

# Redesign of RadioShack 1.8 Inch Big Digit Atomic Clock



## Introduction

The RadioShack 1.8 Inch Big Digit Atomic Clock is a basic alarm clock which features two alarms and has an overly-complicated interface for setting the clock, setting the alarms, checking the alarms, and arming the alarms. The specifications indicate that this clock has the ability to receive a radio-frequency atomic clock time signal, which promises to simplify setting the time. Its larger than average digits are designed for visibility. For clarity, the 1.8" figure in the title applies to the total width of the italicized numerals, not their height (which is about 3"), nor the width of the spanning strokes of the characters (which is about 1").

The front of the clock in normal operation has a large red digital clock display with four digits and three other controls consisting of labeled dots. On the left hand side are two dots labeled ALM1 and ALM2, which are presented vertically. These indicate with a red dot if a particular alarm is armed. On the bottom right side is a dot labeled PM which indicates if the 4-digit time is PM.

Many controls are located on the back of the unit, and most of the rest are concealed behind a lid on the front. The snooze bar is the only control accessible from the front.

To disarm the alarm the user must operate a switch on the back of the clock, located on the top right hand side. This can be accomplished fairly easily if the user is familiar with the

design, however there are no markings of visible on the front to indicate the location of this essential switch. The 2-way alarm arming switch is labeled "ALARM", "ON" and "OFF".

An especially difficult consequence of the alarm arming switch being located on the back is that in order to properly understand what happens when the switch is operated, one has to have it turned away from



oneself. The easiest way to achieve this is to pinch the edge of the clock between a thumb and index finger to move the switch, and observe two ALM dots on the left hand side turning on and off as the alarm(s) are armed and disarmed.

Note: This switch-unseen design has the added problem of leading the user to occasionally touch and sometimes change the switch as the clock is handled, which unfortunately is required for normal use by this design.



Adding to the complexity of this design, the alarm arming switch ("ALARM") doesn't control which alarms are armed. It only switches the clock into a state where either or both alarms are armed. To determine which alarms can be armed, there is a horizontal 3-way switch located in a concealed bank of controls on the bottom-front-right of the unit. This control is



labeled ALM1, ALM1+ALM2, ALM2, with lines connecting each switch position to the labels. As was said before, as the choices are made, the dot(s) on the left hand (opposite) side of the display will light up for each alarm that is selected if the ALARM switch is switched to "ON". If nothing happens then this means that the ALARM is switched off.

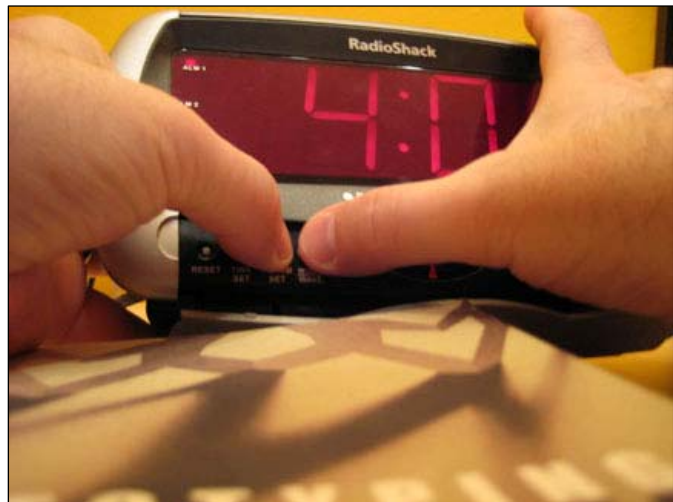
Beyond the difficulties that the user must bear to understanding how to set the alarm, there are still other problems which gravely affect the usability of this device. In order to access the concealed bank of controls on the front bottom, the user MUST pick the unit up completely. If the user picks the clock up correctly, by design the lid should fall down (in an open position), and this is reversed when it is set back down. However, sometimes the user will pick up the clock in such a way that the lid is held closed by the weight of the clock itself, by friction, or by the dangling cord, in which case it is sometimes useful to insert a fingernail into the edge of the plastic lid and open it (effectively leveraging the rest of the clock upward).

Unfortunately, many critical activities MUST also be done with the lid open. These include setting the selected alarm(s) and setting the time, as well as resetting the clock, and triggering the clock to seek the time from the radio frequency NIST time service.

## Setting the Alarm

To set an alarm's hours the user holds down the ALARM SET button with the left thumb, while holding down the HOUR/WAVE button with the right thumb. This allows the hours to be either toggled through or by holding the hour button down the 24 hour cycle can be rushed through. Likewise an alarm's minutes can be set by holding down the ALARM SET button while toggling through or rushing through the 60 minute range. A devilish detail is that an alarm can only be set when the 3-way switch is either pointing to ALM1 or ALM2. If the user attempts to set the alarm while the 3-way switch is set to ALM1+ALM2, nothing happens.

Unfortunately, the design of the ALARM SET button and the other three buttons in the array time setting controls has some especially frustrating limitations. First, the buttons are much too small to be operated with precision, and they don't have enough action, so it is very difficult to tell from touch whether they are being held in effectively or if they may become involuntarily deselected. This can and does routinely happen just from finger fatigue.



