SET TRACK**, after **PRESS & RELEASE**, the time will redisplay after **3** seconds. Alternatively, you can **PRESS & RELEASE** twice to have it redisplay immediately.



16.4 Month & Day

MONTH & DAY

Displays the month and day, delimited by a *decimal*.

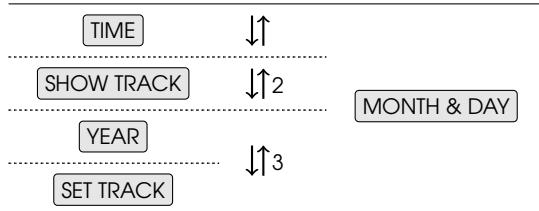
10 1

January 1st

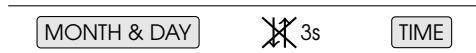
12.3 1

December 31st

To display the month and day from TIME, simply PRESS & RELEASE the SETTINGS KNOB. From other states, you need to PRESS & RELEASE the SETTINGS KNOB multiple times.



If you don't PRESS & RELEASE the SETTINGS KNOB again within **3** seconds, the time will automatically redisplay.



16.5 Year



Displays the year.

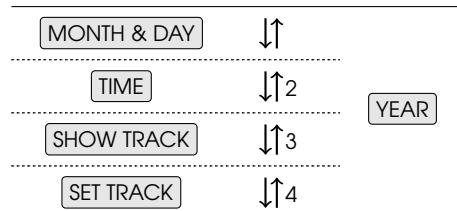
2017

Year 2017

9999

Year 9999

To display the year from MONTH & DAY, simply PRESS & RELEASE the SETTINGS KNOB. From other states, you need to PRESS & RELEASE the SETTINGS KNOB multiple times.



If you don't PRESS & RELEASE the SETTINGS KNOB again within **3** seconds, the time will automatically redisplay.



16.6 Show Track



Displays the current track number that is either playing or poised to play if paused or stopped.

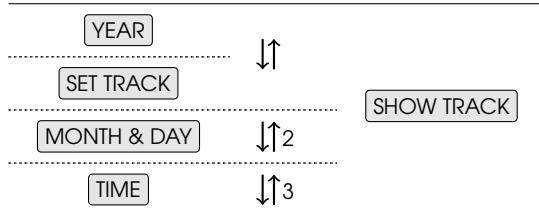
1

Track #1

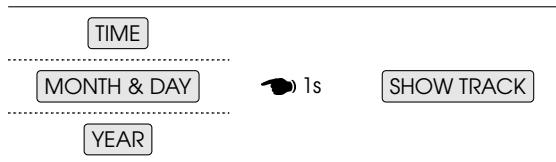
4096

Track #4096

To display the current track from YEAR, simply PRESS & RELEASE the SETTINGS KNOB. Additionally, after SET TRACK, the state goes back to SHOW TRACK. From other states, you need to PRESS & RELEASE the SETTINGS KNOB multiple times.

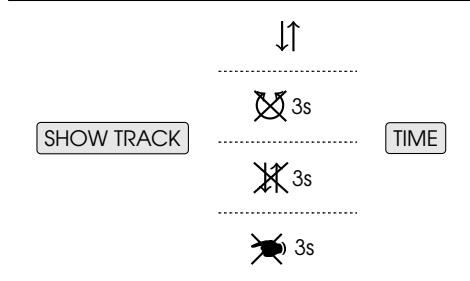


TOUCH can also be used to display the current track from TIME, MONTH & DAY and YEAR. To do so, TOUCH the TOP of the enclosure for **1** second.



For TOUCH to work, make sure you have enabled it via [TOUCH SETTINGS](#) and that the palm of your hand or most of your fingers lay across the top of the enclosure.

If you don't PRESS & RELEASE or TURN the SETTINGS KNOB within **3** seconds after showing the track or aren't touching the top, the time will automatically redisplay. If you PRESS & RELEASE before a TURN, it will immediately go back to TIME.



It will stay in this state as long as touch is detected².

16.7 Set Track



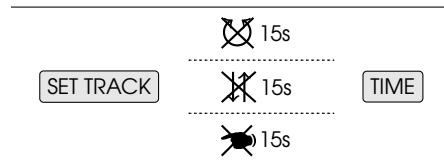
Allows you to select a track for playback. This can be done irrespective of AUDIO state - it can be in PLAY, PAUSE or STOP. This method of selection is also independent of the AUDIO controls - PRESS & RELEASE here will refer to the SETTINGS KNOB and *not* the PLAY | PAUSE | STOP push-button.

² If you have enabled a *Touch Time* via [POWER SETTINGS](#), the screens will turn off and the device will sleep if the *Touch Time* is exceeded.

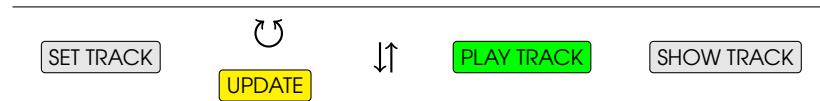
To select a track for playback, you first need to SHOW TRACK. After that, you need to TURN the SETTINGS KNOB within 3 seconds else it will go back to TIME.



The idle timeout will be updated to 15 seconds after which it will go back to TIME. As long as you are turning the SETTINGS KNOB or touching the top of the enclosure the timeout will not occur - it is reset with each turn and while detecting touch.



Continue to TURN the SETTINGS KNOB until you land on the track number you want to play - if you turn counter-clockwise past the first track, the number will wrap to the last track on disk and if you turn clockwise past the last track, the number will wrap to the first track. When you're ready, PRESS & RELEASE the SETTINGS KNOB and the selected track will begin to play and the state will go back to SHOW TRACK.



From SHOW TRACK you can choose to select another track for playback or go back to displaying the time. To go back to TIME, either

- (1) PRESS & RELEASE the SETTINGS KNOB, or
- (2) Wait 3 seconds.

16.8 Night Light

One of the main uses of the LIGHTING window is as a night light. The night light can only be turned on or off from CLOCK mode. To toggle the night light on/off, PRESS & HOLD the SETTINGS KNOB for approximately 2 seconds. This is an equivalent hold time for a RESET, however bars will *not* blink on the DISPLAY.



If the LIGHTING is off, it will turn on³ and if on, it will turn off.



Toggling the night light on/off can be done from *any* state and will not affect, most importantly, track selection.

³ The brightness is independent of this so make sure the BRIGHTNESS KNOB is turned up.

In addition to a white light, up to **3** additional colors are configurable via [SET NIGHT LIGHT](#). To select a different night light color, with the night light on, TURN the SETTINGS KNOB.



Because this requires turning the SETTINGS KNOB, it can only be done in TIME, MONTH & DAY and YEAR states.

Note that only unique colors are considered, so if you haven't configured any of the additional colors there will be no effect. Also, duplicate colors are removed from the cycle.



Another way you can achieve turning the night light on and off is to set one of the configurable colors to black. You can then TURN the SETTINGS KNOB to select it, effectively turning the night light off.

16.8.1 Lighting Animations

There are a number of preset, non-configurable lighting animations, in addition to the solid colors, that you can cycle through. To toggle between a solid color light and the lighting animations, PRESS & HOLD the SETTINGS KNOB for approximately **4** seconds. If the night light is off, it will automatically turn on after **2** seconds as described in the previous section. Continue holding and at **4** seconds it will toggle between a solid color and lighting animation. However, an unfortunate side effect is that if it is on, it will turn off first because of the on/off toggle, then turn back on.



After toggling the animations on, you can cycle through the different ones in the same way you can cycle through the solid colors.

16.9 Coin Cell Battery

There is a **CR2032** coin cell battery, apart from the rechargeable battery, attached to the TOP that continues to keep time even when the device is turned OFF via the POWER SWITCH switch. If the time is incorrect when powering the device ON, the battery may need replacement. For more information see [Replacing the Coin Cell Battery](#).

16.10 Power

In TIME, MONTH & DAY and YEAR, the screens will DIM when the device is in a NAP power state.

In TIME, MONTH & DAY, YEAR and SHOW TRACK, the screens will turn OFF when the device is in a SLEEP power state.

In SET TRACK, the device will neither NAP nor SLEEP.

<i>Power State</i>	<i>Clock State</i>	<i>Screens</i>
NAP	TIME MONTH & DAY YEAR	DIM
	SHOW TRACK SET TRACK	ON
SLEEP	TIME MONTH & DAY YEAR SHOW TRACK	OFF
	SET TRACK	ON

Table 16.3: Clock - Power

16.11 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
TIME	↑	DISPLAY MONTH & DAY	MONTH & DAY
	⌚ 1s	DISPLAY TRACK	SHOW TRACK
	⟳	CYCLE NL	—
MONTH & DAY	↑	DISPLAY YEAR	YEAR
	⌚ 1s	DISPLAY TRACK	SHOW TRACK
	✖ 3s	DISPLAY TIME	TIME
	⟳	CYCLE NL	—

YEAR	↓	DISPLAY TRACK	SHOW TRACK
	⌚ 1s		
	☒ 3s	DISPLAY TIME	TIME
	⟳	CYCLE NL	—
SHOW TRACK	⟳	UPDATE TRACK	SET TRACK
	↓		
	☒ 3s	DISPLAY TIME	TIME
	☒ 3s		
SET TRACK	⟳	UPDATE TRACK	—
	↓	PLAY TRACK	SHOW TRACK
	☒ 15s		
	☒ 15s	DISPLAY TIME	TIME
	☒ 15s		

ANY	 2s	TOGGLE NL ON OFF	—
	 4s	TOGGLE NL COLOR ANIMATION	—
		CHANGE MODE	SET ALARM
			TIMER

Table 16.4: Clock - Reference

16.12 State Diagram

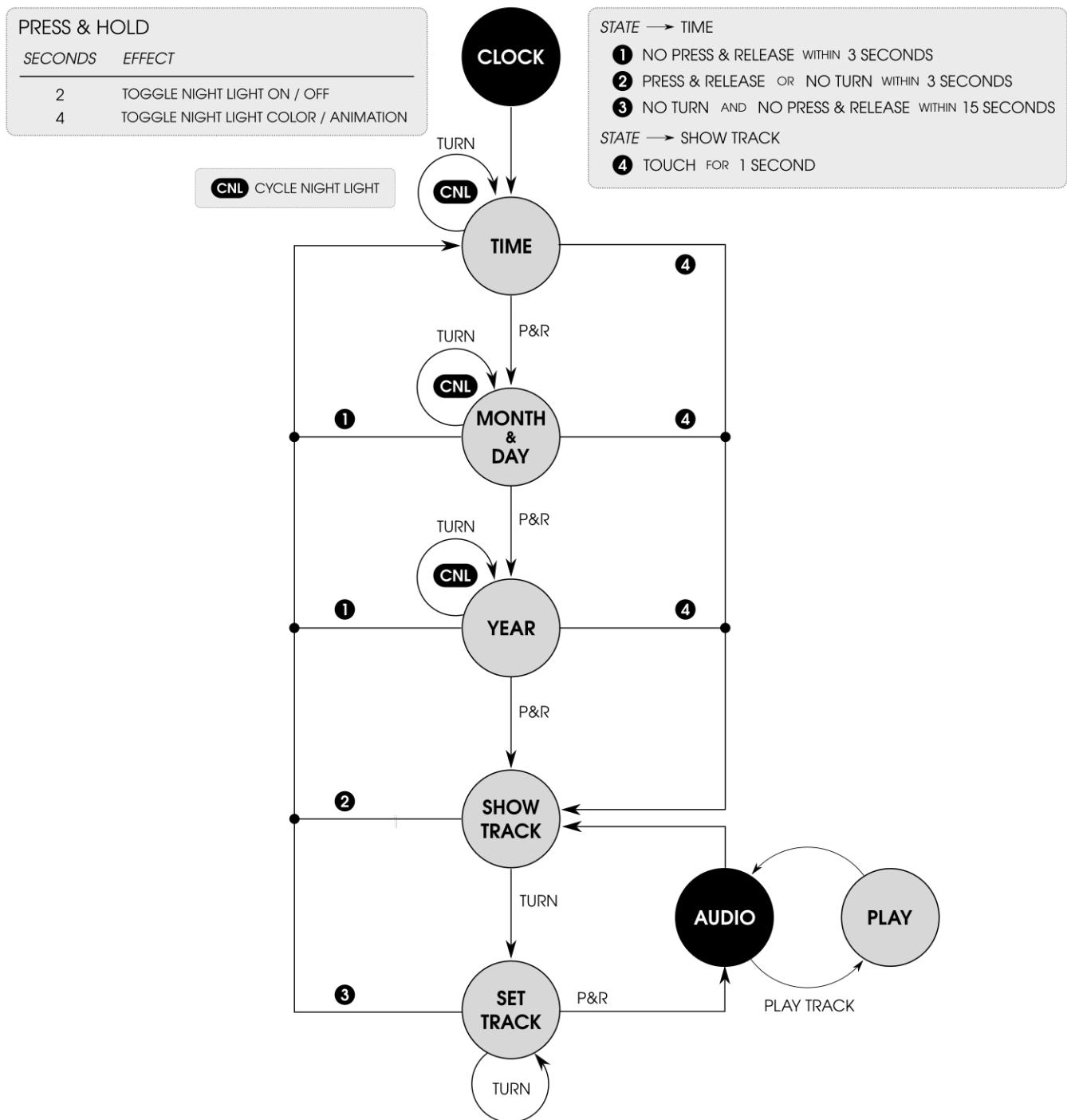


Figure 16.1: Clock - State Diagram

17 Set Alarm

SET ALARM

17.1 Introduction

Allows setting a *time of day* alarm where either the BEEPER or AUDIO can be used as an alarm wakeup source. Additionally it allows for setting the amount of time the alarm will snooze as well as automatic off times for when the alarm has been alerting or IN PROGRESS for too long. The time will be displayed in either **12** or **24** hour format, whichever is used to display the CLOCK.

It is the PRIMARY mode when the SELECTOR DIAL is in the LEFT position. See [ALARM](#) for more information on how the alarm functions.

There are a few ways to get to SET ALARM depending on which direction the SELECTOR DIAL is pointing and which mode the device is currently in.

<i>Position</i>	<i>Mode</i>	<i>Action</i>
	ANY	
	SET CLOCK	
	TOUCH SETTINGS	
	ANY	

Table 17.1: Set Alarm - Mode

A few items of note:

- All previously saved settings will initially be loaded.
- After setting the time of day, you can change mode, and the settings will be saved and the ALARM will be set. This allows for setting the time without having to go through the rest of the settings.
- To RESET, PRESS & HOLD the SETTINGS KNOB until **-----** is blinking on the DISPLAY.
 - (1) If the RESET is done from HOUR, the alarm will be DISABLED and display **OFF**.
 - (2) If done from any other state, it will start over from HOUR.
- When the alarm is DISABLED, PRESS & RELEASE the SETTINGS KNOB to enable the alarm.

17.2 Overview

There are a number of states SET ALARM can be in and are explained in the next sections.

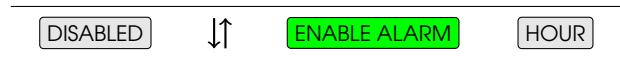
<i>State</i>	<i>Description</i>
HOUR	Set the hour.
MINUTE	Set the minute.
WAKEUP SOURCE	Set the wakeup source - either BEEPER or AUDIO.
SNOOZE TIME	Set the amount of time the alarm will snooze.
WAKE TIME	Set the amount of time the alarm can be alerting before automatically turning off.
TOTAL ALARM TIME	Set the amount of time the alarm can be IN PROGRESS before automatically turning off.
DONE	Display alarm settings.
DISABLED	Alarm is disabled.

Table 17.2: Set Alarm - States

SET ALARM will initially start out in one of two states - HOUR or DISABLED. If the alarm is DISABLED, the display will show



and it will *not* be blinking. To enable the alarm, PRESS & RELEASE the SETTINGS KNOB.



After being enabled, any previously saved settings will be in effect so you do not need to reconfigure the alarm unless you want to change it.

If you want to disable the alarm, from HOUR, perform a RESET, i.e. PRESS & HOLD the SETTINGS KNOB until **-----** is blinking on the display then RELEASE.



The alarm can only be DISABLED from the HOUR state. A RESET from any other state will start over from the HOUR state.

When enabled, to progress through the states, you will TURN the SETTINGS KNOB to select a value, then PRESS & RELEASE the SETTINGS KNOB to cache the setting and move on to the next setting.



When all settings have been configured, the DONE state cycles through and displays each one. It will cycle repeatedly until you PRESS & RELEASE the SETTINGS KNOB.

After setting and caching the MINUTE, you can short circuit the process by changing mode and the alarm will be set and saved.



17.3 Time

Setting the alarm *time of day* happens on one screen of the DISPLAY and is composed of two states - HOUR and MINUTE. The current setting, first HOUR, then MINUTE, will be *blinking*. The time will be displayed in the current format that was chosen in [SET CLOCK](#).

For **12** hour format, a *decimal* at the *lower right* of the DISPLAY is the **PM** indicator.

11:00

11 AM

11:00.

11 PM

A couple of examples in **12** and **24** hour format:

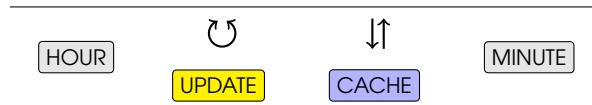
	12 Hour	24 Hour
Seven in the Morning	7:00	07:00
Seven (or 19:00) in the Evening	7:00	19:00

17.3.1 Hour

HOUR

Set the hour when the alarm will start.

To select the HOUR, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to MINUTE.



You can turn in either direction to get to the hour you want to set. The hour will wrap at the 0 and **23** hour marks if the current format is **24** hour.



For **12** hour format, the transitions between **AM** and **PM** when turning clockwise and counter-clockwise from **12 AM** back to **12 AM** are shown below.

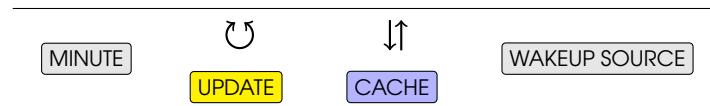


17.3.2 Minute

MINUTE

Set the minute when the alarm will start.

To select the MINUTE, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to WAKEUP SOURCE.



At this point, after caching, you can TURN the SELECTOR DIAL or change mode and the alarm will be set and saved.

17.4 Wakeup Source

WAKEUP SOURCE

Set the wakeup source when the alarm alerts.

Either the BEEPER or AUDIO can be chosen as a wakeup source when the alarm starts or resumes from snoozing.

bEEP

Wake to BEEPER

PLAY

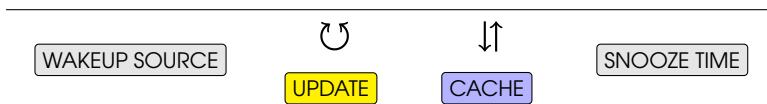
Wake to AUDIO



If the AUDIO is OCCUPIED when the alarm starts, the BEEPER will be used regardless of setting. The AUDIO is considered OCCUPIED if either of the following are true:

- AUDIO is in the PLAY state, *or*
- PLAY | PAUSE | STOP, NEXT or PREVIOUS push-buttons are being PRESSED.

To select the wakeup source, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to SNOOZE TIME.



17.5 Snooze Time

SNOOZE TIME

Set the amount of time in *minutes* the alarm will snooze.

The DISPLAY will show the following

Sn: 10

10 Minutes

and the number on the *right* side of the *colon* will be *blinking*. The time can be set from **1** to **59** minutes.

To select the SNOOZE TIME in minutes, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to WAKE TIME.



17.6 Wake Time

WAKE TIME

Set the amount of time in *minutes* that the alarm can alert for, without being snoozed or manually stopped, before automatically stopping the alarm. Useful if you forget to stop the alarm so it doesn't beep or play music all day.



Set to **0** to DISABLE this setting - the alarm will alert until manually snoozed, stopped or, if enabled, the TOTAL ALARM TIME is exceeded.

The DISPLAY will show the following

On: 10

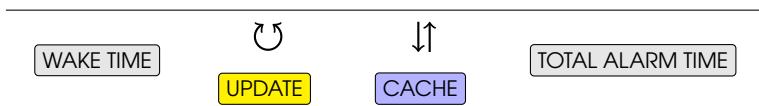
10 Minutes

On: 0

Disabled

and the number on the *right* side of the *colon* will be *blinking*. The time can be set from **0** to **59** minutes with the value **0** being DISABLED.

To select the WAKE TIME in minutes, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to TOTAL ALARM TIME.



17.7 Total Alarm Time

TOTAL ALARM TIME

Set the total amount of time in *hours* that the alarm can be active or IN PROGRESS for after starting before automatically stopping the alarm. Useful if you just don't want to get up in the morning and would otherwise indefinitely snooze it.



Set to **0** to DISABLE this setting - the alarm will stay on, i.e. IN PROGRESS until manually stopped or, if enabled, the WAKE TIME is exceeded during alerting.

The DISPLAY will show the following

AL: 2

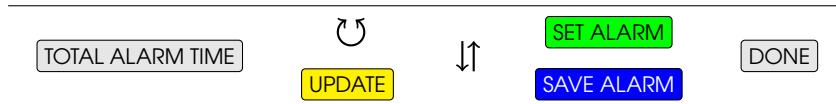
2 Hours

AL: 0

Disabled

and the number on the *right* side of the *colon* will be *blinking*. The time can be set from **0** to **23** hours with the value **0** being DISABLED.

To select the TOTAL ALARM TIME in hours, TURN the SETTINGS KNOB then PRESS & RELEASE to finish. At this point, the ALARM is *set and saved*.

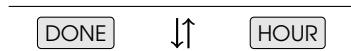


17.8 Done

DONE

This state allows you to review the settings which are shown one by one on the DISPLAY.

At this point you can start over or go to some other mode. To start over and go back to HOUR, PRESS & RELEASE the SETTINGS KNOB.



To go to, say CLOCK mode, TURN the SELECTOR DIAL to the MIDDLE.



17.9 Disabled

DISABLED

The alarm is disabled.

When the alarm is DISABLED, the display will show



Alarm Disabled

and it will *not* be blinking. To enable the alarm, PRESS & RELEASE the SETTINGS KNOB.



After being enabled, any previously saved settings will be in effect so you do not need to reconfigure the alarm unless you want to change it. If you do want to change the alarm, see [Time](#).

To disable the alarm, from HOUR, perform a RESET, i.e. PRESS & HOLD the SETTINGS KNOB until **----** is blinking on the display then RELEASE.



The alarm can only be DISABLED from the HOUR state.

17.10 Power

The screens will turn OFF when the device is in NAP or SLEEP states.

<i>Power State</i>	<i>Set Alarm State</i>	<i>Screens</i>
NAP	ANY	OFF
SLEEP		

Table 17.3: Set Alarm - Power

17.11 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
HOUR	↻	UPDATE HOUR	—
	↓↑	CACHE HOUR BLINK MINUTE	MINUTE
	↓↑	DISABLE ALARM DISPLAY OFF	DISABLED
MINUTE	↻	UPDATE MINUTE	—
	↓↑	CACHE MINUTE BLINK WAKEUP SOURCE	WAKEUP SOURCE
WAKEUP SOURCE	↻	UPDATE WAKEUP SOURCE	—
	↓↑	CACHE WAKEUP SRC BLINK SNOOZE TIME	SNOOZE TIME
SNOOZE TIME	↻	UPDATE SNOOZE TIME	—
	↓↑	CACHE SNOOZE TIME BLINK WAKE TIME	WAKE TIME
WAKE TIME	↻	UPDATE WAKE TIME	—
	↓↑	CACHE WAKE TIME BLINK TOTAL ALARM TIME	TOTAL ALARM TIME
TOTAL ALARM TIME	↻	UPDATE TOTAL ALARM TIME	—
	↓↑	SET ALARM SAVE ALARM DISPLAY ALARM	DONE
DONE	↓↑	BLINK HOUR	HOUR

	↓ ↑	ENABLE ALARM BLINK HOUR	HOUR
DISABLED	↓ ↑		
MINUTE WAKEUP SOURCE SNOOZE TIME WAKE TIME TOTAL ALARM TIME DONE	↓ ↑	RESET BLINK HOUR	HOUR
	↓ ↑		SET CLOCK
HOUR MINUTE DONE ¹ DISABLED	↓ ↑	CHANGE MODE	TOUCH SETTINGS
	↓ ↑		CLOCK
			TIMER
	↓ ↑		SET CLOCK
WAKEUP SOURCE SNOOZE TIME WAKE TIME TOTAL ALARM TIME	↓ ↑	SET ALARM SAVE ALARM CHANGE MODE	TOUCH SETTINGS
	↓ ↑		CLOCK
			TIMER

Table 17.4: Set Alarm - Reference

¹ The alarm has already been set when DONE.

17.12 State Diagram

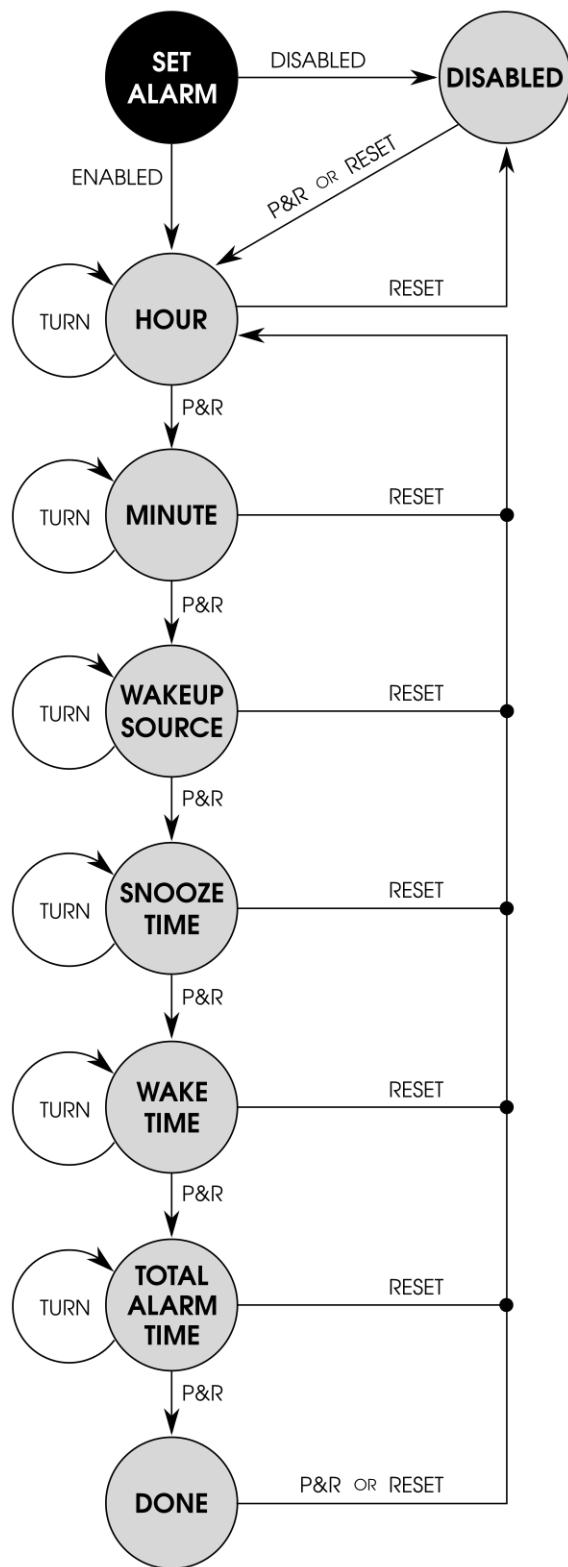


Figure 17.1: Set Alarm - State Diagram

18 Timer

TIMER

18.1 Introduction

Allows setting and running a timer. The timer can be set anywhere from **1** second to **99** hours and **99** minutes, can be paused using the SETTINGS KNOB and alerts when the timer expires using the BEEPER that can be turned off using either the SETTINGS KNOB or TOUCH.

There is also the option, by touching the top of the enclosure for **1** second, to toggle the use of the LIGHTING window as a display of colors that change as the timer counts down giving a visual indication as to the approximate time left.

The clock can also be displayed while the timer is active by using the SETTINGS KNOB.

There are a few ways to get to TIMER mode depending on which direction the SELECTOR DIAL is pointing and which mode the device is currently in.

<i>Position</i>	<i>Mode</i>	<i>Action</i>
	ANY	
		
	POWER SETTINGS	 
	SET NIGHT LIGHT	 
	ANY	 

Table 18.1: Timer - Mode

18.2 Overview

There are a number of states TIMER can be in and are explained in the next sections.

<i>State</i>	<i>Description</i>
	Set hours minutes field.
	Set minutes if SET H M is in hours or seconds if in minutes.
	Timer is actively counting down.
	Timer countdown is paused.
	Timer expired and is alerting/beeping.
	State after alerting is stopped or first state if a time has previously been set.

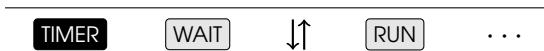
Table 18.2: Timer - States

The first time TIMER is entered after the device is switched ON, the time will have to be set and the first state will be SET H|M. The general progression involves first, setting the time, after which the timer starts running, then letting the timer count down to 0 at which time it begins alerting, and then stopping the alerting by either TURNING the SETTINGS KNOB or TOUCHING the TOP of the enclosure.



For touch to work, make sure you have enabled it via [TOUCH SETTINGS](#) and that the palm of your hand or most of your fingers touch the top of the enclosure - it won't likely be enough to just touch or tap the top with one finger.

Subsequent entries into TIMER mode will load the previously set time and the first state will be WAIT¹ from which you can either start the timer by pressing and releasing the SETTINGS KNOB.



¹ The time isn't saved when the device is powered OFF via the POWER SWITCH switch, so each time the device is powered ON it will start in SET H|M state and you will have to set the time.

or set a new time by turning the SETTINGS KNOB.



When the timer is running, you can PAUSE it by a PRESS & RELEASE of the SETTINGS KNOB. To resume, PRESS & RELEASE again.



18.3 Set Time

Setting the time occurs on one screen of the DISPLAY and is composed of two states - SET H|M and SET M|S. The current setting, first SET H|M, then SET M|S, will be *blinking*. The time can be set anywhere from 1 second to 99 hours and 99 minutes.

00:0 |

1 Second

99:99.

99 Hours & 99 Minutes

59:00

59 Minutes

1:00.

1 Hour

Like other options, the numbers in the fields will wrap. Below shows the basic milestones as you turn in one direction or the other when in SET H|M.

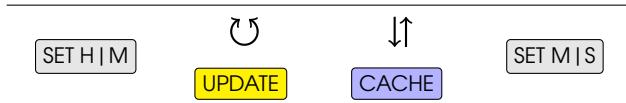


18.3.1 Set Hours or Minutes

SET H|M

Set the hours or minutes.

To select the hours or minutes, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to SET M|S.

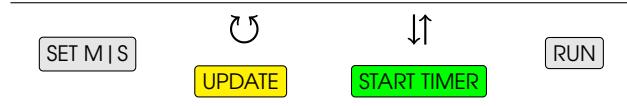


18.3.2 Set Minutes or Seconds

SET M | S

Set the minutes or seconds.

To select the minutes or seconds, TURN the SETTINGS KNOB then PRESS & RELEASE to start the timer.



18.4 Run

RUN

Timer is actively counting down.

As the timer is actively counting down, the DISPLAY is updated every second.

- If the time left is *less* than 1 hour, the time will be formatted as minutes and seconds - **MM:SS** - and progress can easily be seen as the seconds count down.
- Otherwise, when the time left is 1 hour or greater, since the time will be formatted as hours and minutes - **HH:MM** - the *decimal* in the *lower right* of the DISPLAY will *blink* on and off every second to give an indication of progress.

To stop the timer before it has finished counting down, perform a RESET, i.e. PRESS & HOLD the SETTINGS KNOB until **----** is blinking on the DISPLAY. This can also be done in the PAUSE state.



When the timer expires, it will begin alerting with the BEEPER.



18.4.1 Lighting

The LIGHTING window will be lit and progress seamlessly through the following primary hues as the timer counts down giving a visual indication as to the approximate time left.



This is useful if you are some distance from the device and can't see the time on the DISPLAY or in a dimly lit or dark area and not facing the DISPLAY. However, if you don't want the lighting on while the timer is counting down, it can be turned off.

To toggle between showing and not showing the colors in the LIGHTING window, TOUCH the TOP of the enclosure for **1** second. This can also be done in the PAUSE state.



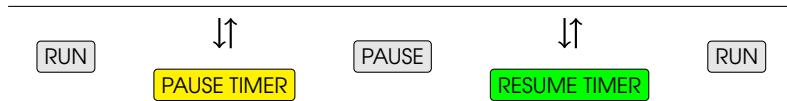
For touch to work, make sure you have enabled it via [TOUCH SETTINGS](#) and that the palm of your hand or most of your fingers lay on top of the enclosure.

18.5 Pause



Timer is paused.

When the timer is counting down, i.e. in the RUN state, you can pause it. To toggle between the RUN and PAUSE states, PRESS & RELEASE the SETTINGS KNOB.



18.6 Alert



The timer has expired and is alerting.

When the timer expires, the BEEPER will alert and both the DISPLAY and LIGHTING will blink in sync. The LIGHTING window will blink red if it hasn't been turned off and the DISPLAY will blink



You can either PRESS & RELEASE the SETTINGS KNOB or TOUCH the TOP of the enclosure to stop the alerting. After the alerting is stopped, the TIMER will go to the WAIT state.



18.7 Wait

WAIT

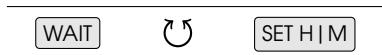
Wait for user input.

This is the state the TIMER enters after ALERT or from RUN, PAUSE or ALERT when RESET. Also, if you have previously set a time, it will be the first state upon reentering TIMER mode.

If you don't need to update the time, PRESS & RELEASE the SETTINGS KNOB and the timer will start counting down and be in the RUN state.



If you want to adjust the time, TURN the SETTINGS KNOB.



18.8 Show Clock

When in RUN or PAUSE states the DISPLAY can toggle between showing the clock time and timer countdown time. To toggle between the two, TURN the SETTINGS KNOB at least **3 detents** quickly either clockwise or counter-clockwise.



Really just a quick TURN in either direction will work. The timer will continue to count down and the LIGHTING window will continue to change color in either case, so when the clock time is displayed, you can still get a feel for the amount of timer time left by the color in the LIGHTING window. When the timer expires, it will go into the ALERT state which will take over the DISPLAY.

18.9 Power

The screens will either DIM or turn OFF depending on the current state. If the TIMER is in either RUN or ALERT states, the screens will DIM for both NAP and SLEEP states, however, the device will *not* go to sleep - it will instead NAP. For the other TIMER states, the screens will turn OFF in both NAP and SLEEP power states.

<i>Power State</i>	<i>Timer State</i>	<i>Screens</i>
NAP	RUN ALERT SET H M SET M S PAUSE WAIT	DIM
SLEEP → NAP	RUN ALERT	DIM
SLEEP	SET H M SET M S PAUSE WAIT	OFF

Table 18.3: Timer - Power

18.10 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
SET H M	⟳	UPDATE H M	—
	↑↓	BLINK M S	SET M S
SET M S	⟳	UPDATE M S	—
	↑↓	START TIMER	RUN
RUN	↑↓	PAUSE TIMER	PAUSE
	⟳ 3	TOGGLE SHOW CLOCK TIMER	—
	⌚ 1s	TOGGLE LIGHTING ON OFF	—
	TIMER EXPIRES	ALERT BLINK DONE	ALERT

			—
			—

Table 18.4: Timer - Reference

18.11 State Diagram

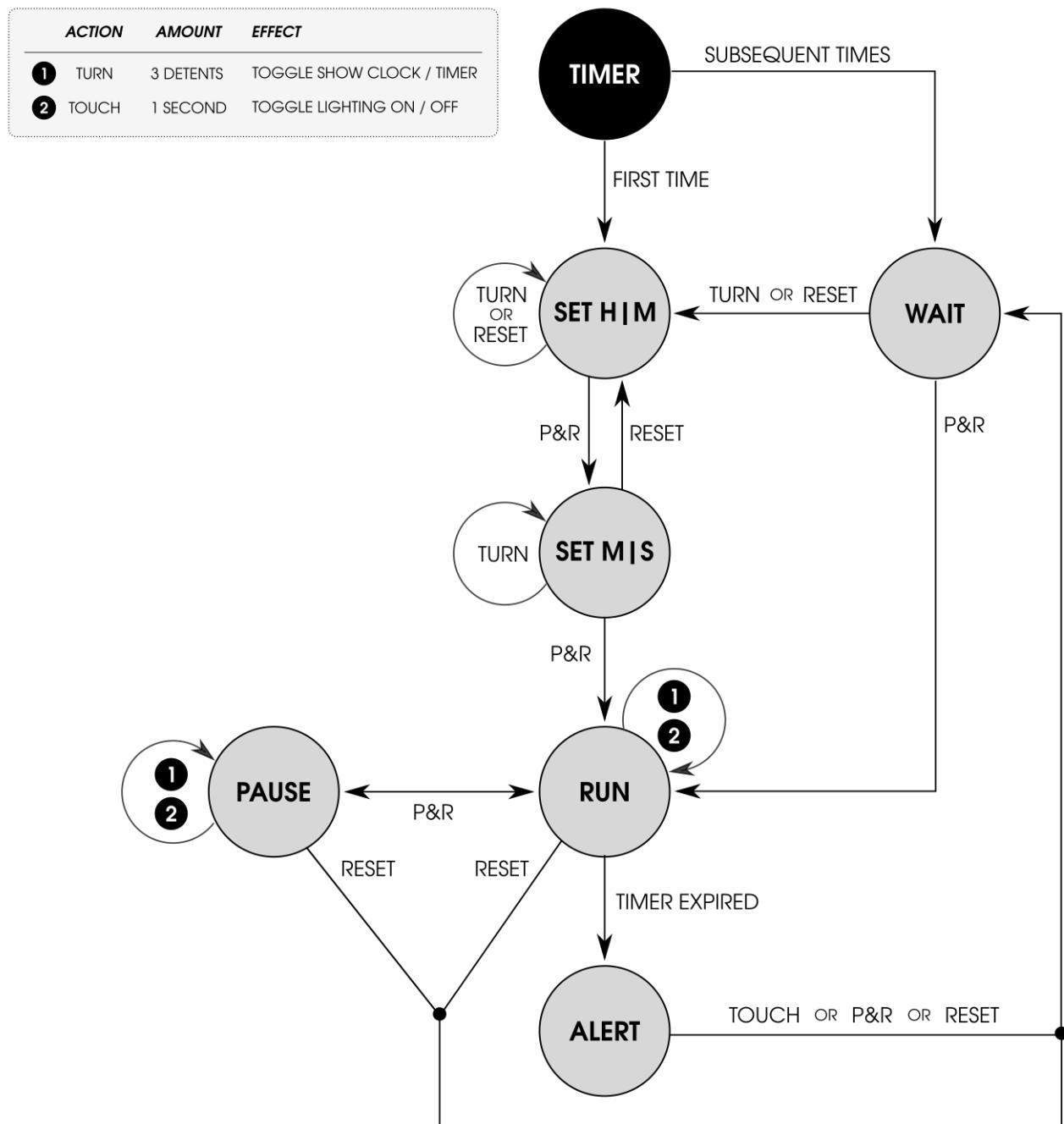


Figure 18.1: Timer - State Diagram

V

Secondary Modes

19 Set Clock

SET CLOCK

19.1 Introduction

Allows setting the date and time, selecting either **12** or **24** hour format for displaying the time and choosing whether or not the time will be automatically updated for Daylight Saving Time.

There are a few ways to get to SET CLOCK depending on which direction the SELECTOR DIAL is pointing and which mode the device is currently in. The most straightforward way is:

- (1) TURN the SELECTOR DIAL to the LEFT.
- (2) PRESS & HOLD the SETTINGS KNOB until you see **====** blink on the DISPLAY then RELEASE.

<i>Position</i>	<i>Mode</i>	<i>Action</i>
	ANY	
	SET ALARM	
	TOUCH SETTINGS	
	ANY	

Table 19.1: Set Clock - Mode

A few items of note:

- The date and time initially loaded will be that which the clock currently holds.
- For Daylight Saving Time, the last saved setting will be loaded.
- After setting the time, you can change mode, and the clock will be set and saved. This allows setting the time without having to go through the rest of the settings.
- To RESET and start over, PRESS & HOLD the SETTINGS KNOB until  is blinking on the DISPLAY.

19.2 Overview

There are a number of states SET CLOCK can be in and are explained in the next sections.

<i>State</i>	<i>Description</i>
	Set the time format - 12 or 24 hour.
	Set the hour.
	Set the minute.
	Set the month.
	Set the day.
	Set the year.
	Set to automatically update the time for Daylight Saving Time.
	Display clock settings.

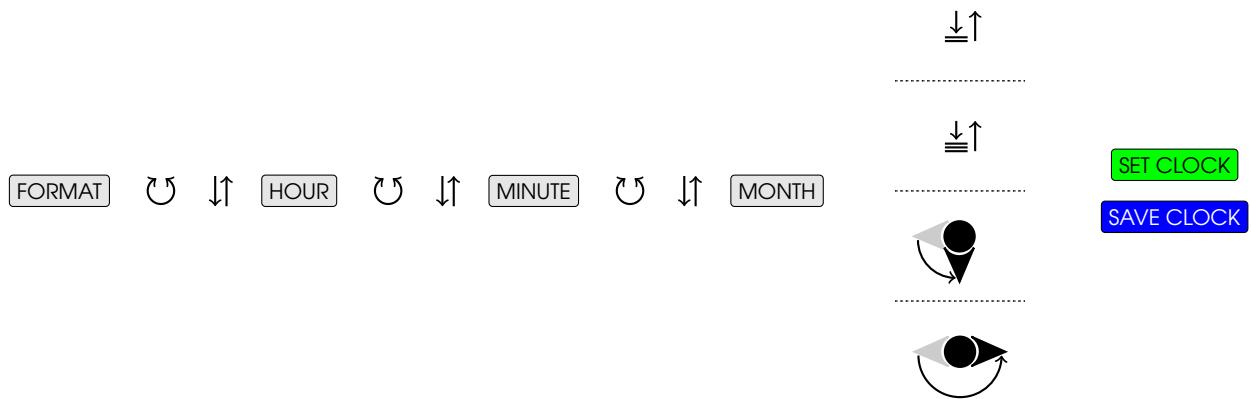
Table 19.2: Set Clock - States

To progress through the states, you will TURN the SETTINGS KNOB to select a value, then PRESS & RELEASE the SETTINGS KNOB to save the setting and move on to the next setting.



When all settings have been configured, the DONE state cycles through and displays each one. It will cycle repeatedly until you PRESS & RELEASE the SETTINGS KNOB.

After setting the minute, you can short circuit the process and the clock will be saved and set.



19.3 Format¹

FORMAT

Set either **12** or **24** hour format for the time to be displayed in.

12 H

12 Hour Format

24 H

24 Hour Format

The time can be displayed in either **12** or **24** hour format. If **12** hour format is chosen, a *decimal* at the *lower right* of the DISPLAY is the **PM** indicator.

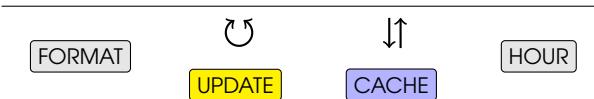
12:00

12 AM

12:00.

12 PM

To select the format, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to HOUR.



19.4 Time

Setting the time occurs on one screen of the DISPLAY and is composed of two states - HOUR and MINUTE. The current setting, first HOUR, then MINUTE, will be *blinking*. The time will be displayed in the format chosen in FORMAT. A couple of examples in **12** and **24** hour format:

¹ The format is set before the time so that the time is displayed in the format selected.

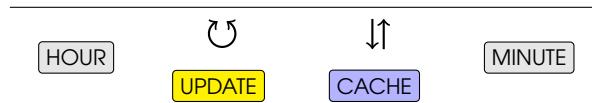
	<i>12 Hour</i>	<i>24 Hour</i>
Five Thirty in the Morning	5:30	05:30
Five Thirty (or 17:30) in the Evening	5:30	17:30

19.4.1 Hour

HOUR

Set the hour.

To select the hour, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to MINUTE.



You can turn in either direction to get to the hour you want to set. The hour will wrap at the 0 and 23 hour marks if the current format is 24 hour.



For **12** hour format, the transitions between **AM** and **PM** when turning clockwise and counter-clockwise from **12 AM** back to **12 AM** are shown below.



19.4.2 Minute

MINUTE

Set the minute.

To select the minute, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to YEAR.



At this point, after caching, you can TURN the SELECTOR DIAL or change mode and the alarm will be set and saved.

19.5 Year²

YEAR

Set the year.

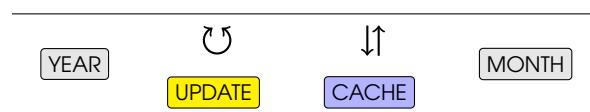
2017

Year 2017

9999

Year 9999

To select the year, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to MONTH.



19.6 Month & Day

Setting the month and day occurs on one screen of the DISPLAY and is composed of two states - MONTH and DAY. The current setting, first MONTH, then DAY, will be *blinking*. The month and day are delimited using a *decimal*. A couple of examples:

10 1

January 1st

12.3 1

December 31st

19.6.1 Month

MONTH

Set the month.

To select the month, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to DAY.



You can turn in either direction to get to the month you want to set. The month will wrap at the 1 and 12 month marks.

10 1



12.0 1

12.0 1



10 1

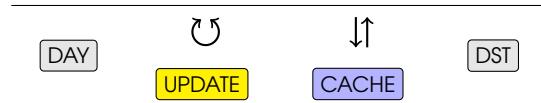
² The year is set before the month and day so that it can be determined whether or not the year is a leap year and what the last day of February is.

19.6.2 Day

DAY

Set the day.

To select the day, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to DST.



You can turn in either direction to get to the day you want to set. The day will wrap at 1 and whatever the maximum day for the month is. For example:



19.7 Daylight Saving Time

DST

Set whether or not the clock will automatically adjust the time for Daylight Saving Time.

The DISPLAY will show the following

ds: **Y**

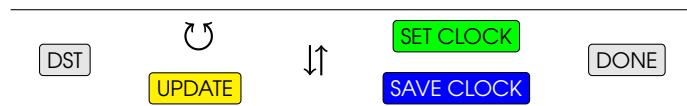
DST Enabled

ds: **N**

DST Disabled

and the letter on the *right* side of the *colon* will be *blinking*. The **Y** stands for *yes*, you want the clock automatically adjusted and **N** stands for *no*, you do not want it adjusted.

To select the DST setting, TURN the SETTINGS KNOB then PRESS & RELEASE to finish. At this point, the CLOCK is *set and saved*.



19.8 Done

DONE

This state allows for review of the settings which are shown one by one on the DISPLAY.

At this point you can start over or go to some other mode. To start over and go back to FORMAT, PRESS & RELEASE the SETTINGS KNOB.



To go to, say CLOCK mode, TURN the SELECTOR DIAL to the MIDDLE.



19.9 Power

The screens will turn OFF when the device is in NAP or SLEEP states.

<i>Power State</i>	<i>Set Clock State</i>	<i>Screens</i>
NAP	ANY	OFF
SLEEP		

Table 19.3: Set Clock - Power

19.10 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
FORMAT	↻	UPDATE FORMAT	—
	↑↓	CACHE FORMAT BLINK HOUR	HOUR
HOUR	↻	UPDATE HOUR	—
	↑↓	CACHE HOUR BLINK MINUTE	MINUTE

MINUTE	⟳	UPDATE MINUTE	—
	↓↑	CACHE MINUTE BLINK YEAR	YEAR
YEAR	⟳	UPDATE YEAR	—
	↓↑	CACHE YEAR BLINK MONTH	MONTH
MONTH	⟳	UPDATE MONTH	—
	↓↑	CACHE MONTH BLINK DAY	DAY
DAY	⟳	UPDATE DAY	—
	↓↑	CACHE DAY BLINK DST	DST
DST	⟳	UPDATE DST	—
	↓↑	SET CLOCK SAVE CLOCK DISPLAY CLOCK	DONE
DONE	↓↑	BLINK FORMAT	FORMAT
ANY	↓↑	RESET BLINK FORMAT	FORMAT
HOUR MINUTE DONE ³	↓↑		SET ALARM
	↓↑		TOUCH SETTINGS
	⌚	CHANGE MODE	CLOCK
	⌚		TIMER

³ The clock has already been set when DONE.

			SET ALARM
YEAR			TOUCH SETTINGS
MONTH		SET CLOCK SAVE CLOCK CHANGE MODE	CLOCK
DAY			
DST			TIMER

Table 19.4: Set Clock - Reference

19.11 State Diagram

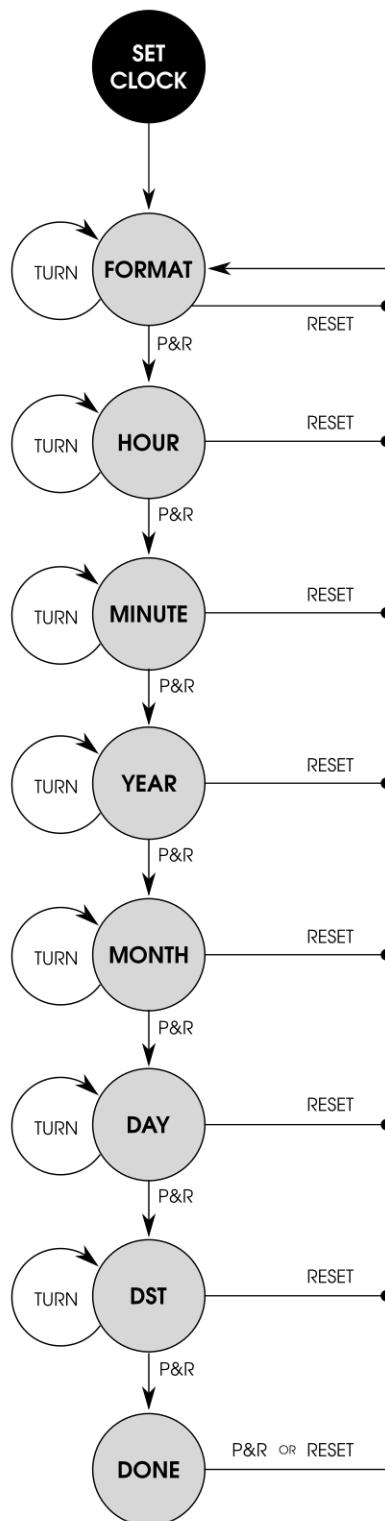


Figure 19.1: Set Clock - State Diagram

20 Power Settings

POWER SETTINGS

20.1 Introduction

Allows configuring timers for putting the device into NAP or SLEEP states and auto-stopping the AUDIO. Also allows for configuring an amount of time in seconds that can be used to force the device into a SLEEP state using TOUCH.

As a semi-portable device that can run on the RECHARGEABLE BATTERY, these settings can be used to prolong the battery charge. See [POWER](#) for information on the different power states and what they do.

There are a few ways to get to POWER SETTINGS depending on which direction the SELECTOR DIAL is pointing and which mode the device is currently in. The most straightforward way is:

- (1) TURN the SELECTOR DIAL to the RIGHT.
- (2) PRESS & HOLD the SETTINGS KNOB until  is blinking on the DISPLAY then RELEASE.

<i>Position</i>	<i>Mode</i>	<i>Action</i>
 	ANY	 
	TIMER SET NIGHT LIGHT	     
	ANY	

Table 20.1: Power Settings - Mode

A few items of note:

- The values initially loaded will be the last saved values.
- Until a setting has been saved, current POWER settings will be in effect. That is, the device may NAP or SLEEP while in POWER SETTINGS mode, but will only do so if left idle.
- To RESET and start over, PRESS & HOLD the SETTINGS KNOB until you see  blink on the DISPLAY.

20.2 Overview

There are a number of states TIMER can be in and are explained in the next sections.

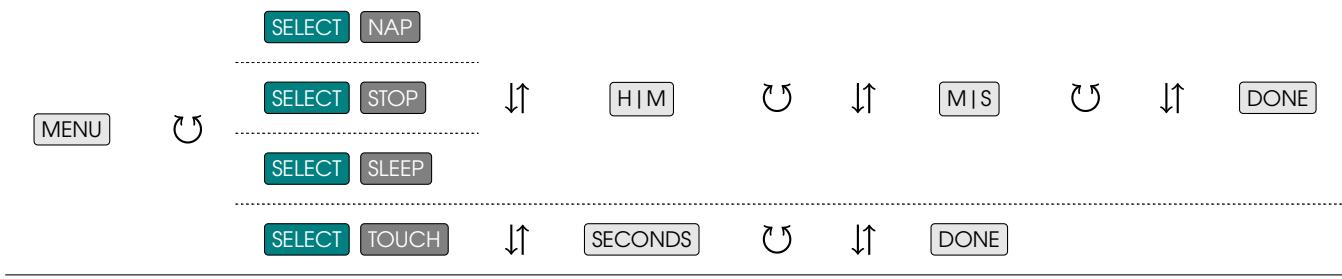
<i>State</i>	<i>Description</i>
	Select a power setting option.
	Set the <i>hours</i> or <i>minutes</i> of the setting selected.
	Set the <i>minutes</i> or <i>seconds</i> of the setting selected.
	Set the seconds for <i>touch</i> induced sleep.
	Display setting.

Table 20.2: Power Settings - States

The MENU has **4** options to select from:

<i>Option</i>	<i>Display</i>
	
	
	
	

The general progression involves first selecting a menu option, then setting the timer for that option. TURN the SETTINGS KNOB to cycle through the menu options, PRESS & RELEASE the SETTINGS KNOB to select one, then proceed to set the timer for that option.



20.3 Menu

MENU

Select a power setting to configure.

The MENU is where you will select the power setting you want to configure a timer for. There are **4** options to select from.

<i>Option</i>	<i>Display</i>
NAP	nAP
STOP	STOP
SLEEP	SLEE.
TOUCH	TOUCH

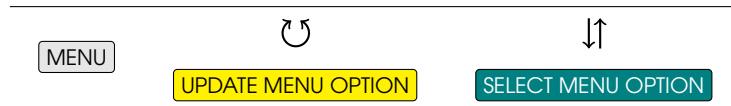
NAP, STOP and SLEEP can be set from **10** seconds to **99** hours and **99** minutes. Setting the timer to **0:00** disables the setting. If you roll over into hours a *decimal* at the *bottom right* of the DISPLAY is used to indicate that the time is in hours and minutes or **HH:MM** format.



TOUCH can be set from **2** to **60** seconds. Setting the seconds to **0** disables the setting.



To select an option, TURN the SETTINGS KNOB then PRESS & RELEASE.



20.3.1 Nap

NAP

Set the amount of idle time that needs to pass before the device enters a NAP power state.

In addition to the timer, certain conditions must be met before the device enters a NAP power state. Refer to [Nap](#) in the [POWER](#) section for more information.

Set to **0:00** to disable napping.

20.3.2 Stop

STOP

Set the amount of idle time that needs to pass before the device auto-stops the AUDIO.

In addition to the timer, certain conditions must be met before the device auto-stops the AUDIO. Refer to [Audio Auto-Stop](#) in the [POWER](#) section for more information.

Set to **0:00** to disable auto-stopping the AUDIO.

20.3.3 Sleep

SLEEP

Set the amount of idle time that needs to pass before the device enters a SLEEP power state.

In addition to the timer, certain conditions must be met before the device enters a SLEEP power state. See [Sleep](#) in the [POWER](#) section for more information.

Set to **0:00** to disable sleeping.

20.3.4 Touch

TOUCH

Set the amount of time in seconds that the TOP needs to be *continuously* touched for before forcing the device into a SLEEP power state. See [Touch Sleep](#) in the [POWER](#) section for more information.

Set to **0** to disable touch induced sleep.

20.4 Timer

Setting the timer for NAP, STOP and SLEEP menu options occurs on one screen of the DISPLAY and is composed of two states - H|M and M|S. The current setting, first H|M, then M|S, will be *blinking*.

The timer can be set anywhere from 10 seconds to 99 hours and 99 minutes. Set to **0:00** to disable the timer setting.

0:00

Disabled

0: 10

10 Seconds

99:99.

99 Hours & 99 Minutes

To the *left* of the *colon* is where you set the minutes or if more than **59** minutes, the hours. As you TURN the SETTINGS KNOB clockwise the number will increase until it hits **59** minutes at which point it will change over to hours and display a *decimal* in the *lower right* of the DISPLAY. The decimal indicates that the time is in hours and minutes or **HH:MM**.

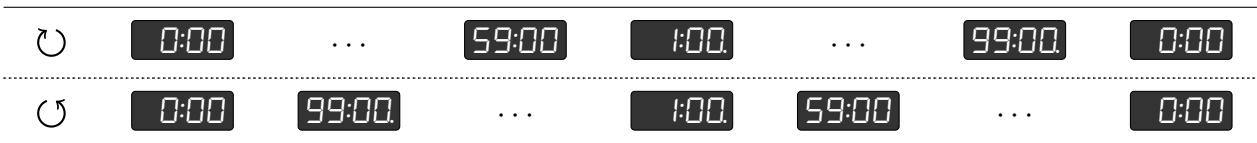
59:00

59 Minutes

1:00.

1 Hour

Like other options the numbers in the fields will wrap. Below shows the basic milestones as you turn in one direction or the other when in **H|M**.



If the **H|M** chosen is **0** then the minimum **M|S** value is **0:10**. The value will jump between **0** (disabled) and **10** (minimum) when turning the SETTINGS KNOB.

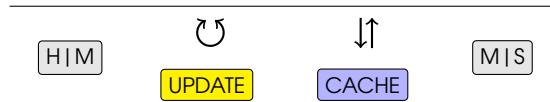


20.4.1 Hours or Minutes

H|M

Set the timer hours or minutes.

To select the **H|M**, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to **M|S**.



20.4.2 Minutes or Seconds

M|S

Set the timer minutes or seconds.

To select the **M|S**, TURN the SETTINGS KNOB then PRESS & RELEASE to finish.



20.5 Seconds

SECONDS

Set the number of seconds required for touch induced sleep.

This state only applies to the TOUCH menu option. The minimum time that can be set is **2** seconds and the maximum is **60** seconds. Set to **0** to disable the setting.



Disabled



2 Seconds



60 Seconds

To select the seconds, TURN the SETTINGS KNOB then PRESS & RELEASE to finish.



20.6 Done

DONE

Displays the menu selection and timer value.

At this point you can start over or go to some other mode. To start over and go back to MENU, PRESS & RELEASE the SETTINGS KNOB.



To go to, say CLOCK mode, TURN the SELECTOR DIAL to the MIDDLE.



20.7 Power

The screens will turn OFF when the device is in NAP or SLEEP states.¹

<i>Power State</i>	<i>Power Settings State</i>	<i>Screens</i>
NAP	ANY	OFF
SLEEP		

Table 20.3: Power Settings - Power

¹ The current power settings will be used while you are configuring. When DONE, the new setting will take effect.

20.8 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
MENU	↻	UPDATE MENU OPTION	—
	↓↑	SELECT NAP SELECT STOP SELECT SLEEP SELECT TOUCH	HIM BLINK HIM BLINK SECONDS
HIM	↻	UPDATE HIM	—
	↓↑	CACHE HIM BLINK M S	M S
M S	↻	UPDATE M S	—
	↓↑	SAVE TIMER START TIMER DISPLAY TIMER	DONE
SECONDS	↻	UPDATE SECONDS	—
	↓↑	SAVE TIMER DISPLAY TIMER	DONE
DONE	↓↑	BLINK MENU OPTION	MENU
ANY	↓↑	RESET BLINK MENU OPTION	MENU
	↓↑		TIMER
	↓↑	CHANGE MODE	SET NIGHT LIGHT
	↙↗		CLOCK SET ALARM

Table 20.4: Power Settings - Reference

20.9 State Diagram

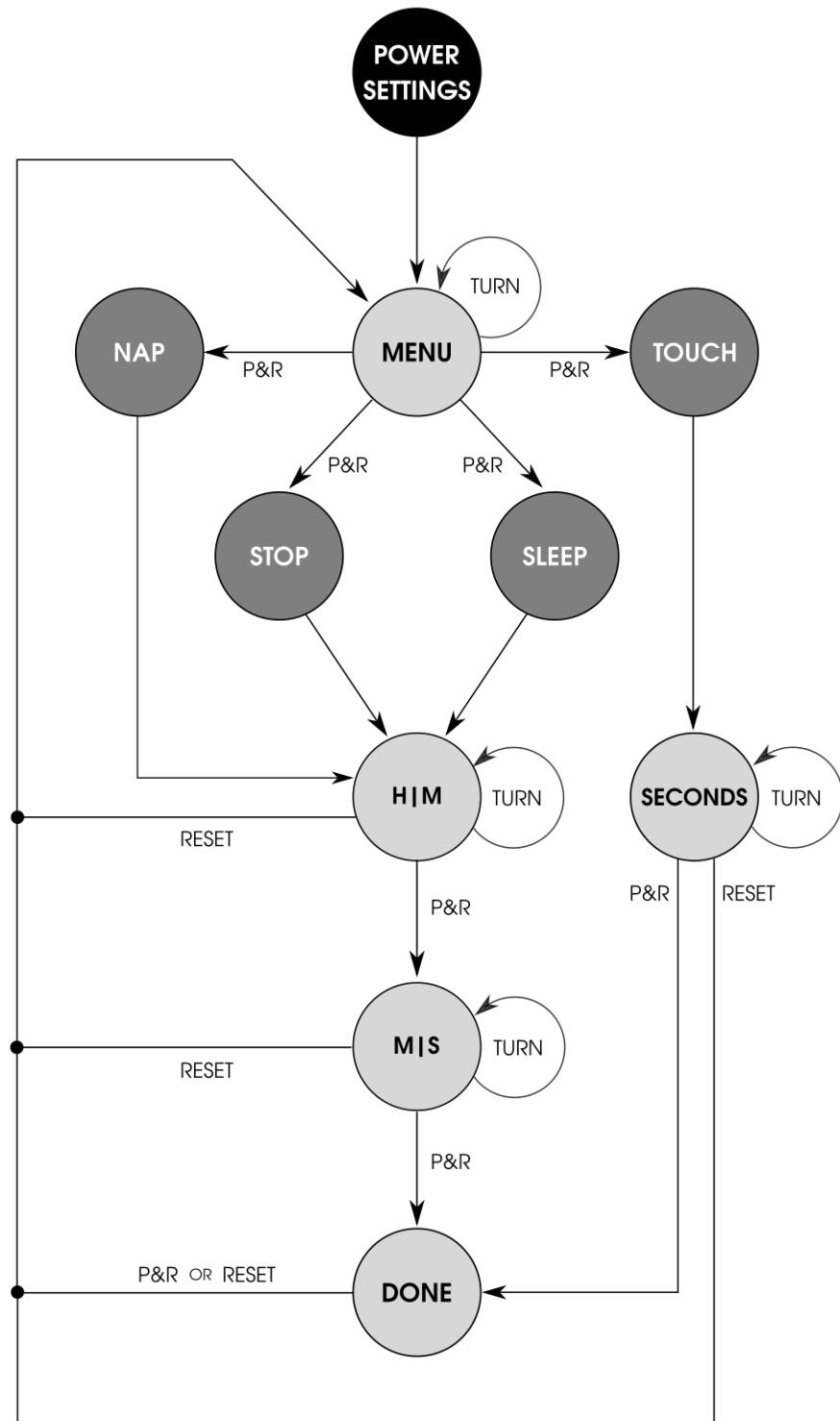


Figure 20.1: Power Settings - State Diagram

VI

Tertiary Modes

21 Touch Settings

TOUCH SETTINGS

21.1 Introduction

Allows for configuring, calibrating and testing the touch sensing capability of the device. It can also be disabled here.

In this mode, the main goal is to come up with a number called a touch threshold. When a reading is taken, if its value is greater than the threshold, a touch event is registered. It's recommended that you first select the CALIBRATE menu option and follow the instructions for that. If you are unable to get a consistent beep without chirping when touching during TEST & ADJUST, try the READ method, then the CONFIGURE method. If nothing good comes of any of these, you can load the DEFAULTS and try again or simply DISABLE touch altogether. Most everything that can be done using touch can be done using other means. There are a few exceptions:

- Forcibly putting the device to sleep - see [Touch](#) in [POWER SETTINGS](#) and [Touch Sleep](#) in [POWER](#).
- Toggling the timer lighting - see [Lighting](#) in [TIMER](#).

There are a few ways to get to TOUCH SETTINGS depending on which direction the SELECTOR DIAL is pointing and which mode the device is currently in. The most straightforward way is:

- (1) TURN the SELECTOR DIAL to the LEFT.
- (2) PRESS & HOLD the SETTINGS KNOB until  is blinking on the DISPLAY then RELEASE.

<i>Position</i>	<i>Mode</i>	<i>Action</i>
	ANY	
		
	SET ALARM SET CLOCK	

Table 21.1: Touch Settings - Mode

21.2 Capacitive Touch Sensing

The touch capability in this device uses [Capacitive Touch Sensing](#) which measures changes in capacitance of an *electrode* to detect touch events. The figure below shows how it is modeled as a capacitor and the corresponding parts of the device.

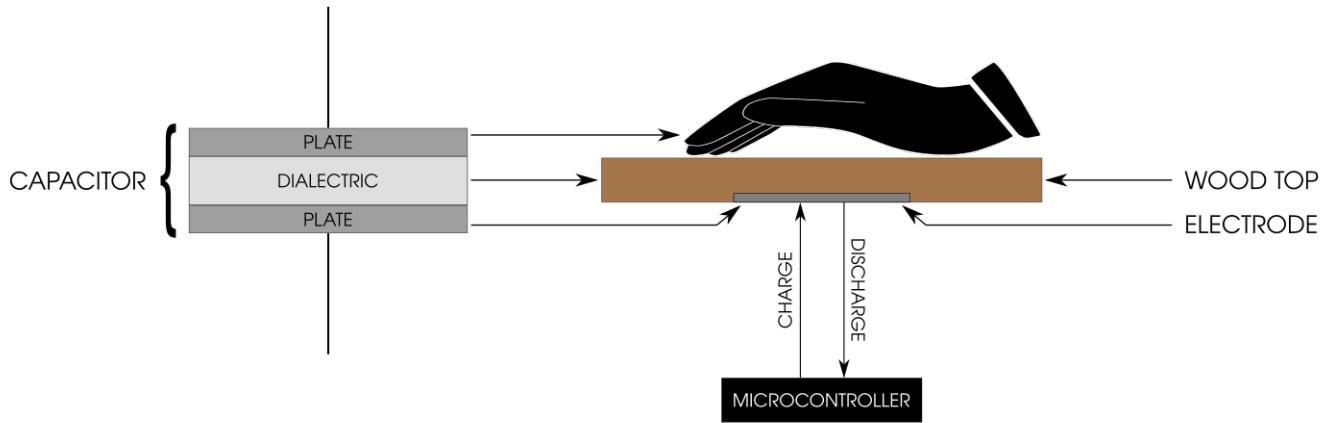


Figure 21.1: Capacitive Touch Sensing

Since humans are electrical conductors, the hand forms the other plate of the capacitor model. As the hand approaches and lies on top of the enclosure, the capacitance, or charge capacity of the electrode will *increase*.

Changes in capacitance are detected by measuring the amount of time it takes to charge and discharge the electrode.

When a reading is taken, a fixed size reference capacitor is charged and discharged using a configurable charge rate denoted as REFCHRG. At the same time, the electrode is charged and discharged a set number of times using another configurable charge rate denoted as EXTCHRG. Since its capacitance does *not* change, the fixed size capacitor provides a *reference* and will always charge/discharge at the same rate. On the other hand, the electrode capacitance *varies*, so its charge/discharge rate will vary. The number of times the electrode is charged/discharged or *scanned* per reading is determined by two configurable quantities denoted as NSCN and PS. NSCN is a base *number of scans* and PS is a *prescaler* or multiplier applied to NSCN. The product of the two determines the number of times the electrode is charged/discharged during a reading.

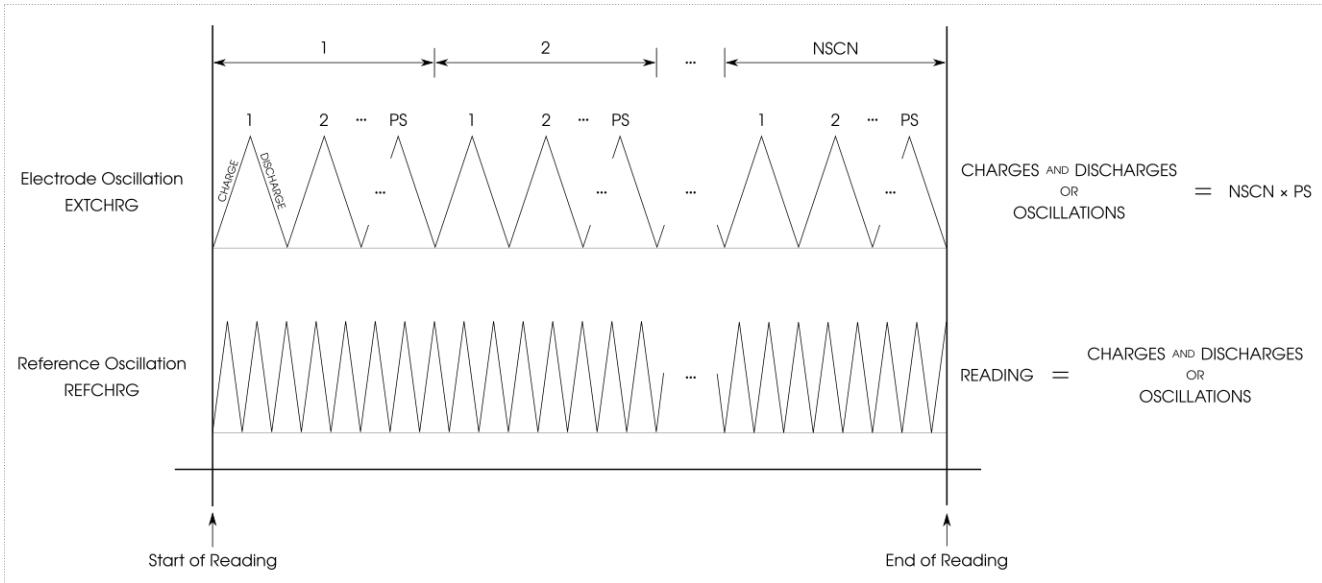


Figure 21.2: Anatomy of a Touch Sensor Reading

As the hand approaches the electrode, the capacitance *increases* resulting in more time required to charge and discharge the electrode. This increase in time or decreased frequency results in more reference capacitor charges and discharges per electrode charge/discharge resulting in a higher reading.

As an analogy, consider the filling and draining of a bath tub - the larger the tub, the longer it will take to fill it up and to drain it. Think of the electrode as a bath tub that increases in size when touched therefore taking longer to fill and drain. This increase in fill/drain time of the electrode when touched means that the fixed size reference capacitor - a bath tub that doesn't change in size - can be filled and drained more times per electrode fill and drain.

The **READING** taken is basically the number of times it takes to fill and drain the fixed size reference capacitor per electrode fill and drain cycle - the cycle being defined as $NSCN \times PS$.

Below are two graphs that illustrate the capacitance difference and how it is measured. The first illustrates a reading taken when *not touched* and the second when *touched*. This example uses $NSCN = 3$ and $PS = 2$, so the number of electrode scans per reading is: $NSCN \times PS = 6$.

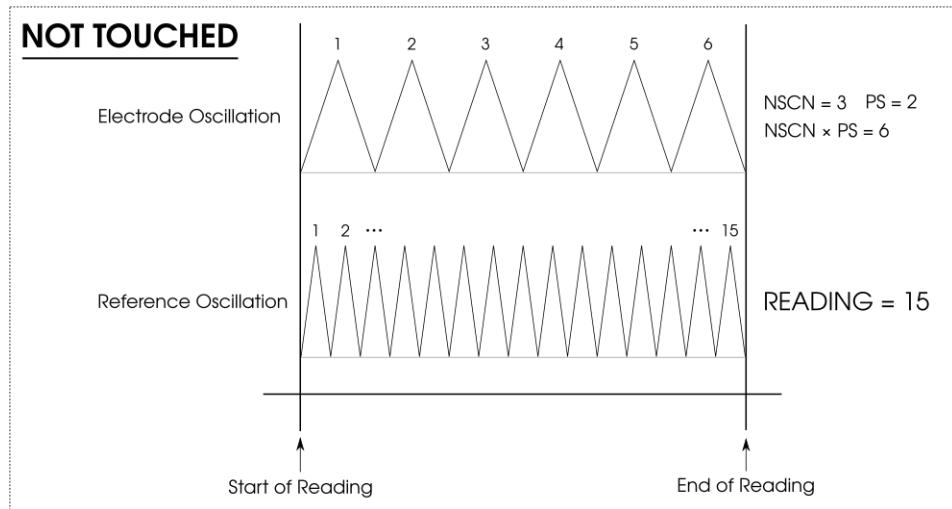


Figure 21.3: Touch Reading Comparison - Not Touched

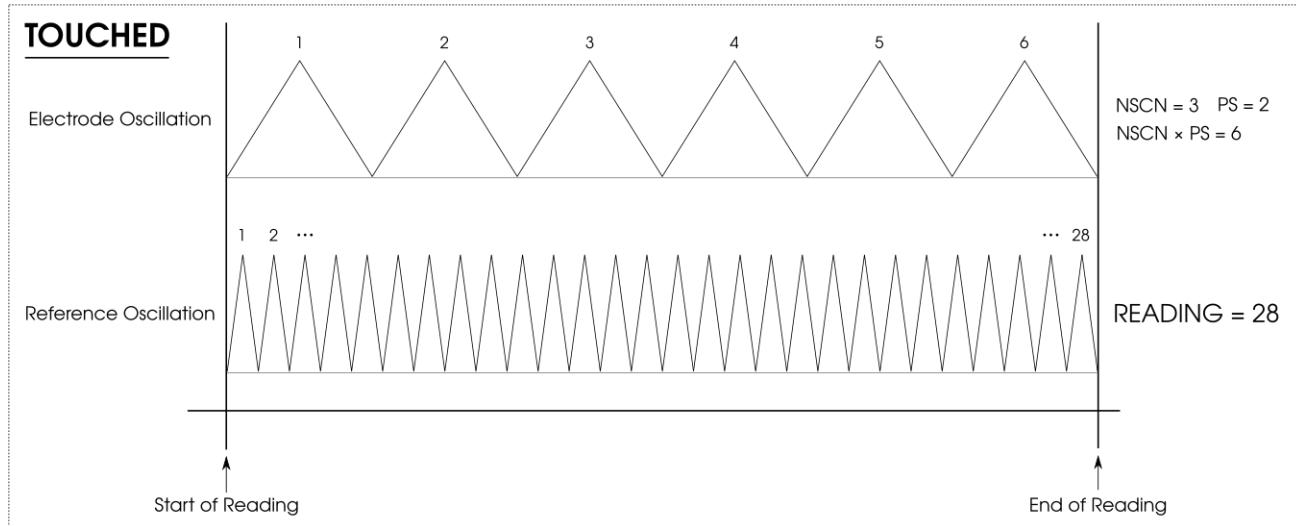


Figure 21.4: Touch Reading Comparison - Touched

When touched, the higher capacitance created means that it will take longer to charge and discharge resulting in more reference oscillations per electrode scan and therefore a higher reading.

Despite the fact that a reading can be calculated, the device still has to be told when a reading should be considered as a legitimate touch event. As initially mentioned, the main goal of TOUCH SETTINGS is to come up with a touch *threshold* value. This is a value for which a touch event is registered when the value of a reading equals or exceeds it.

In the above example, if the threshold value was between **16** and **28** inclusive, a touch event would *not* have been registered in the NO TOUCH case and *would* have been registered in the TOUCH case, as expected.

However, if the threshold value was set to **15** or less, a touch event *would* have been registered in the NO TOUCH case as well as the TOUCH case. And if the threshold value was greater than **28**, *no* touch event would have been registered in either case. These outcomes are unexpected and undesirable.

The preceding explanation of how capacitive touch sensing works on this device is simplified and idealized. The reality is that readings will fluctuate. It's possible that readings may differ when the device is in different locations or environmental conditions. Additionally, when touching, readings will vary based on how much of the hand is covering the electrode and how much force is used. Keep this in mind during the TEST & ADJUST phase when setting the final threshold value. Try not to choose a value on the edge, but somewhere *above and beyond* the *highest* reading when *not* touching and somewhere around an *average* reading when *touching*.¹

21.3 Overview

There are a number of states TOUCH SETTINGS can be in and are explained in the next sections.

<i>State</i>	<i>Description</i>
MENU	Select a menu option.
	CALIBRATE
WAIT BASELINE	Wait before baseline calibration run.
BASELINE RUN	Baseline calibration run.
WAIT TOUCH	Wait before touch calibration run.
TOUCH RUN	Touch calibration run.
	READ
TOUCH & READ	Set initial touch threshold by touching and reading value.
	CONFIGURE
NSCN	Configure the number of scans per reading.
PS	Configure the prescaler - the multiplier applied to NSCN.
REFCHRG	Configure the reference charge per reading.
EXTCHRG	Configure the external/electrode charge per reading.

¹ The CALIBRATE procedure takes some of the guess work out of this decision.

	CALIBRATE READ CONFIGURE
TEST & ADJUST	Test and adjust touch threshold value.
	CALIBRATE READ CONFIGURE DEFAULTS
DONE	Display settings.
	DISABLE
DISABLED	Touch disabled.

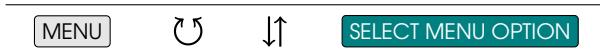
Table 21.2: Touch Settings - States

[MENU]

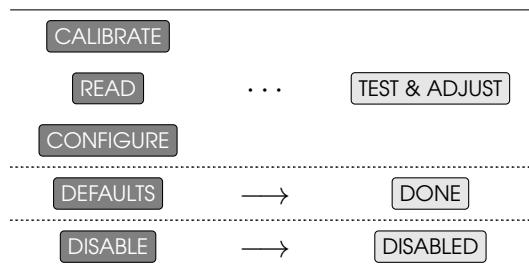
The general progression through the states starts with the MENU. The MENU has 5 options to select from.

Option	Display
CALIBRATE	CAL.
READ	rEAd
CONFIGURE	ConF.
DEFAULTS	dEF.
DISABLE	OFF

To select an option, TURN the SETTINGS KNOB then PRESS & RELEASE.



After selecting a menu option, the path taken is dependent on the option selected. The paths for CALIBRATE, READ and CONFIGURE all lead to TEST & ADJUST while DEFAULTS goes directly to the DONE state and DISABLE to the DISABLED state.



TEST & ADJUST

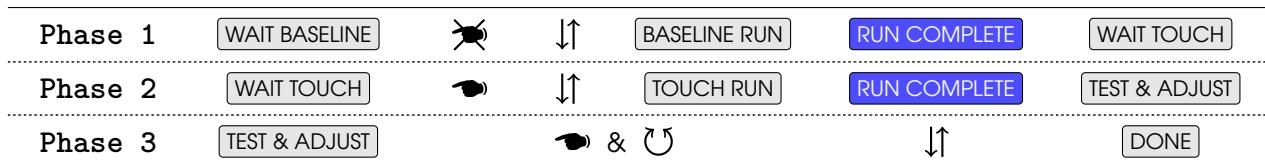
This state involves tuning the final threshold value after calibrating, reading or configuring. The TOP of the enclosure is touched while the SETTINGS KNOB is turned until a solid beep from the BEEPER is heard. When satisfied, PRESS & RELEASE the SETTINGS KNOB to finish.



CALIBRATE

Set the touch threshold via a calibration process.

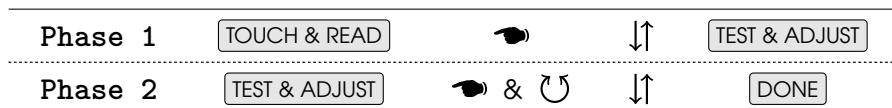
Calibration involves **3** phases. First is a BASELINE RUN, where a number of readings are taken *without* touching the top of the enclosure. After completion, the same process is done *touching* the top of the enclosure. Finally, a TEST & ADJUST adjust phase is performed to tune the final touch threshold value.



READ

Set the touch threshold through touch readings.

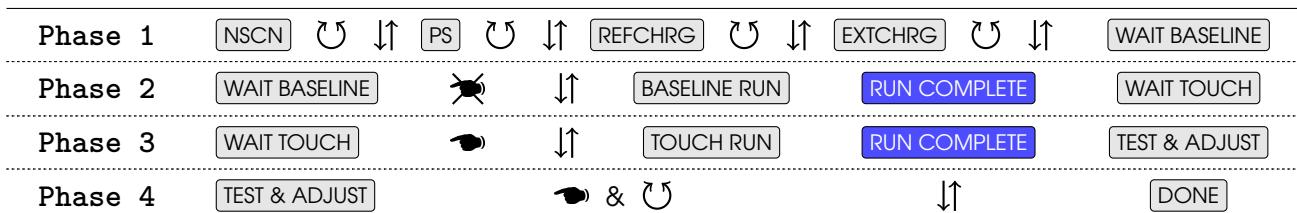
Reading involves **2** phases. The first is simply touching the top of the device which will display readings when touched. Then PRESS & RELEASE the SETTINGS KNOB to carry a reading value over into TEST & ADJUST where you will tune the final touch threshold value.



CONFIGURE

Set the touch threshold by first configuring touch sensitivity values, then proceeding through calibration.

Configuration involves **4** phases. The first is setting values relevant to touch sensitivity. The remaining phases are the same as with the CALIBRATE menu option.



DEFAULTS

Reset the touch sensitivity and threshold values to "safe" defaults.

DEFAULTS

DONE

DISABLE

Disable touch capability.

DISABLE

DISABLED

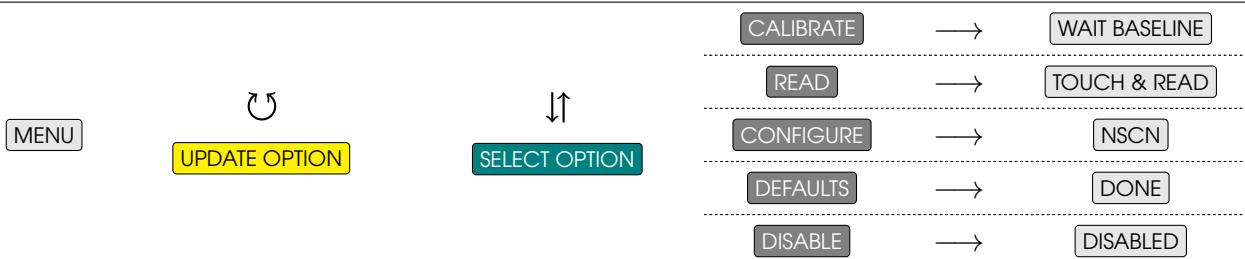
21.4 Menu

MENU

Select one of the 5 menu options.

<i>Option</i>	<i>Display</i>	<i>Description</i>
CALIBRATE	CAL.	Go through a calibration process followed by testing and adjusting to set the final touch threshold value.
READ	rEAd	Get touch readings then test and adjust to set the final touch threshold value.
CONFIGURE	ConF.	Configure various settings relevant to touch sensitivity before going through the calibration process.
DEFAULTS	dEF.	Load default touch sensitivity and threshold values.
DISABLE	OFF	Disable touch - all touch capability on the device will be disabled.

To select a menu option, TURN the SETTINGS KNOB then PRESS & RELEASE when the option you want to select is displayed.



21.5 Calibrate

CALIBRATE

Calibration involves **3** phases. First is a BASELINE RUN, where a number of readings are taken *without* touching the top of the enclosure. After completion, the same process is done *touching* the top of the enclosure which is the TOUCH RUN. Finally, a TEST & ADJUST phase is performed to tune the final touch threshold value.

For the BASELINE RUN, do *not* touch the TOP of the enclosure. The highest reading when not touched is used as a baseline during the TEST & ADJUST phase for which you can not adjust below. It is used to prevent false touch triggering when not being touched.

For the TOUCH RUN, *lightly* place your entire hand, palm down, on TOP of the enclosure. There is no need to press down - just let gravity supply the force. An average of all of the readings is taken as a touch threshold starting point for the TEST & ADJUST phase.

21.5.1 Wait Baseline

WAIT BASELINE

After selecting the CALIBRATE menu option the device will wait for you to proceed. The DISPLAY will be blinking

base

and the lighting area will be lit red.

- (1) Make sure you are *not* touching the TOP of the enclosure before proceeding.
- (2) PRESS & RELEASE the SETTINGS KNOB to begin the calibration procedure.



21.5.2 Baseline Run

BASELINE RUN

The device will proceed to take **65535** readings. This phase of calibration requires no user action so remember *not* to touch the device while this is happening. Progress can be seen by the lighting area cycling through the colors of the rainbow



as well as the display showing a running count of the number of readings taken in hexadecimal from **0** to **FFFF**. Both the lighting and the count are simply an indication of progress and are otherwise insignificant.



21.5.3 Wait Touch

WAIT TOUCH

After the BASELINE RUN run is complete, the display will be blinking



and the lighting area will be lit red.

- (1) Make sure you that you are *touching* the TOP of the enclosure before proceeding. Lightly lay your entire hand, palm down, on TOP of the enclosure - refer to [Figure 11.1](#) in the [TOUCH SENSOR](#) section.
- (2) PRESS & RELEASE the SETTINGS KNOB to begin the TOUCH RUN.



21.5.4 Touch Run

TOUCH RUN

The device will again proceed to take **65535** readings. Remember to keep your hand lightly on top of the enclosure while this is running. Progress can be seen by the lighting area cycling through the colors of the rainbow



as well as the display showing a running count of the number of readings taken in hexadecimal from **0** to **FFFF**.

When done, the DISPLAY will show a hexadecimal representation of the average taken over all of the readings. Hexadecimal is used since the maximum value that is possible for a threshold, depending on configuration, can exceed **9999** which is the maximum decimal value that the DISPLAY can show.

This average value will be the starting value used during [TEST & ADJUST](#).



21.6 Read

READ

This is the easiest procedure for setting the touch threshold, however, it is not as robust as [CALIBRATE](#) and may result in false positive touch events, i.e., a touch event being detected when the top is *not* being touched. This is because a proper baseline is not established, making it possible to set the threshold too low.

21.6.1 Touch & Read

TOUCH & READ

Obtain a threshold starting point by lightly laying your hand across the top of the enclosure.

After selecting the READ menu option, readings from the touch sensor will appear on the DISPLAY and a color will light up in the LIGHTING window. The values on the DISPLAY will likely be the same or fluctuate slightly in either direction when *not* touching the top. As your hand approaches and lies flat across the top, the value will increase and the color in the LIGHTING window will change.

With your hand *lightly* resting on TOP of the enclosure, PRESS & RELEASE the SETTINGS KNOB to carry the value over into the TEST & ADJUST phase.



21.7 Configure

CONFIGURE

Allows for configuring values related to touch sensitivity.

Selecting the CONFIGURE option allows for setting values that affect the touch sensitivity of the device. The sensitivity can be described as a range of values for which a touch event is detected. Higher sensitivity provides a larger range, but may lead to erroneous events. Lower sensitivity has a smaller range, but may require more touching force and also may not detect touch events.

There are **4** configurable values and related states.

NSCN	<i>Number of Scans</i> per reading.
PS	<i>Prescale</i> or multiplication factor applied to NSCN.
REFCHRG	<i>Reference Charge</i> - the amount of current in μA (microamps) used in charging/discharging the internal reference capacitor.
EXTCHRG	<i>External Charge</i> - the amount of current in μA (microamps) used in charging/discharging the electrode.

The values as they relate to touch sensitivity can basically be described with the following equation:

$$\text{Sensitivity} = \frac{\text{EXTCHRG}}{\text{REFCHRG} \times \text{NSCN} \times \text{PS}} \quad (21.1)$$

The *smaller* the value, the *more* sensitive.

After the settings are configured, the calibration process must be done. Refer to [CALIBRATE](#) upon completion.

21.7.1 Number of Scans

Select the number of consecutive scans per reading.

The touch module takes readings at regular intervals independent of whether or not it is being touched. When a reading is started, so is a process of charging and discharging the electrode. This number represents the base number of times it will charge/discharge or scan the electrode before logging a final reading.

The higher the number, the more sensitive it will be which may allow for better detection of a wider range of touching force and proximity. However as the number increases, so does the amount of time it takes to complete a full scan which if too long, may result in missed touches or inconsistent behavior.



After you have completed configuration and enter the calibration phase, you can get a sense of how long a reading will take by the amount of time it takes to do each calibration run - if it seems to take too long, you may want to run through the configuration again and lower the value.

The DISPLAY will show the following

n5: 10

10 Scans

and the number on the *right* side of the *colon* will be *blinking*.

To select the number of scans per reading, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to PS.



21.7.2 Prescaler

Select a value to scale the *Number of Scans*.

This setting scales or multiplies the value selected in NSCN by the value selected here. For example, if 10 was selected in NSCN and 4 is selected here, the effective number of scans will be: $10 \times 4 = 40$ Scans per Reading.

There are two reasons this is a separate setting from NSCN:

- (1) The hardware makes this distinction and expects two distinct values.

- (2) It's quicker and easier, requiring much less turning of the SETTINGS KNOB, to get a value between 1 and 4096 that is the product of the two values.

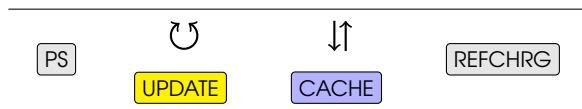
The DISPLAY will show the following

PS: 4

4× Prescaler

and the number on the *right* side of the *colon* will be *blinking*.

To select the prescaler, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to REFCHRG.



21.7.3 Reference Charge

REFCHRG

Select the charge rate in μA for the fixed size reference capacitor.

This setting determines the charge rate in μA , i.e. microamps, used to charge the fixed size reference capacitor when taking a reading. The higher the charge rate, the less time it will take to charge the fixed size reference capacitor. A higher value here will increase the sensitivity since it will result in a higher range of readings.

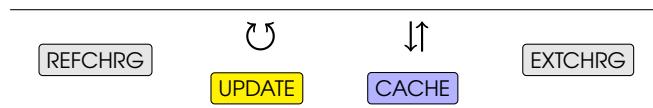
The DISPLAY will show the following

rC: 16

16 μA Reference Charge

and the number on the *right* side of the *colon* will be *blinking*.

To select the reference charge, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to EXTCHRG.



21.7.4 External Charge

EXTCHRG

Select the charge rate in μA for the external electrode.

This setting determines the charge rate in μA , i.e. microamps, used to charge the electrode when taking a reading. It is similar to REFCHRG but applies to the electrode instead of the reference capacitor. The higher the charge rate, the less time it will take to charge the electrode, other

factors being equal. A higher value here will lessen the sensitivity since it will result in a lower range of readings. However, because the electrode is relatively large, it's a good idea to keep this value high and higher than the value chosen for REFCHRG.

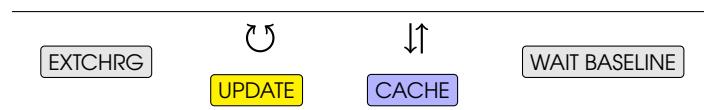
The DISPLAY will show the following

EC:32

32 μ A External Charge

and the number on the *right* side of the *colon* will be *blinking*.

To select the external/electrode charge, TURN the SETTINGS KNOB then PRESS & RELEASE to cache the setting and move on to the **CALIBRATE** phase.



21.8 Defaults

DEFAULTS

Loads "safe" default touch sensitivity and threshold values.

Selecting the DEFAULTS menu option loads touch sensitivity and threshold values that have been tested with this device. This doesn't mean that they are necessarily going to just work since as mentioned, location, environmental factors, touching force, etc. are factors that can influence readings. However, they can provide a sane starting point if "bad" values have been set via CONFIGURE. It's recommended that after loading the DEFAULTS that you follow the **CALIBRATE** procedure.

To load the DEFAULTS, from the **MENU**, TURN the SETTINGS KNOB to select the option which is shown on the DISPLAY as **dEF**, then PRESS & RELEASE to finish.



21.9 Test & Adjust

TEST & ADJUST

Test and adjust the final threshold value.

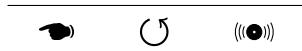
A hexadecimal value will be shown on the DISPLAY that represents a starting point for the final touch threshold value.² The LIGHTING area will be lit according to how that number translates to an **RGB** color. The color is not significant and is only used to show change and as a visual indicator of the value.

This number will ultimately, after adjustment, be the threshold value used when detecting touch events so it's important to get this the way you want it. If things don't seem to be working as

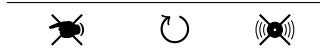
² The actual value is only important internally and isn't something you have to remember.

described, try starting over, and if that doesn't work, try doing the configuration first, before calibration. If all else fails, you can disable touch altogether.

If it's not already beeping, with your hand still on the TOP, slowly TURN the SETTINGS KNOB *counter-clockwise* until you hear the **BEEPER** sound.



Slowly turn until you get a good consistent beep with no chirping. Then take your hand off to make sure it's *not* beeping. If it is, TURN the SETTINGS KNOB CLOCKWISE until it stops and then some.

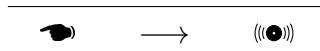


How sensitive you want it is up to you, but a good point of reference is that it should start beeping with only a light touch. Continue this process *with* and *without* AUDIO playing. For some reason, the amplifier causes a higher degree of fluctuation in readings and you don't want it beeping when not touching in either situation.

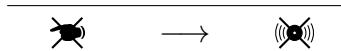


If it's beeping at all when *not* touching, with or without the AUDIO playing, the device may malfunction. For example if you've set a touch time for forced sleep, it may constantly sleep because it thinks it's being touched. Or when the alarm wakes, it may immediately snooze without actually being touched.

To reiterate, the beeper should continuously sound when touched with your preference of touching force.



and *must* be silent when not touched.



When the above conditions are met and you are satisfied with the touch sensitivity, to finish, PRESS & RELEASE the SETTINGS KNOB to save the threshold and possible sensitivity settings set via **CONFIGURE**.



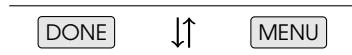
21.10 Done

DONE

This state allows you to review the settings which are shown one by one on the DISPLAY.

For CALIBRATE and READ, only the touch threshold is shown. For CONFIGURE and DEFAULTS, the NSCN, PS, REFCHRG and EXTCHRG are shown in addition to the touch threshold.

To return to the MENU, PRESS & RELEASE the SETTINGS KNOB.



To go to, say CLOCK mode, TURN the SELECTOR DIAL to the MIDDLE.



21.11 Disabled

DISABLED

Touch capability is completely disabled on the device.

This state indicates that touch has been completely disabled. Instead of the MENU, the display will show



and will *not* be blinking. To re-enable touch, and return to the MENU, PRESS & RELEASE the SETTINGS KNOB.



To disable touch, from the MENU, TURN the SETTINGS KNOB to select the DISABLE menu option, which is shown on the DISPLAY as OFF and *will* be blinking, then PRESS & RELEASE to disable touch capability on the device.



21.12 Power

The screens will either DIM or turn OFF depending on the current state. If TOUCH SETTINGS is in any of the following states, the screens will DIM for both NAP and SLEEP states, however, the device will *not* go to sleep - it will instead NAP.

- BASELINE RUN
- TOUCH RUN
- TOUCH & READ
- TEST & ADJUST

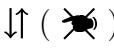
For the other TOUCH SETTINGS states, the screens will turn OFF in both NAP and SLEEP power states.

<i>Power State</i>	<i>Touch Settings State</i>	<i>Screens</i>
NAP	<div style="display: flex; justify-content: space-around;"> BASELINE RUN TOUCH RUN </div> <div style="display: flex; justify-content: space-around;"> TOUCH & READ </div> <div style="display: flex; justify-content: space-around;"> TEST & ADJUST </div> <hr/> <div style="display: flex; justify-content: space-around;"> MENU DISABLED DONE </div> <div style="display: flex; justify-content: space-around;"> WAIT BASELINE WAIT TOUCH </div> <div style="display: flex; justify-content: space-around;"> NSCN PS REFCHRG EXTCHRG </div>	DIM
SLEEP → NAP	<div style="display: flex; justify-content: space-around;"> BASELINE RUN TOUCH RUN </div> <div style="display: flex; justify-content: space-around;"> TOUCH & READ </div> <div style="display: flex; justify-content: space-around;"> TEST & ADJUST </div> <hr/> <div style="display: flex; justify-content: space-around;"> MENU DISABLED DONE </div> <div style="display: flex; justify-content: space-around;"> WAIT BASELINE WAIT TOUCH </div> <div style="display: flex; justify-content: space-around;"> NSCN PS REFCHRG EXTCHRG </div>	OFF
SLEEP	<div style="display: flex; justify-content: space-around;"> BASELINE RUN TOUCH RUN </div> <div style="display: flex; justify-content: space-around;"> TOUCH & READ </div> <div style="display: flex; justify-content: space-around;"> TEST & ADJUST </div> <hr/> <div style="display: flex; justify-content: space-around;"> MENU DISABLED DONE </div> <div style="display: flex; justify-content: space-around;"> WAIT BASELINE WAIT TOUCH </div> <div style="display: flex; justify-content: space-around;"> NSCN PS REFCHRG EXTCHRG </div>	DIM

Table 21.3: Touch Settings - Power

21.13 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
MENU	↻	UPDATE MENU OPTION	—
	↓	SELECT CALIBRATE BLINK BASE	WAIT BASELINE
	↓	SELECT READ DISPLAY READING	TOUCH & READ
	↓	SELECT CONFIGURE BLINK NSCN	NSCN
	↓	SELECT DEFAULTS LOAD DEFAULTS DISPLAY DEFAULTS	DONE
	↓	SELECT DISABLE DISABLE TOUCH DISPLAY OFF	DISABLED
NSCN	↻	UPDATE NSCN	—
	↓	CACHE NSCN BLINK PS	PS
PS	↻	UPDATE PS	—
	↓	CACHE PS BLINK REFCHRG	REFCHRG
REFCHRG	↻	UPDATE REFCHRG	—
	↓	CACHE REFCHRG BLINK EXTCHRG	EXTCHRG
EXTCHRG	↻	UPDATE EXTCHRG	—
	↓	CACHE EXTCHRG BLINK BASE	WAIT BASELINE

[WAIT BASELINE]	↓↑ ()	START BASELINE RUN	[BASELINE RUN]
[BASELINE RUN]	RUN FINISHED	[CACHE BASELINE] [BLINK] 	[WAIT TOUCH]
[WAIT TOUCH]	↓↑ ()	START TOUCH RUN	[TOUCH RUN]
[TOUCH RUN]	RUN FINISHED	[CACHE THRESHOLD] [DISPLAY THRESHOLD]	[TEST & ADJUST]
[TOUCH & READ]		[DISPLAY READING]	—
	↓↑ ()	[CACHE THRESHOLD] [DISPLAY THRESHOLD]	[TEST & ADJUST]
[TEST & ADJUST]		() → TOUCH DETECTED	—
		() → NO TOUCH DETECTED	—
		[UPDATE THRESHOLD]	—
	↓↑	[SAVE SETTINGS] [DISPLAY SETTINGS]	[DONE]
[DONE]	↓	[BLINK MENU OPTION]	[MENU]
[DISABLED]	↓↑		[MENU]
[DISABLED]	↓↑	[ENABLE TOUCH] [BLINK MENU OPTION]	[MENU]

		RESET BLINK CAL.	MENU
CALIBRATE WAIT BASELINE			
CALIBRATE BASELINE RUN WAIT TOUCH TOUCH RUN TEST & ADJUST	↓↑	RESET BLINK base	WAIT BASELINE
READ TOUCH & READ	↓↑	RESET BLINK rEAd	MENU
READ TEST & ADJUST	↓↑	RESET DISPLAY READING	TOUCH & READ
CONFIGURE NSCN		RESET BLINK ConF.	MENU
CONFIGURE PS REFCHRG EXTCHRG WAIT BASELINE BASELINE RUN WAIT TOUCH TOUCH RUN TEST & ADJUST	↓↑	RESET BLINK NSCN	NSCN
ANY	↓↑		SET ALARM
	↓↑	CHANGE MODE	
			CLOCK
			TIMER

Table 21.4: Touch Settings - Reference

21.14 State Diagram

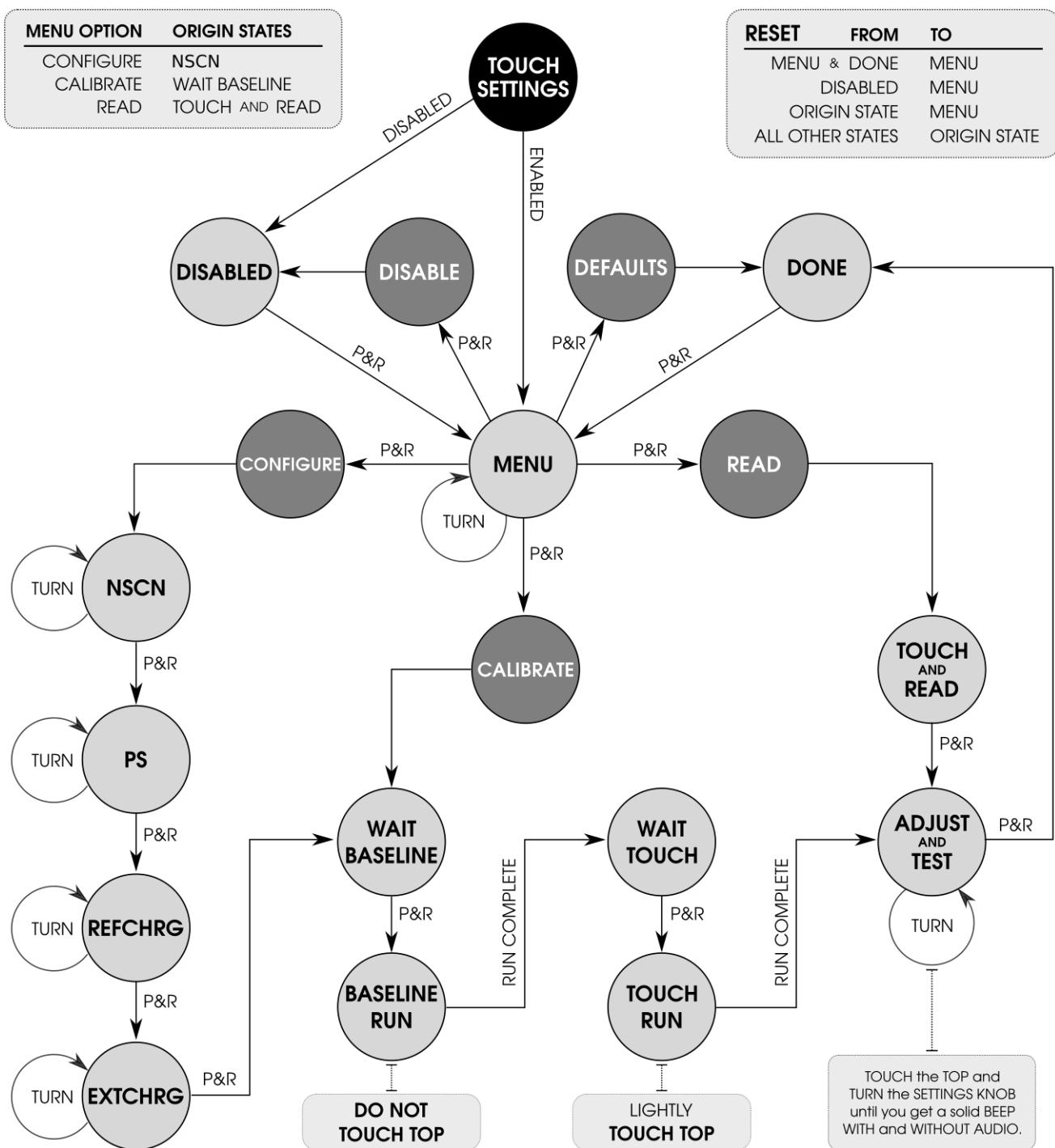


Figure 21.5: Touch Settings - State Diagram

22 Set Night Light

SET NIGHT LIGHT

22.1 Introduction

Allows for setting any of the **3** configurable night light colors using any of **3** methods.

The LIGHTING is composed of **16 RGB** LEDs. Each LED is composed of a Red, a Green and a Blue pixel. The color of each LED is determined by the blend of these pixels.

There are a number of preset colors that can be chosen from. Additionally, the color can be customized by either selecting the individual values for the Red, Green and Blue pixels or by selecting **HSB** values - Hue, Saturation and Brightness.

There are a few ways to get to SET NIGHT LIGHT depending on which direction the SELECTOR DIAL is pointing and which mode the device is currently in. The most straightforward way is:

- (1) TURN the SELECTOR DIAL to the RIGHT.
- (2) PRESS & HOLD the SETTINGS KNOB until  is blinking on the DISPLAY then RELEASE.

<i>Position</i>	<i>Mode</i>	<i>Action</i>
	ANY	
		
	TIMER POWER SETTINGS	

Table 22.1: Set Night Light - Mode

A few items of note:

- The night light number initially loaded will be the one currently displayed if the night light is on.
- When using a different method from the one used previously to set the color, an attempt will be made to get the settings as close to the color as possible.
- The color will be updated in real time and shown in the LIGHTING window.
- When using either RGB or HSB, you will **DOUBLE-CLICK** the SETTINGS KNOB to finish. It's done this way because it is assumed that one will likely want to go through the process a number of times to fine tune the color.
- To RESET and start over from the top menu, PRESS & HOLD the SETTINGS KNOB until you see  blink on the DISPLAY.

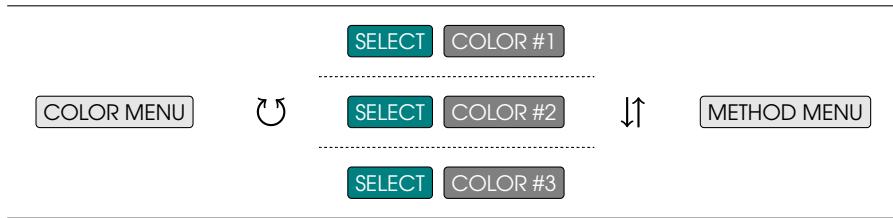
22.2 Overview

There are a number of states SET NIGHT LIGHT can be in and are explained in the next sections.

<i>State</i>	<i>Description</i>
	Select one of the three night light colors you want to set.
	Select the method for setting the color.
	Set the color by selecting one of many preset colors.
	Set the Red pixel value.
	Set the Green pixel value.
	Set the Blue pixel value.
	Set a Hue value.
	Set a Saturation value.
	Set a Brightness value.
	Display settings values.

Table 22.2: Set Night Light - States

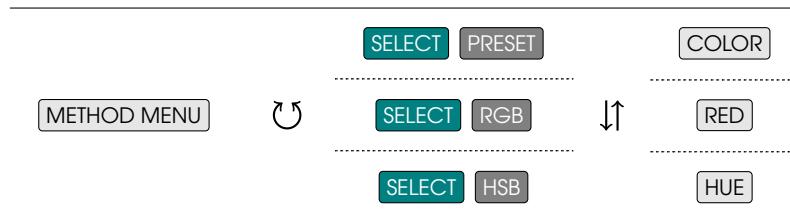
To progress through the states, you will first TURN the SETTINGS KNOB to select one of the **3** configurable night light colors, COLOR #1, COLOR #2 or COLOR #3, then PRESS & RELEASE the SETTINGS KNOB.



The METHOD MENU has three options for setting the color.

<i>Option</i>	<i>Display</i>
PRESET	Colr
RGB	rGb
HSB	HSl

TURN the SETTINGS KNOB to select the method for setting the color of the chosen night light then PRESS & RELEASE.



PRESET

Select a preset color.

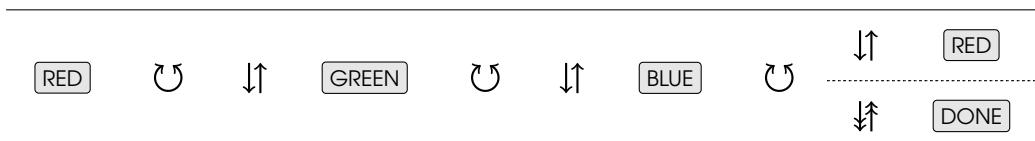
This menu option is probably the easiest to use for setting the color. There are over **100** colors to choose from in a somewhat random order. There is one state - COLOR - when taking this path before finishing.



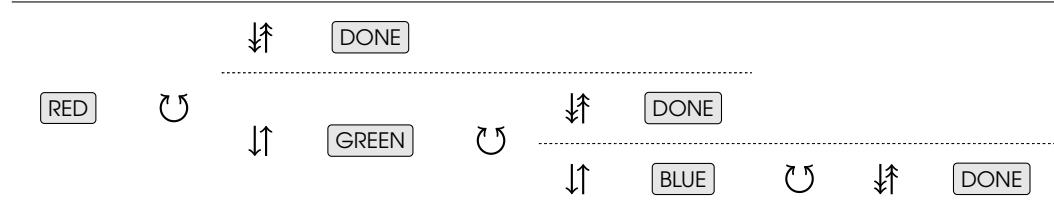
RGB

Create a color by selecting individual RED, GREEN and BLUE pixel values.

This method allows you to select values for the individual RED, GREEN and BLUE pixels of the LEDs.



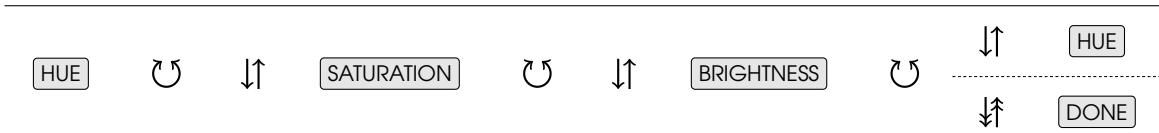
At any time you can DOUBLE-CLICK to finish.



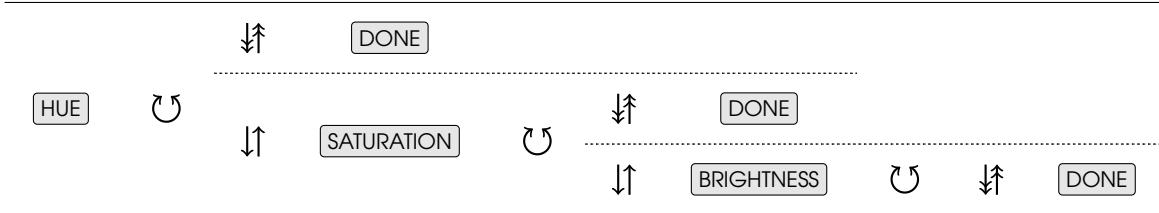
HSB

Create a color by selecting HUE, SATURATION and BRIGHTNESS values.

This method allows you to set the night light color by individually selecting HUE, SATURATION and BRIGHTNESS values.



At any time you can DOUBLE-CLICK to finish.

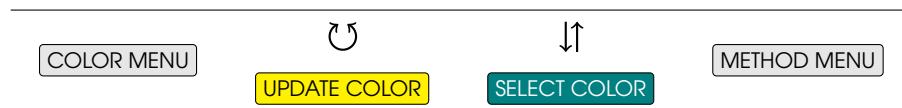


22.3 Color Menu

COLOR MENU

Select one of the three night light colors you want to configure.

To select one of the night light colors, TURN the SETTINGS KNOB then PRESS & RELEASE to go on to select a method for setting the color of the night light selected. As you cycle through the numbers, the current color of that number will light up the LIGHTING window.



22.4 Method Menu

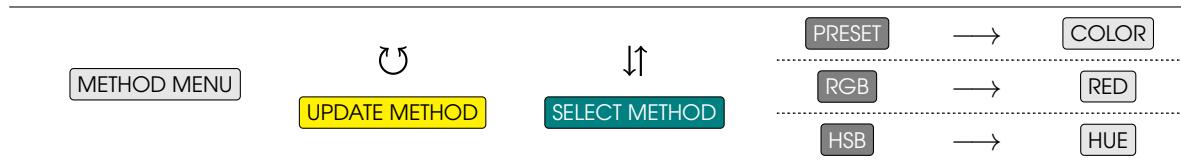
METHOD MENU

Select a method for setting a night light's color.

There are **3** ways to set the color of the selected night light.

<i>Method</i>	<i>Display</i>	<i>Description</i>
		Select a COLOR from a number of preset colors.
		Create a color by selecting the individual RED, GREEN and BLUE pixel values.
		Create a color by selecting HUE, SATURATION and BRIGHTNESS values.

To select a method, TURN the SETTINGS KNOB to choose one of the above, then PRESS & RELEASE to select the method and move on to the first state of the chosen method.



22.5 Color

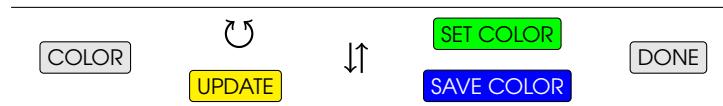


Select a color from a number of preset colors.

There over 100 preset colors to choose from. The ordering may seem somewhat random but you'll notice that many colors types are grouped together. As you TURN the SETTINGS KNOB, the current color will light up in the LIGHTING window and its index/number will be shown on the DISPLAY. There is no correlation between the index and the color other than its position in the list of preset colors.

The first and last colors are *white* and *black* respectively. To quickly get to the last color from the first, turn *counter-clockwise* and 1 will wrap to the last number.

To select a color, TURN the SETTINGS KNOB to cycle through the colors then PRESS & RELEASE to select a color and finish.



22.6 RGB



This method allows you to select values for the individual RED, GREEN and BLUE pixels of the LEDs.¹

¹ More detailed information on the RGB color model can be found [here](#).

The allowable values for each range from **0** to **255**, but note that the values are displayed in hexadecimal.² Hexadecimal value **FF** is equivalent to the decimal value **255**. All you really need to know is that turning *counter-clockwise* will *decrease* the intensity of the RGB pixel being set and turning *clockwise* will *increase* the intensity.

A few items of note:

- Setting all three to **FF** will give you *white*.
- Setting all three to **00** will give you *black*. This can be utilized in **CLOCK** mode so you can **TURN** the **SETTINGS KNOB** instead of having to **PRESS & RELEASE** the **SETTINGS KNOB** to turn the night light off.
- As you change an RGB value, the color will be updated in the **LIGHTING** area.
- To finish, you will **DOUBLE-CLICK** the **SETTINGS KNOB**. This can be done in any of the RGB states.

Unlike other settings, a single **PRESS & RELEASE** of the **SETTINGS KNOB** will continue to cycle through the **RED**, **GREEN** and **BLUE** states to give you an opportunity to go through the process again and tune the values to get the color you want. A **DOUBLE-CLICK** of the **SETTINGS KNOB** will get you out of this loop and finish.



Depending on the color set, there may be some desyncing between the **DISPLAY** and **LIGHTING** at low brightness levels. This is because given different values for the pixels, they may drop out before the **DISPLAY** turns off and may take an extra turn or two to come back on after the **DISPLAY** has turned on.



Depending on the color set, you may notice that at low brightness levels the color changes. This is because at some point one of the RGB pixels drops out or turns off before the others.

22.6.1 Red

RED

Select the intensity of the **RED** pixel.

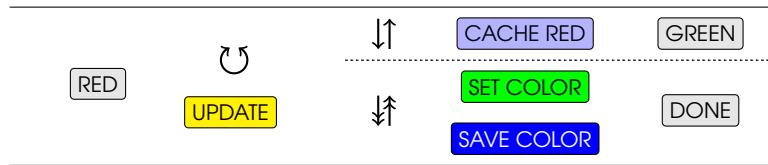
The **DISPLAY** will show the following

r :FF

and the number on the *right* side of the *colon* will be *blinking*. To select the **RED** value, **TURN** the **SETTINGS KNOB** then either:

² See [Hexadecimal](#) in the Appendix.

- (1) PRESS & RELEASE the SETTINGS KNOB to cache the value and move on to GREEN, or
- (2) DOUBLE-CLICK the SETTINGS KNOB to set, save and finish.



22.6.2 Green

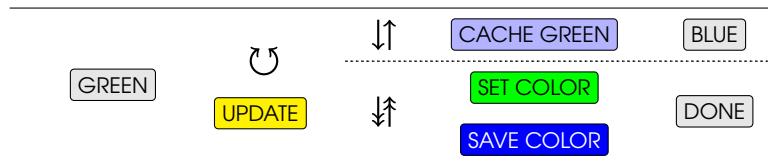
Select the intensity of the GREEN pixel.

The DISPLAY will show the following

9 :FF

and the number on the *right* side of the *colon* will be *blinking*. To select the GREEN value, TURN the SETTINGS KNOB then either:

- (1) PRESS & RELEASE the SETTINGS KNOB to cache the value and move on to BLUE, or
- (2) DOUBLE-CLICK the SETTINGS KNOB to set, save and finish.



22.6.3 Blue

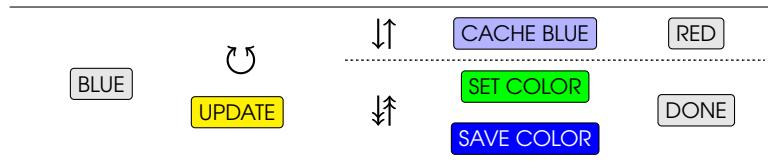
Select the intensity of the BLUE pixel.

The DISPLAY will show the following

b :FF

and the number on the *right* side of the *colon* will be *blinking*. To select the BLUE value, TURN the SETTINGS KNOB then either:

- (1) PRESS & RELEASE the SETTINGS KNOB to cache the value and cycle back to RED, or
- (2) DOUBLE-CLICK the SETTINGS KNOB to set, save and finish.



22.7 HSB

HSB

This method allows you to set the night light color by individually selecting HUE, SATURATION and BRIGHTNESS values.³

The allowable values for each range from **0** to **255**, but note that the values are displayed in hexadecimal.⁴ Hexadecimal value **FF** is equivalent to the decimal value **255**. All you really need to know is that turning *counter-clockwise* will *decrease* the HSB value being set and turning *clockwise* will *increase* it.

A few items of note:

- Changing the HUE essentially changes the color which may make using this method easier than the RGB method.
- Lowering the SATURATION value will *whiten* the HUE.
- Try not to change the BRIGHTNESS from **FF** since the brightness is adjustable via the BRIGHTNESS KNOB and may desync the LIGHTING and DISPLAY.
- As you change an HSB value, the color will be updated in the LIGHTING area.
- To finish, you will DOUBLE-CLICK the SETTINGS KNOB. This can be done in any of the HSB states.

Like RGB, a single PRESS & RELEASE of the SETTINGS KNOB will continue to cycle through the HUE, SATURATION and BRIGHTNESS states to give you an opportunity to go through the process again and tune the values to get the color you want. A DOUBLE-CLICK of the SETTINGS KNOB will get you out of this loop and finish.



Depending on the values set, there may be some desyncing between the DISPLAY and LIGHTING at low brightness levels. This is because given different values for the pixels, they may drop out before the DISPLAY turns off and may take an extra turn or two to come back on after the DISPLAY has turned on.



Depending on the values set, you may notice that at low brightness levels the color changes. This is because at some point one of the RGB pixels drops out or turns off before the others.

³ More detailed information on the HSB color space can be found [here](#).

⁴ See [Hexadecimal](#) in the Appendix.

22.7.1 Hue

HUE

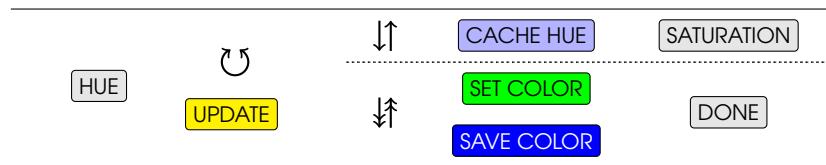
Select a HUE value.

The DISPLAY will show the following

H :00

and the number on the *right* side of the *colon* will be *blinking*. To select the HUE value, TURN the SETTINGS KNOB then either:

- (1) PRESS & RELEASE the SETTINGS KNOB to cache the value and move on to SATURATION, or
- (2) DOUBLE-CLICK the SETTINGS KNOB to set, save and finish.



22.7.2 Saturation

SATURATION

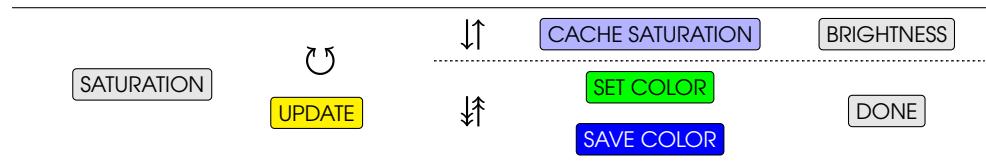
Select a SATURATION value.

The DISPLAY will show the following

S :00

and the number on the *right* side of the *colon* will be *blinking*. To select the SATURATION value, TURN the SETTINGS KNOB then either:

- (1) PRESS & RELEASE the SETTINGS KNOB to cache the value and move on to BRIGHTNESS, or
- (2) DOUBLE-CLICK the SETTINGS KNOB to set, save and finish.



22.7.3 Brightness

BRIGHTNESS

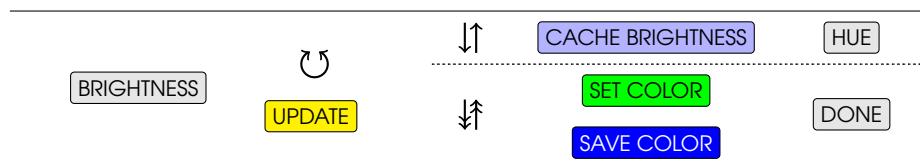
Select a BRIGHTNESS value.

The DISPLAY will show the following

b :00

and the number on the *right* side of the *colon* will be *blinking*. To select the BRIGHTNESS value, TURN the SETTINGS KNOB then either:

- (1) PRESS & RELEASE the SETTINGS KNOB to cache the value and cycle back to HUE, or
- (2) DOUBLE-CLICK the SETTINGS KNOB to set, save and finish.

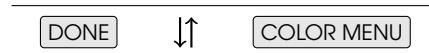


22.8 Done

DONE

This state allows for review of the settings which are shown on the DISPLAY.

At this point you can start over or go to some other mode. To start over and go back to COLOR MENU, PRESS & RELEASE the SETTINGS KNOB.



To go to, say CLOCK mode, TURN the SELECTOR DIAL to the MIDDLE.



22.9 Power

The screens will turn OFF when the device is in NAP or SLEEP states.

<i>Power State</i>	<i>Set Night Light State</i>	<i>Screens</i>
NAP	ANY	OFF
SLEEP		

Table 22.3: Set Night Light - Power

22.10 Reference

<i>State</i>	<i>Action</i>	<i>Effect</i>	<i>Next</i>
	↻	UPDATE MENU OPTION	—
COLOR MENU	↓	SELECT COLOR #1 SELECT COLOR #2 BLINK METHOD SELECT COLOR #3	METHOD MENU
	↻	UPDATE MENU OPTION	—
METHOD MENU	↓	SELECT PRESET BLINK COLOR SELECT RGB BLINK RED SELECT HSB BLINK HUE	COLOR RED HUE
COLOR	↻	UPDATE COLOR	—
	↓	SET COLOR SAVE COLOR DISPLAY SETTINGS	DONE

RED	⟳	UPDATE RED	—
	↑↓	CACHE RED BLINK GREEN	GREEN
	↔	SET COLOR SAVE COLOR DISPLAY SETTINGS	DONE
GREEN	⟳	UPDATE GREEN	—
	↑↓	CACHE GREEN BLINK BLUE	BLUE
	↔	SET COLOR SAVE COLOR DISPLAY SETTINGS	DONE
BLUE	⟳	UPDATE BLUE	—
	↑↓	CACHE BLUE BLINK RED	RED
	↔	SET COLOR SAVE COLOR DISPLAY SETTINGS	DONE
HUE	⟳	UPDATE HUE	—
	↑↓	CACHE HUE BLINK SATURATION	SATURATION
	↔	SET COLOR SAVE COLOR DISPLAY SETTINGS	DONE
SATURATION	⟳	UPDATE SATURATION	—
	↑↓	CACHE SATURATION BLINK BRIGHTNESS	BRIGHTNESS
	↔	SET COLOR SAVE COLOR DISPLAY SETTINGS	DONE

		UPDATE BRIGHTNESS	
BRIGHTNESS		CACHE BRIGHTNESS BLINK HUE	HUE
		SET COLOR SAVE COLOR DISPLAY SETTINGS	DONE
DONE		BLINK MENU OPTION	COLOR MENU
		RESET BLINK MENU OPTION	COLOR MENU
ANY			TIMER
		CHANGE MODE	CLOCK
			SET ALARM

Table 22.4: Set Night Light - Reference

22.11 State Diagram

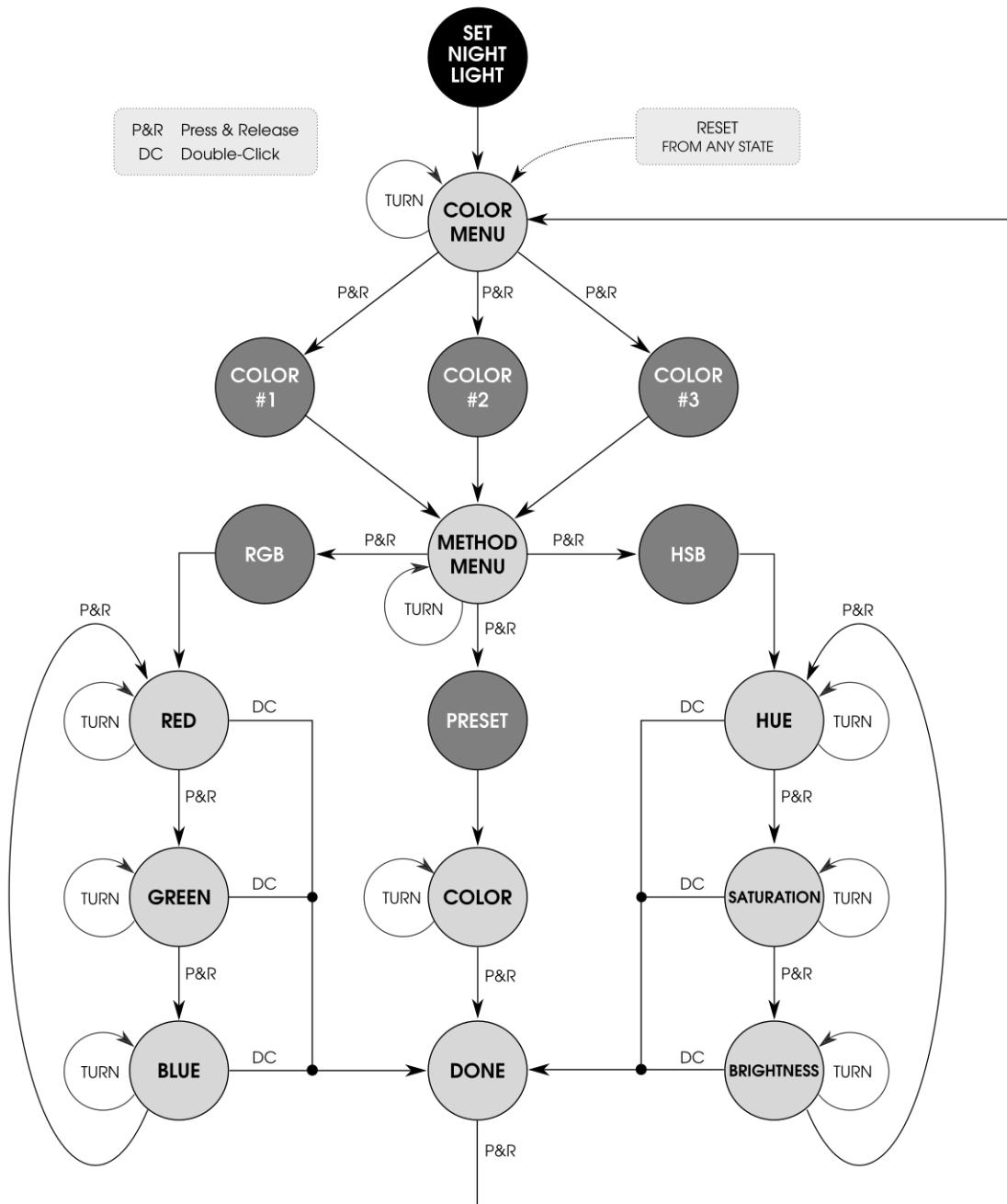


Figure 22.1: Set Night Light - State Diagram

VII

Maintenance

23 Cleaning

A dry or slightly damp rag, preferably microfiber, should be sufficient to get fingerprints, dust and other crud off of the wood finish and aluminum face plate.



Do not use alcohol. Alcohol will ruin the finish. And to be safe, don't clean it with any kind of chemical cleaning solution.

24 Disassembly

Disassembly should only be necessary once every several years to change the COIN CELL BATTERY. The MICRO SD CARD should last for quite a while and should not need replacement for many years. Unfortunately, there is no way to add and remove songs from the MICRO SD CARD without disassembly and manually removing the card to do so. However, it is recommended that this is kept to a minimum.

24.1 Warnings

Please read and heed these warnings. The device can be damaged if you do not.



Be extra careful when removing the screws. This can't be stressed enough. Righty-tighty, lefty-loosey. If you right-tighty when you should be lefty-loosey, the screw **WILL STRIP** the threads in the wood.



When removing the screws take note of which screws came out of which holes. When initially tapping the holes, threads may have been stripped in one or more of the holes requiring a deeper hole and a longer screw.



Take care when lifting the TOP off. The wires attaching the TOUCH SENSOR and COIN CELL BATTERY to the MICROCONTROLLER are attached from the TOP to the circuit board on the BACK. The wires are long enough to take it off, turn it over and set it on top of the open enclosure. But the fit may be tight and it may not simply come off, and pulling it off too abruptly may result in an upward force proportional to the frictional force that was making it difficult to pull off in the first place resulting in the wires getting torn from their connections.



Be extra careful when reassembling. As soon as you feel *any* pressure when turning a screw - **STOP**. If you continue, the threads in the wood **WILL BE STRIPPED** and the screw will no longer hold.



When reassembling, do *not* rely on the screws pulling the enclosure together. Make sure all pieces are tight and flush *before* tightening the screws.



DO NOT USE POWER TOOLS.

24.2 Tools

Only one tool is required - a **3/32"** Hex Driver. However, it is recommended that you have handy pencil and paper to keep track of which holes the screws came out of.

<i>Quantity</i>	<i>Item</i>
1	3/32" Hex Driver, T-handle or Key
1	Pen or pencil
1	Piece of paper

24.3 Top Removal

To remove the TOP, you will need to remove the **4** screws that attach the SIDES to the TOP. The order of removal is unimportant. The TOP will then be turned, flipped and placed on top of the enclosure.



Do the following before proceeding:

- Switch the device OFF using the **POWER SWITCH**.
- Unplug the **POWER ADAPTER**.

24.3.1 Removing the Screws

The screws used are technically machine screws which are generally used with metals, however the wood used for the enclosure is sufficiently dense. Machine screws are used so that the device can be easily taken apart and put back together - though care must be taken when doing so.

Utilizing machine screws as opposed to self-tapping wood screws involves a different process. First a hole is drilled, much like a pilot hole for a self-tapping wood screw, but instead of using a screw driver to drive the screw in, a tap and tap driver is used to create the threads in the hole.

Despite the wood being very dense, it is very easy to strip the threads if overtightened - either when loosening and turning the wrong way or when tightening. So go slow, very slow, and as soon as you feel **ANY RESISTANCE, STOP TURNING**.

Removing Screws

- (1) Orient the enclosure so that you are *facing* the screw you will be loosening.
- (2) Insert the **3/32"** Hex Driver into the head of the screw.
- (3) *Slowly* turn *counter-clockwise* until the screw is *completely* loosened and pull it out.
- (4) Make a note with pencil and paper of the hole the screw came out of and place the screw next to or on top of it.
- (5) Repeat the above steps for all screws to be removed.



Figure 24.1: Disassembly - Loosen Screws



If removing the MICRO SD CARD, in addition to removing the **4** screws attaching the SIDES to the TOP, you may need to remove the **2** screws attaching the LEFT SIDE to the BOTTOM.

24.3.2 Top Placement

After removing the screws, you will lift the TOP, turn it over and place it on top of the enclosure, sitting perpendicular to its attached orientation.

Top Placement

- (1) *Slowly* pull the TOP up. If there is resistance, *gently* rock the TOP from side to side to loosen it until it easily detaches.
- (2) Lift it *no more* than about **1"** above the enclosure - just high enough to be able to turn it perpendicular to the way it is oriented.
- (3) Turn the TOP *counter-clockwise* or to the *left* until it is perpendicular to its attached orientation.
- (4) Flip it over from *left* to *right*.
- (5) *Gently* place it on top of the enclosure.

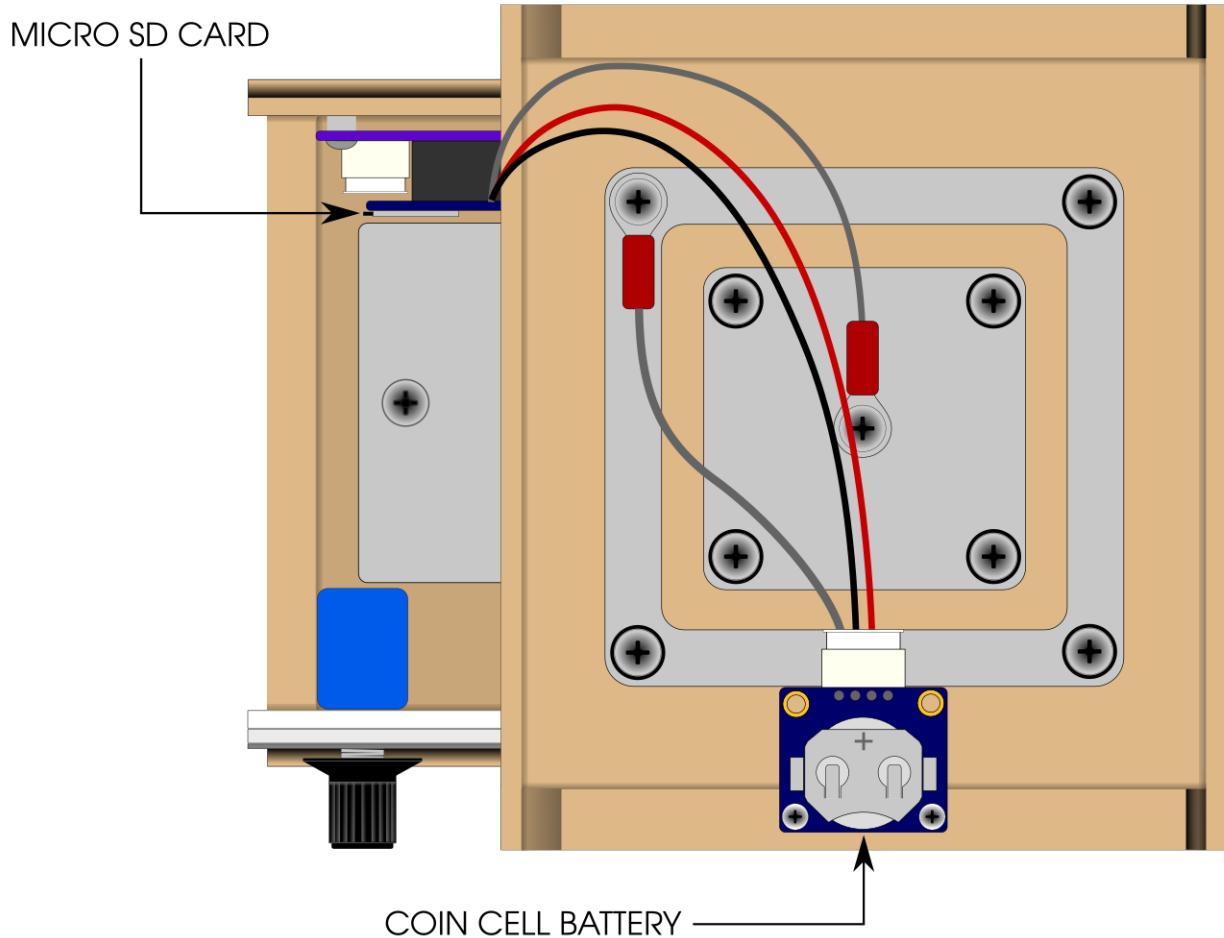


Figure 24.2: Disassembly - Placement of Top

24.4 Reassembly

Place the TOP and possibly the LEFT SIDE, if it was necessary to remove to get to the MICRO SD CARD, back in place. Make sure all wires are *within* the enclosure so that they are not crimped when placing the pieces back together and that all pieces are tight and flush before putting the screws back in and tightening.

Again, go slow, very slow, when tightening the screws and as soon as you feel **ANY RESISTANCE, STOP TURNING**.

Tightening Screws

- (1) Make sure the TOP and SIDES are tight and flush.
- (2) Orient the enclosure so that you are *facing* the screw you will be tightening.
- (3) Insert the screw into the hole - make sure it is the same screw that came out of the hole.
- (4) Insert the **3/32"** Hex Driver into the head of the screw.
- (5) *Slowly* turn *clockwise*. As soon as you feel *any resistance*, **STOP** turning.
- (6) Repeat the above steps for all removed screws.



Figure 24.3: Reassembly - Tighten Screws

25 Replacing the Coin Cell Battery

Replacing the [COIN CELL BATTERY](#) shouldn't be necessary for several years. It is a **CR2032** and is located just underneath the TOP on the *left* side. To access the battery, the TOP needs to be removed - refer to the [Disassembly](#) section for instructions.

25.1 Parts

One **CR2032** coin cell battery is necessary.

<i>Quantity</i>	<i>Part</i>
1	CR2032 (3V) Coin Cell Battery

25.2 Removal

To remove the COIN CELL BATTERY, simply push it from within the bounds of the TOP towards the outside.

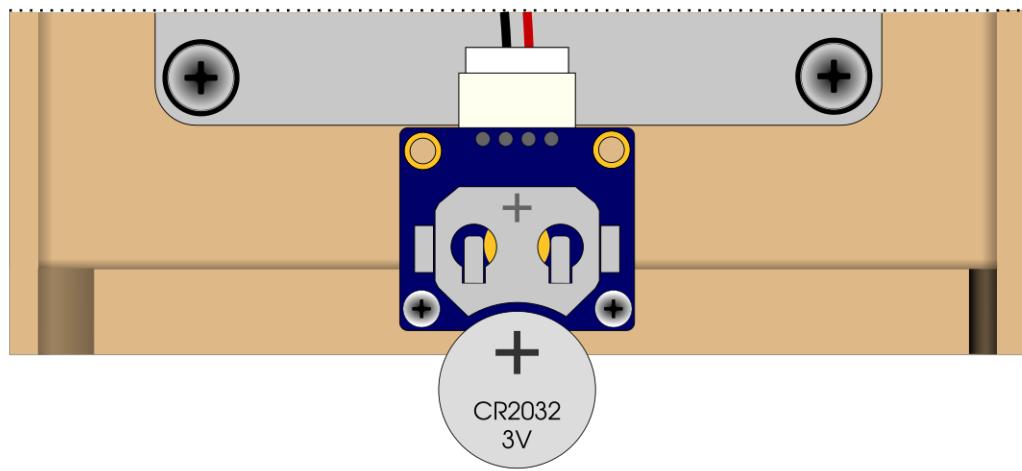
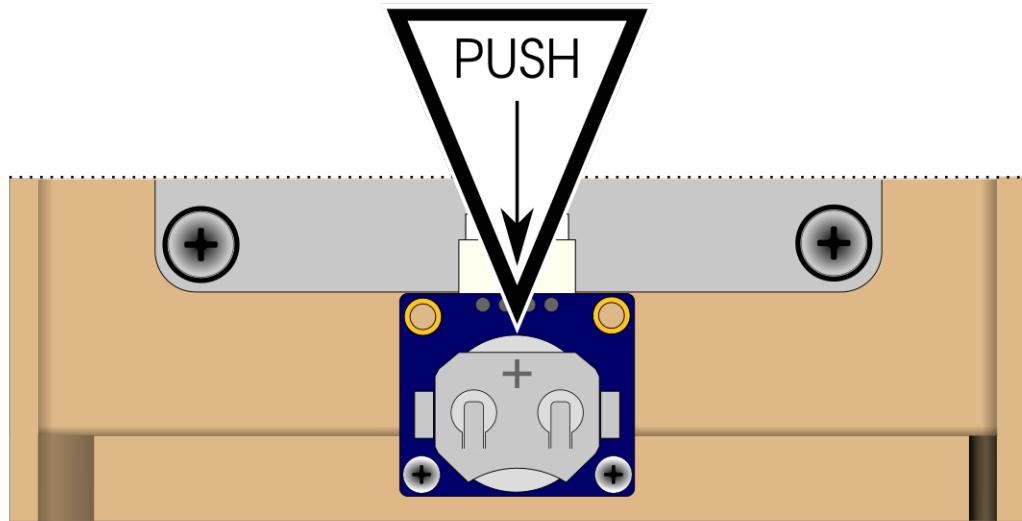


Figure 25.1: Removing the Coin Cell Battery

25.3 Insertion



When inserting the new battery, orientation is critical. If the polarity is reversed, damage may occur.

Before inserting the new battery, make sure the or positive side of the battery is *facing up*. After verifying this, simply push it in the way it came out.

26 Removing the Micro SD Card

The MICRO SD CARD is held in place by a spring clip attached to a part on the circuit board. Removal involves pushing the card inward until you hear a *click*, then releasing. The card will be partially pushed out by the spring clip. You can then pull the card out the rest of the way. To put the card back in, push until you hear a *click* and it will catch into place. Verify that it is in place by gently pulling on it - it should *not* pull out.

Before the MICRO SD CARD can be removed, the enclosure needs to be partially disassembled - refer to [Disassembly](#) for instructions.



You may need to detach the LEFT SIDE to get to the card. If so remove the **2** screws that attach the LEFT SIDE to the BOTTOM in addition to the **4** that attach the SIDES to the TOP - see [Removing the screws](#) in the [Top Removal](#) section.

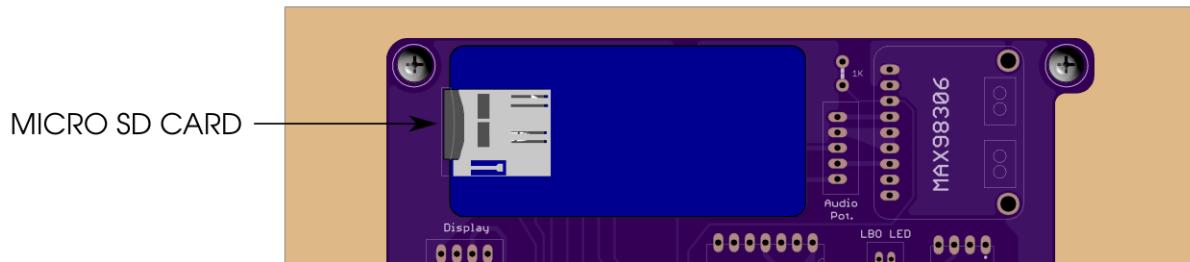


Figure 26.1: Micro SD Card - Location

26.1 Removal

To remove the card:

- (1) Push the MICRO SD CARD inward until you hear a *click*.

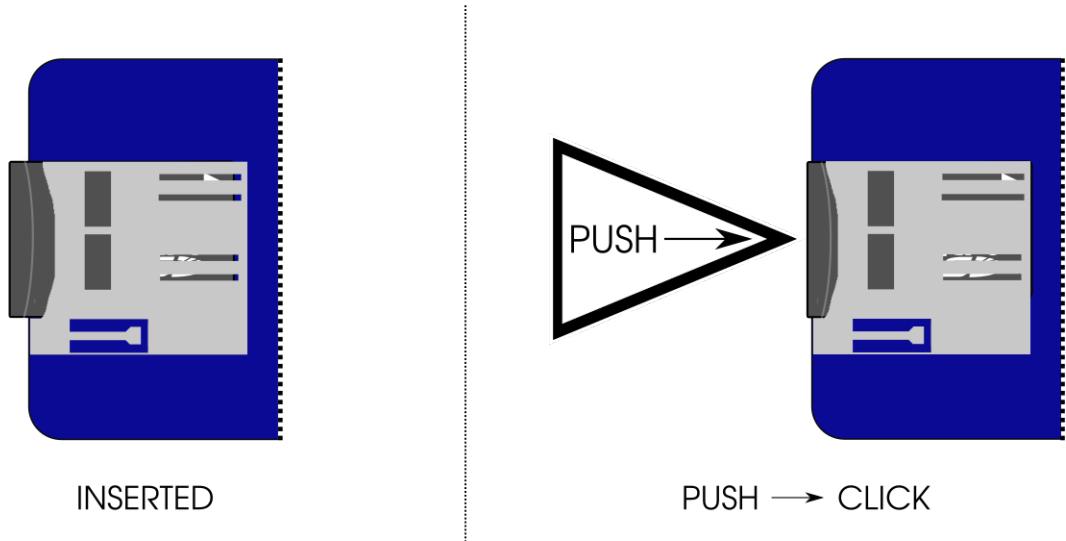


Figure 26.2: Micro SD Card - Removal (Step 1)

(2) Release and the card will be partially pushed out.

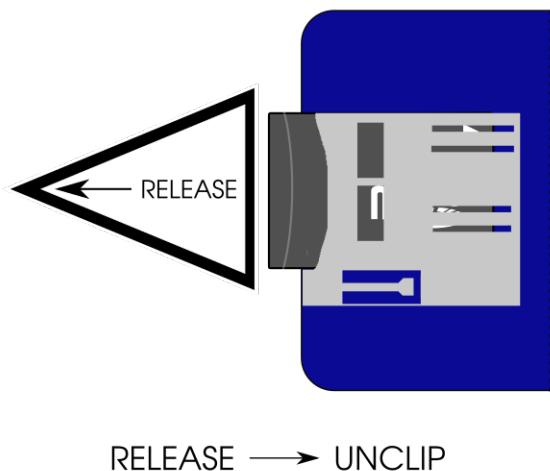


Figure 26.3: Micro SD Card - Removal (Step 2)

(3) Pull the card out the rest of the way.

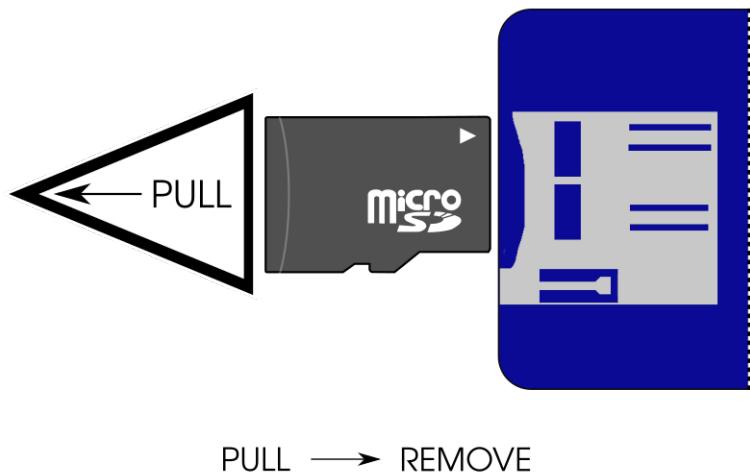


Figure 26.4: Micro SD Card - Removal (Step 3)

26.2 Insertion

To insert the card:

- (1) Push the MICRO SD CARD inward until you hear a *click*.

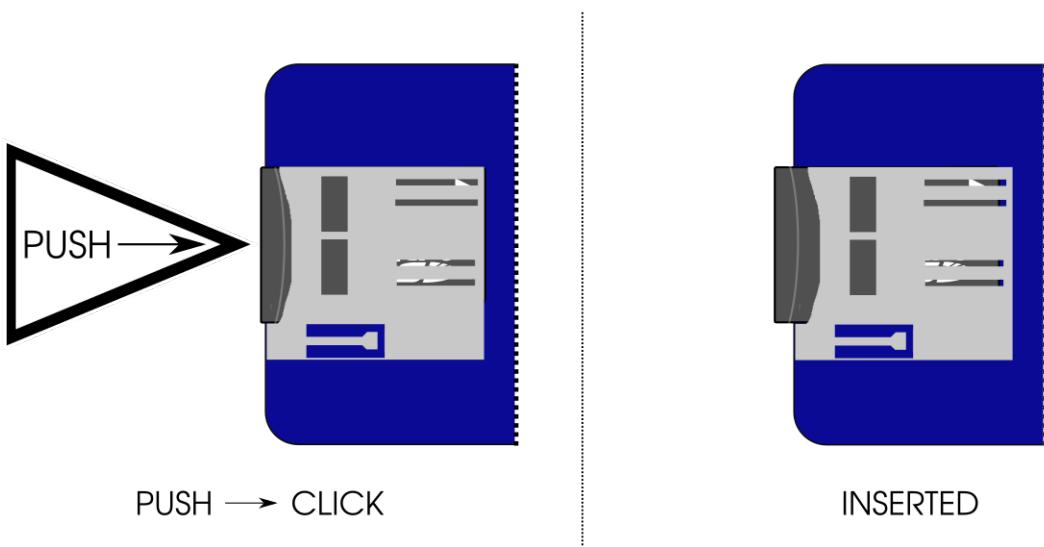


Figure 26.5: Micro SD Card - Insertion

26.3 Adding / Removing Songs

Disassembly is primarily meant for maintenance and changing the COIN CELL BATTERY and should *not* be done often. Unfortunately the only way to add / remove songs from the MICRO SD CARD is to partially disassemble the enclosure - see [Disassembly](#) for instructions.

The MICRO SD CARD can have any number of songs on it, however, the *maximum* number of songs that the device will be able to play is **4096**.

There are a number of ways to add files to the MICRO SD CARD. It will be assumed that a desktop or laptop computer with a windowed environment is being used such as a Mac or Windows.

26.3.1 Preparation

Preparation involves partially disassembling the enclosure, removing the MICRO SD CARD from the holder on the circuit board and attaching the card to a computer.

Preparation

- (1) Partially disassemble the enclosure - refer to [Disassembly](#) for instructions.
- (2) Remove the MICRO SD CARD - refer to [Removal](#) for instructions.
- (3) Insert the card into the computer. There are a couple of ways this may be accomplished.
 - If your computer has a built-in MICRO SD CARD reader, you should be able to use that.
 - Use a USB card reader.^a After inserting the card into the reader, insert the reader into a USB port on the computer.
- (4) The card should be recognized as a disk volume on the computer. The card that comes pre-installed is named **MUSIC**. Open a window that shows the contents of the disk.

^a One that I have used without issue is **Transcend RDF5**.

26.3.2 Adding Songs

Adding songs involves moving **MP3** or **M4A** music files that are on the computer to the MICRO SD CARD.



The files *must* be **MPEG-2 Audio Layer III** or **MPEG-4 Audio^a** files and they *must* have an **.mp3** or **.m4a** file extension. Files that are *not* **MP3** or **M4A** and that do *not* have either of the two file extensions in the file name will *not* work.

^a Used primarily by iTunes.

Adding Songs

- (1) Open another window that has the songs you want to add.
- (2) Drag and drop the **MP3** and/or **M4A** files you want to add onto the MICRO SD CARD volume.

Note that the disk has no concept of sorting and the order in which the songs are "sorted" on the disk is the order in which they are added to the disk. If you want the songs to be played in a specific order, add them *one at a time* to the MICRO SD CARD.

26.3.3 Removing Songs

Removing songs simply involves deleting the files from the MICRO SD CARD.

Removing Songs

- (1) Delete or "Move to Trash" the files you want removed from the MICRO SD CARD volume.

26.3.4 Finishing

Finishing involves ejecting then physically removing the MICRO SD CARD from the computer, putting it back in the holder on the circuit board and closing up the enclosure.

Finishing

- (1) Safely remove or eject the MICRO SD CARD. This is *not* physical removal but tells the computer to finish any possible pending operations, such as writes to the disk, *before* physical removal.
- (2) Physically remove the MICRO SD CARD from the computer.
- (3) Reinsert the MICRO SD CARD back into the holder on the circuit board - refer to [Insertion](#) for instructions.
- (4) Reassemble the enclosure - refer to [Reassembly](#) for instructions.

26.4 Replacement

The MICRO SD CARD may eventually fail and need to be replaced. This section will only focus on formatting the new card. See the [Disassembly](#) section and the preceding sections for removing the card from the enclosure and adding songs.

The new card must meet these requirements.

- The card *must* have at least a **90 MB/sec** read speed, *and*
- The card *must* be formatted with the **FAT32** filesystem using **512** bytes per sector.



If the read speed of the card is less than **90 MB/sec**, the audio may stutter and not play correctly.



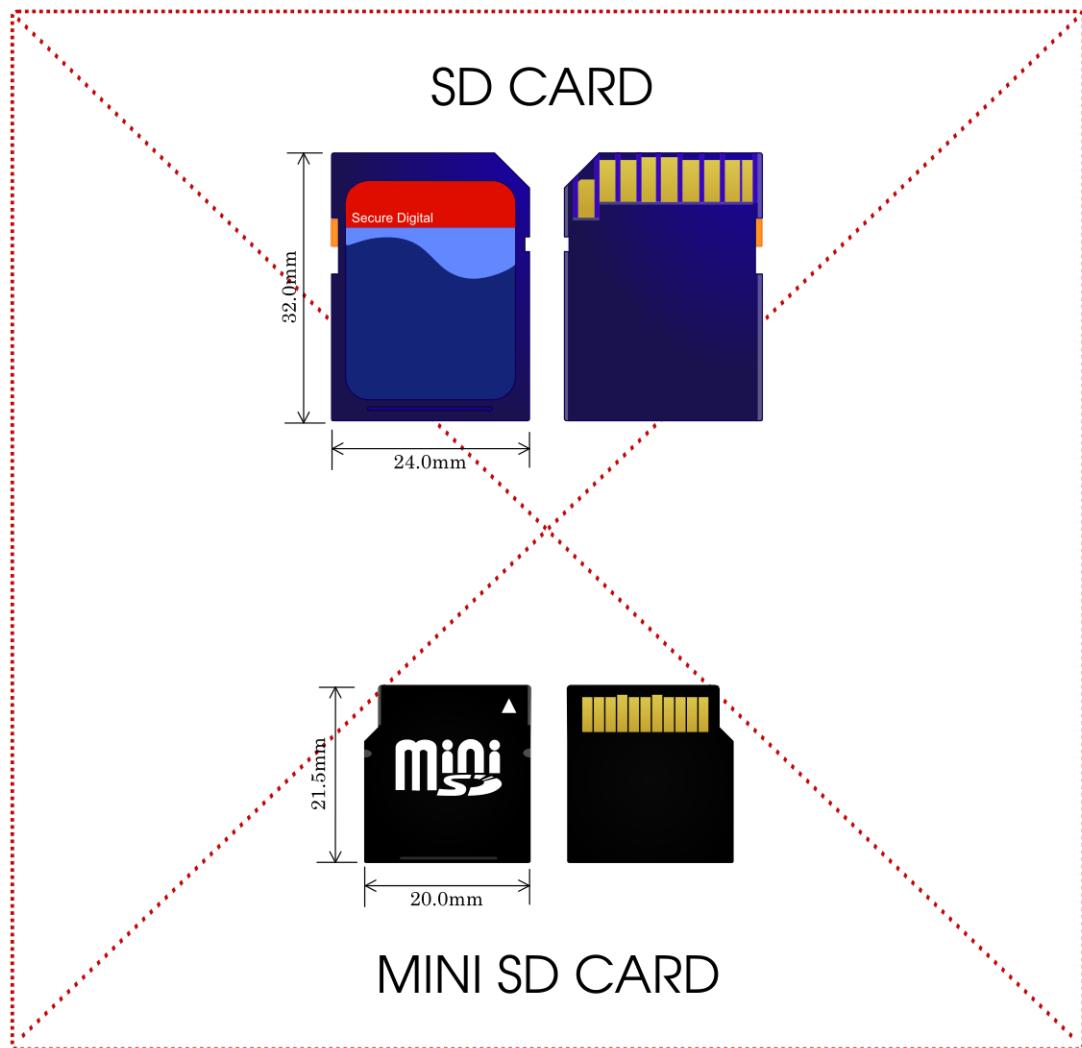
If the card is not formatted with the **FAT32** filesystem using **512** bytes per sector, the device will *not* be able to read the card.

26.4.1 Parts

One Micro SD Card with at least a **90 MB/sec** read speed specification is needed.

<i>Quantity</i>	<i>Part</i>
1	Micro SD Card w/ 90 MB/sec or more Read Speed

A Micro SD Card is distinguished from a normal SD card and the Mini SD Card in that it is the smallest of the three.



MICRO SD CARD

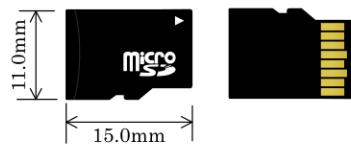


Figure 26.6: SD Cards

26.4.2 Formatting

It is recommended that the [SD Memory Card Formatter](#) application be used to format the card. It is provided for free by the [SD Association](#). The following will assume use of this application.

Download & Open

- (1) Download the *SD Memory Card Formatter* application from https://www.sdcards.org/downloads/formatter_4/. It is available for both Windows and Mac so make sure you choose the appropriate download for your operating system.
- (2) Insert the new MICRO SD CARD into the computer.
- (3) Open the *SD Memory Card Formatter* application.

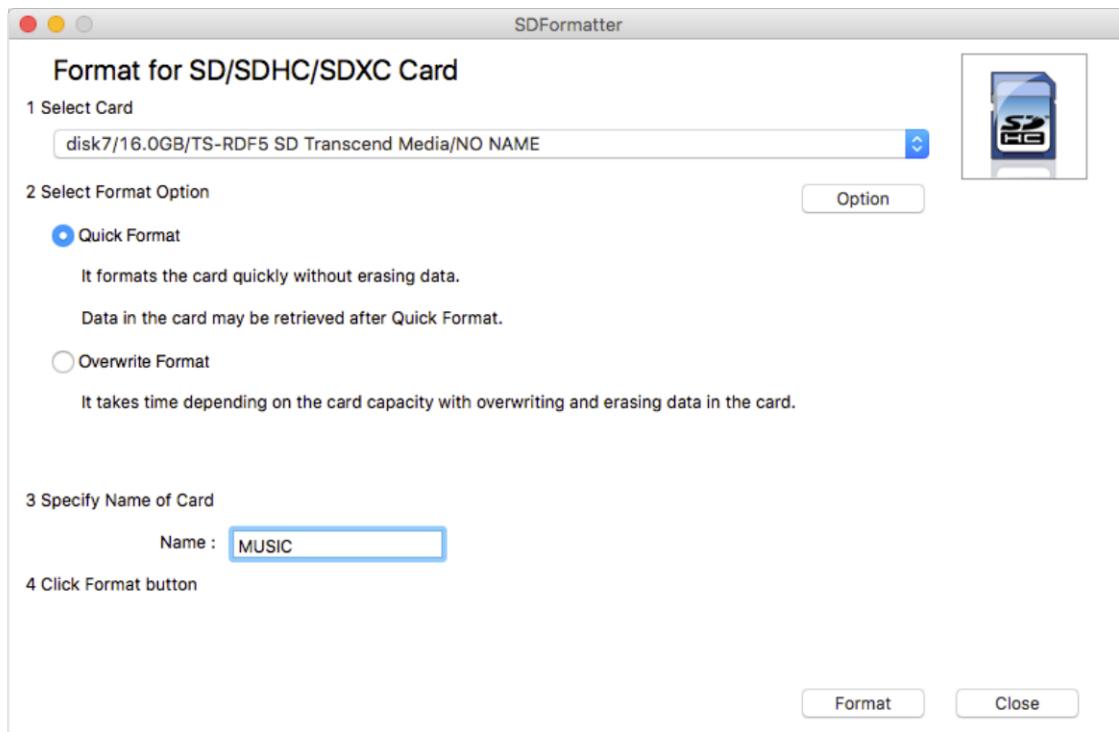


Figure 26.7: Micro SD Card - SD Memory Card Formatter

The window is partitioned into **4** sections which will correspond to the next steps. Make sure when selecting the card in the first step, that you select the card you just inserted. If you select a different card, all of its contents will be erased.



Selecting the wrong card will result in erasing the contents of that card.

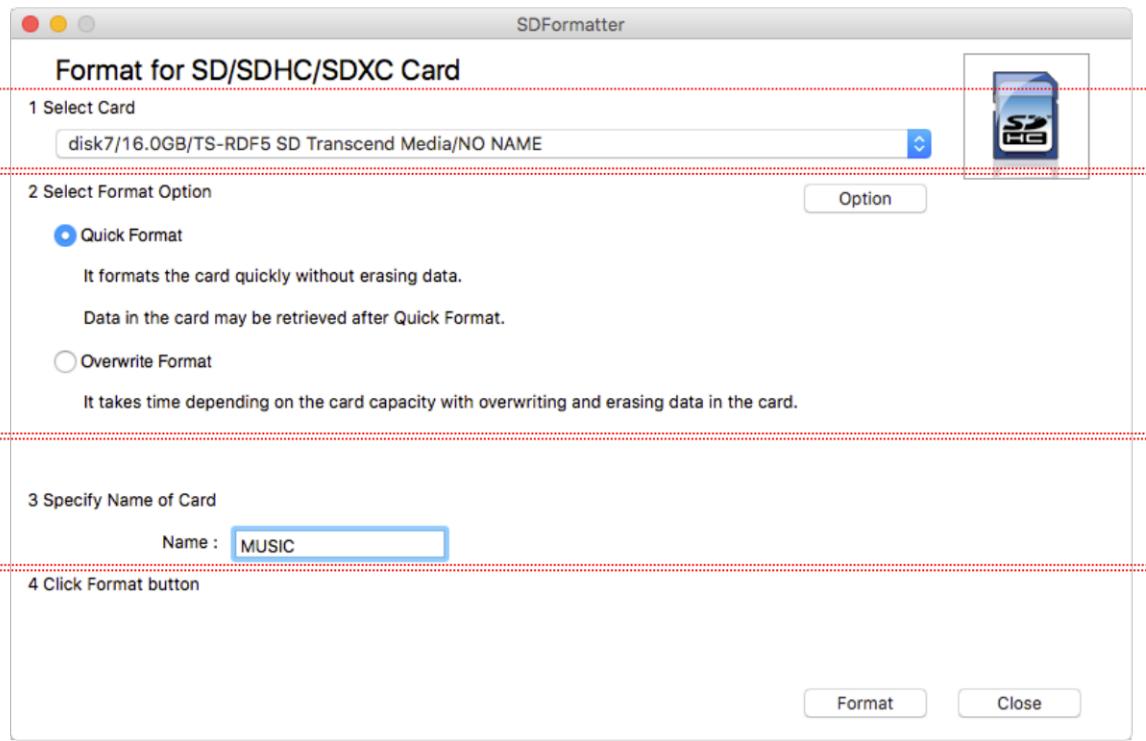


Figure 26.8: Micro SD Card - Formatting

Format

(1) Select Card

Select the card you just inserted from the drop-down menu at the top. If there is more than one choice, make sure you choose the correct card.

(2) Select Format Option

Leave this alone.

(3) Specify Name of Card

You can name this anything you like.

(4) Click Format button

Click on the "Format" button in the lower right. It should not take long and when finished you should see some blue text underneath the option indicating success.

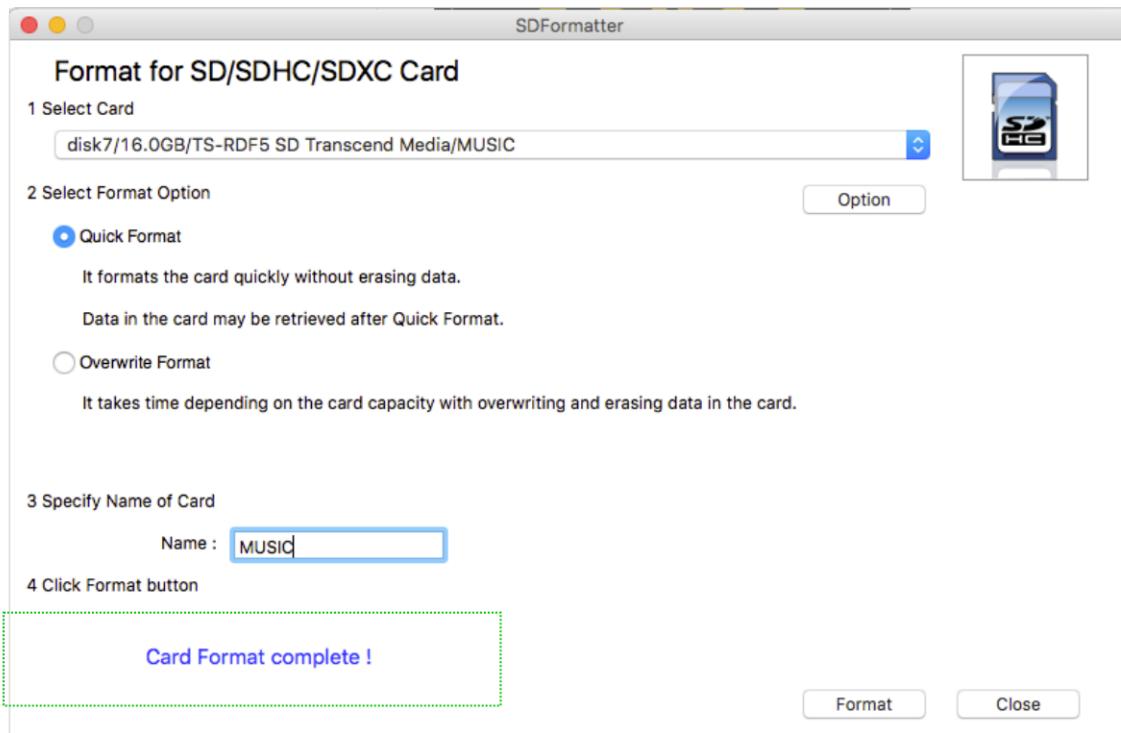


Figure 26.9: Micro SD Card - Formatting Success

You can now add music to the card - see [Adding Songs](#).

VIII

Troubleshooting

27 Common Issues

The following table lists common issues, their severity and possible resolutions.

<i>Problem</i>	<i>Severity</i>	<i>Solution</i>
Speakers pop when turning the AUDIO on.	NORMAL	Turn the VOLUME down before turning the AUDIO on.
The DISPLAY shows remnants when switched ON.	NORMAL	The DISPLAY is getting power initially before it can display what it should.
The LOW BATTERY INDICATOR flickers.	NORMAL	Try turning the VOLUME down and recharge. See Low Battery Indicator and Powering & Recharging .
You see OFF displayed but didn't do anything.	NORMAL	The ALARM was turned off due to <i>Wake Time</i> exceeded or <i>Total Alarm Time</i> exceeded.

	LOW	Try turning the VOLUME up.
You try to play a track and hear nothing.	MEDIUM	There may be a file that for some reason is unreadable. ¹ Try picking another track. If multiple tracks don't play then it may be a problem with the MICRO SD CARD - see below.
	HIGH	The MICRO SD CARD is formatted incorrectly or has failed. See Removing the Micro SD Card for more information.
An error code and string are shown on the DISPLAY.	HIGH	See the Errors section.

Table 27.1: Troubleshooting Common Issues

¹ It could be that though the file has the correct extension, it isn't actually the type of file the extension would indicate.

28 Errors

Listed below are all of the possible errors that the device can recognize. In the event that you see one show up on the DISPLAY, try the following.

- TURN or PRESS the SETTINGS KNOB or TURN the SELECTOR DIAL or fiddle with some other control on the FRONT or TOUCH the TOP if the TOUCH SENSOR is enabled.

If the error on the DISPLAY doesn't go away or the problem continues to persist:

- Switch the device OFF then back ON using the POWER SWITCH.

Again, if the error doesn't go away or the problem continues to persist, refer to the following sections.



If you are unable to resolve the problem or the device is unusable because of the problem, please send the device back for repair. Almost every part is replaceable.

<i>Error Code</i>	<i>Error String</i>	<i>Description</i>
1	C.SEL.	Problem with the SELECTOR DIAL.
2	C.SET.	Problem with the SETTINGS KNOB.
3	C.br.	Problem with the BRIGHTNESS KNOB.
4	C.PL.R	Problem with PLAY PAUSE STOP push-button.
5	C.nE.	Problem with NEXT push-button.

6	C.P<small>r</small>E.	Problem with PREVIOUS push-button.
7	bEEP	Problem with the BEEPER.
8	d ISP.	Problem with the DISPLAY - may not show.
9	LEdS	Problem with the LIGHTING.
10	T<small>OU</small>CH	Problem with the TOUCH SENSOR.
11	F<small>IL</small>E	Problem with the MICRO SD CARD or filesystem on the MICRO SD CARD.
12	A<small>UD</small>.	Problem with audio decoder or amplifier.
13	PLAY	The AUDIO is disabled.
14	P<small>RO</small>BL.	Problem obtaining audio files from the MICRO SD CARD.
15	P.O<small>PE</small>.	Problem opening an audio file on the MICRO SD CARD.
16	P.R<small>UD</small>.	Problem communicating with audio decoder or reading a file.
17	E.P<small>TE</small>.	Problem getting access to timer.

Table 28.1: Error Codes

28.1 Hardware

This class of error indicates a problem with the hardware. There are a few possibilities as to the cause:

- (1) The named piece of hardware has failed.
- (2) The microcontroller has failed.

(3) The *connection* between the named piece of hardware and microcontroller has been severed. This could be due to a couple of reasons:

- A cable that connects the named piece of hardware to the circuit board is disconnected or severed, *or*
- A solder connection or trace on the circuit board has gone bad.

(4) The named piece of hardware is actually working which likely points to a bug in the software.

It is also possible that a piece of hardware could be malfunctioning without any error showing up on the DISPLAY.

28.1.1 Controls

If there is a problem with one of the controls, first check to see if the cable connecting the control to the circuit board is disconnected or severed. Refer to [Disassembly](#) for instructions on removing the TOP.

28.1.1.1 Selector Dial

! CSEL.

The side of the cable that is connected to the SELECTOR DIAL is soldered. There are **4** connections to the SELECTOR DIAL. If any one of these is disconnected then the problem is likely one of connection and *not* due to the SELECTOR DIAL itself being broken.

The side of the cable that is connected to the circuit board is a very secure connection, however, it is possible that a solder joint that connects the female connector to the circuit board has failed.

28.1.1.2 Settings Knob

2 CSET.

The cable connecting the SETTINGS KNOB is terminated with a connector that slides over the pins of the SETTINGS KNOB. If this is disconnected, try reconnecting it. The figure below shows how the cable should be oriented, with the *red* cable on the *bottom*.

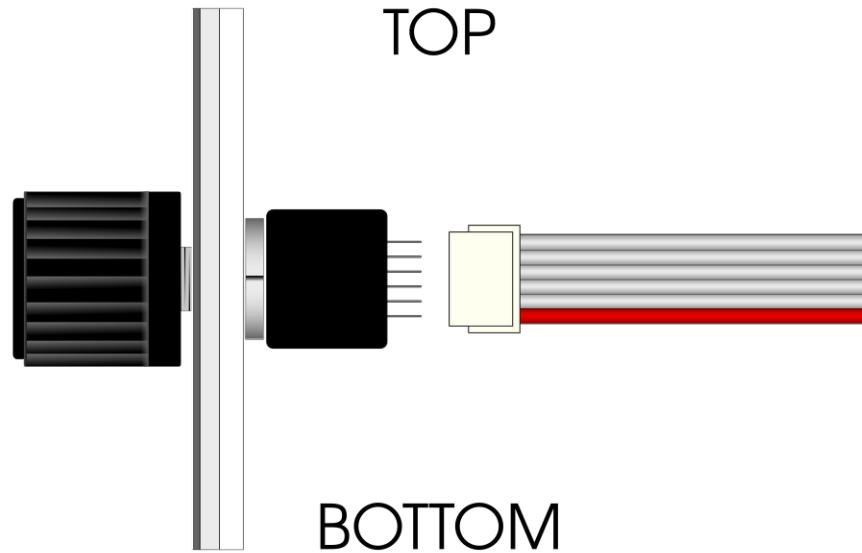


Figure 28.1: Settings Knob and Brightness Knob Cable Alignment

The side of the cable that is connected to the circuit board is a very secure connection, however, it is possible that a solder joint that connects the female connector to the circuit board has failed.

If the SETTINGS KNOB responds to turning but *not* to pressing, then the problem may be due to the circuitry that does switch debouncing.

28.1.1.3 Brightness Knob

3 Cbr.

The cable connecting the SETTINGS KNOB is terminated with a connector that slides over the pins of the SETTINGS KNOB. If this is disconnected, try reconnecting it. See the [Figure 28.1](#) in [Settings Knob](#) above for how the cable should be aligned.

The side of the cable that is connected to the circuit board is a very secure connection, however, it is possible that a solder joint that connects the female connector to the circuit board has failed.

28.1.1.4 Play | Pause | Stop

4 CPLR

The side of the cable that is connected to the PLAY | PAUSE | STOP push-button is soldered. There are **2** connections to the PLAY | PAUSE | STOP push-button. If any one of these is disconnected then the problem is likely one of connection and *not* due to the PLAY | PAUSE | STOP push-button itself being broken.

The side of the cable that is connected to the circuit board is a very secure connection, however, it is possible that a solder joint that connects the female connector to the circuit board has failed.

The problem may also be due to the circuitry that does switch debouncing.

28.1.1.5 Next

5 CnE

The side of the cable that is connected to the NEXT push-button is soldered. There are **2** connections to the NEXT push-button. If any one of these is disconnected then the problem is likely one of connection and *not* due to the NEXT push-button itself being broken.

The side of the cable that is connected to the circuit board is a very secure connection, however, it is possible that a solder joint that connects the female connector to the circuit board has failed.

The problem may also be due to the circuitry that does switch debouncing.

28.1.1.6 Previous

6 CPrE

The side of the cable that is connected to the PREVIOUS push-button is soldered. There are **2** connections to the PREVIOUS push-button. If any one of these is disconnected then the problem is likely one of connection and *not* due to the PREVIOUS push-button itself being broken.

The side of the cable that is connected to the circuit board is a very secure connection, however, it is possible that a solder joint that connects the female connector to the circuit board has failed.

The problem may also be due to the circuitry that does switch debouncing.

28.1.2 Beeper

7 bEEP

The BEEPER is soldered directly to the circuit board. If it is loose then it's a problem of connection, otherwise it has failed.

28.1.3 Screens

28.1.3.1 Display

8 d ISP.

The DISPLAY is actually working, at least in part, if you see this error. It indicates a problem with the I²C communication bus between the DISPLAY and the microcontroller.

The cable connection to both the DISPLAY and circuit board is are very secure connections, however, it is possible that a solder joint that connects the female connector to one or both has failed.

28.1.3.2 Lighting

9 LEds

There are **2** rows of **8** LEDs in each row that make up the LIGHTING. Each row or strip is soldered to a small circuit board. These connections may be the problem for the failure.

The cable connection to both the LIGHTING and circuit board is are very secure connections, however, it is possible that a solder joint that connects the female connector to one or both has failed.

28.1.4 Touch Sensor

10 TOUCH

There is a wire connecting the TOUCH SENSOR to the microcontroller. The terminal connecting to the TOUCH SENSOR is a ring terminal held in place by a screw. Make sure this is tight.

Otherwise, the cable may be severed.

28.1.5 Filesystem or Micro SD Card

11 FILE

This could mean that either:

- (1) The filesystem on the MICRO SD CARD is not formatted as **FAT32** with **512** bytes / sector, *or*
- (2) The filesystem is corrupted and/or the MICRO SD CARD is bad.

If you have just replaced the MICRO SD CARD, it may mean that it was formatted incorrectly. If you haven't replaced the MICRO SD CARD, then it will likely need replacing. Refer to [Removing the Micro SD Card](#) for instructions.

28.1.6 Audio Decoder or Amplifier

12 Aud.

This likely means that the audio decoder or amplifier has failed.

28.2 Audio

These errors may or may not be recoverable and may or may not be hardware issues.

28.2.1 Audio Disabled

13 PLAY

This error indicates that the AUDIO has been *disabled* due to one of the following:

11 FILE
12 Aud.
14 PF IL.
15 P.OPE.
16 PRaud.

You will see one of the above errors *first*, then this error indicating that the AUDIO has been disabled and is unusable.

28.2.2 Audio Files

14 PF IL.

There is a problem obtaining the audio files from the MICRO SD CARD.

15 POPE.

There is a problem opening an audio file that is on the the MICRO SD CARD.

16 PRud.

There is a problem communicating with the audio decoder or a problem reading an audio file that is on the the MICRO SD CARD.

These are likely due to one of the following:

- (1) The MICRO SD CARD is not formatted correctly or is failing.
- (2) There is a problem with the audio decoder.

If you have just replaced the MICRO SD CARD, it may mean that it was formatted incorrectly. If you haven't replaced the MICRO SD CARD, then try replacing it. Refer to [Removing the Micro SD Card](#) for instructions.

If the above doesn't solve the problem, then it likely means that the audio decoder has failed.

28.3 Timer

17 EP IL.

This error indicates that a timer could not be acquired. It should never happen and indicates a bug in the software.

IX**Appendix**

29 Hexadecimal

Hexadecimal¹ is a base **16** numeral system. It is composed of **16** symbols as opposed to decimal (base **10**) which is composed of **10**. The symbols **0-9** in hexadecimal are equivalent to the same in decimal. The values **10-15** in hexadecimal are represented by the letters **A, B, C, D, E** and **F** (or alternatively lower case **a, b, c, d, e** and **f**).

Hexadecimal Letter Symbols

<i>Symbol</i>	A	B	C	D	E	F
<i>Decimal Equivalent</i>	10	11	12	13	14	15
<i>Display</i>	A	b	c	d	E	F

Some settings use hexadecimal since the DISPLAY is limited to four digits and a larger number can be represented using fewer digits in hexadecimal. The maximum decimal number that can be represented with **4** digits is **9999** whereas the maximum hexadecimal is **65535**. There are also cases where **2** digits are used during configuration - in this case the maximum is **99** for decimal and **255** for hexadecimal.

¹Browse [here](#) for a more detailed explanation.

Maximum Values per Number of Digits				
Number of Digits	1	2	3	4
Decimal	9	99	999	9999
Hexadecimal	F = 15	FF = 255	FFF = 4095	FFFF = 65535

Table 29.1: Maximum Decimal and Hexadecimal Values per Number of Digits

To determine the value of a number, you can multiply the digit by the base to the power of the digit position minus 1 and add up the results.

$$\sum_{n=1}^{Digits} Digit[n] \times Base^{n-1} \quad (29.1)$$

In decimal you have the 1's (10^0), 10's (10^1), 100's (10^2), 1000's (10^3), 10000's (10^4), etc. columns or digit positions, and in hexadecimal you have 1's (16^0), 16's (16^1), 256's (16^2), 4096's (16^3), etc. columns / digit positions. Take for example, the decimal number 25341_{10} .² The hexadecimal equivalent is $62FD_{16}$ and can be converted to decimal.

²A subscript attached to a number is used to denote the base of that number.

Hexadecimal 62FD₁₆ → Decimal 25341₁₀

<i>n</i>	<i>Digit[n]</i>	<i>Baseⁿ⁻¹</i>	<i>Digit[n] × Baseⁿ⁻¹</i>	Result
1	D = 13	$16^{1-1} = 16^0 = 1$	13×1	13
2	F = 15	$16^{2-1} = 16^1 = 16$	15×16	240
3	2	$16^{3-1} = 16^2 = 256$	2×256	512
4	6	$16^{4-1} = 16^3 = 4096$	6×4096	24576
<i>Total</i>				25341

The number 25341₁₀ can only be shown on the DISPLAY using hexadecimal notation and will look like the following.

62Fd

30 Display Numbers & Letters

30.1 Numbers

<i>Number</i>	<i>Decimal</i>	<i>Hexadecimal</i>
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9

10	—	
11	—	
12	—	
13	—	
14	—	
15	—	

Table 30.1: Number Display Representations

30.2 Letters

<i>Letter</i>	<i>Upper Case</i>	<i>Lower Case</i>
A / a		—
B / b	—	
C / c		
D / d	—	
E / e		—
F / f		—

G / g

g

H / h

H

h

I / i

I

i

J / j

J

K / k

—

—

L / l

L

l

M / m

—

—

N / n

—

n

O / o

O

o

P / p

P

Q / q

—

—

R / r

r

S / s

S

—

T / t

—

t

U / u

U

u

V / v

—

—

W / w	—	—
X / x	—	—
Y / y	—	Y
Z / z	—	—

Table 30.2: Letter Display Representations