Also the time setting controls are located too close to one other, and also too close to their labels. Furthermore they have nothing to distinguish them from one another by feel. Additionally their position on the far left, behind the lid, means that the most natural way to operate the whole affair is pushing the time control buttons with both thumbs while the remaining fingers support the device. The off-center location of the time controls requires the right thumb to stretch awkwardly, and by putting one's fingers over the buttons, the labels are at that point no longer able to be seen.

## Setting the Time

Setting the time is really the same exercise as setting the alarm, except that there are a couple of extra issues. The most glaring is that the HOUR/WAVE button is modal. When TIME SET is depressed, pressing HOUR/WAVE allows the user to visit all 24 hours in 3 seconds by holding the button down, or to toggle one hour at a time. This is effectively



"hour" mode. However, if TIME SET (or ALARM SET) is not depressed, or becomes un-depressed while cycling, the clock's "Manual Time Update" is triggered. Note: "Wave" presumably refers to the radio waves that should reset the clock.

Entering wave mode replaces the 4-digit time display with ":00". The manual explains that this is a complex display of counting minutes, as the clock attempts to receive a signal to reset the time. The display also shows a 4-position signal strength bar meter which appears to the left of the colon. Pressing TIME SET returns the clock to displaying the time.

It is unclear what would happen if the clock received a signal when entering "wave" mode. One supposes that it would set itself, however the manual indicates that this process may take up to 20 minutes, so it is not clear what would happen to the clock as it orients itself to the time signal. The

### SIGNAL STRENGTH DETECTION

\_:00 appears when the clock receives a signal. The digit left of the colon indicates the level of signal strength.

Signal Indicator	Signal Strength
Blank	No signal
Single bar	Weak
Double bar	Medium
Triple bar	Strong

Place your clock in a location with strong signal strength. It is recommended to locate the clock near a window facing the direction of Fort Collins, Colorado. If the clock has poor signal reception or unstable signal marks, move the clock to another location.

While the clock is receiving, press TIME SET once to go to the Time display mode. The clock continues receiving the atomic time. Press HOUR/WAVE to enter Signal Strength display.

While the clock is receiving, if you set the time or an alarm, the clock stops receiving immediately.

When receiving cannot be completed at 7 minutes after power up, the clock returns to the time display with clock 12:07 am appears and remote control (RC) receiving continues.

manual also concedes that the NIST time-seek feature may not work at all. Amazingly it advises: "It is recommended to locate the clock near a window facing in the direction of Fort Collins, Colorado. If the clock has poor signal reception or unstable signal marks, move the clock to another location."

## Other Controls

Beside the four time control buttons, there is a fifth button which is very small and deliberately difficult to press, which changes the time to 3AM.

Finally, there are several other controls on the back of the clock. In all there are 3 2-way sliding switches, and 1 4-way sliding switch. Viewed from the back, on the bottom left is a DIMMER switch which is labeled HIGH and LOW. On the top right is the 4-way TIME ZONE switch labeled PST, MST, CST, and EST. Bottom right is the DST switch labeled ON and OFF.



## Two Proposed Redesigns for the RadioShack 1.8 Inch Big Digit Atomic Clock

The two proposed redesigns of the RadioShack 1.8 Inch Big Digit Atomic Clock are very similar to one another, but take the requirements for the clock in different directions, one with a touch screen design and the other with a button based design. The interface which is the focus of the redesign and which is also studied in the GOMS analysis section is the combined set of controls which are used to set the time, and set and arm the alarms.

Many structural elements are shared between both redesigns. First there are no longer any controls which are invisible from the front of the clock. Second, the clock display appears very similar in both redesigns. In fact, of the three sections (left, middle and right), only the middle section has any controls which appear different from one redesign to the other. On the left is the "Combined Setting/Displaying Mode". In the middle is the time and time controls. And on the right is the "Alarm Setting Mode".

### The Touch Screen Redesign



In the touch screen redesign all the controls are on the touch screen itself. The "Combined Setting/Displaying Mode" controls consist of a stack of 4 words and a "Mode" label. At all times all four words appear on screen and one of the words is an active selection, which is indicated by a reversal of the colors. Touching any part of this control advances the selection down one position until it returns eventually to the top.

The "Alarm1", "Alarm2", and "Time" selections unlock the middle "Number Section" for editing, which makes the numbers smaller, and triangles signifying the top of an arrow labeled "+" and "-" appear as reversed buttons above and below the hour and minute numbers. When the "Combined Setting/Displaying Mode" again becomes "Locked" the number section is again restored to its default working state which is to have the +/- controls disappear and the numbers again take up the full height of the display.

An AM/PM toggle is part of the "Number Section" display, and above it is a toggle control for amount of brightness the unit produces, symbolized alternatively by an eye which is either open or closed. A closed eye indicates not seeing/darkness, and open indicating seeing/brightness (i.e. dim vs. bright).

On the right hand side of the display is the "Alarm Arm Mode" section, labeled simply "Arm". This section consists of a similar interface to the "Combined Setting/Displaying Mode" section, with an advancing selection that moves between four items in a list which also are always onscreen: "1", "2", "1+2", and a symbol for none which is a circle with a line through it. Really this is also one big control, and touching it anywhere moves the selection down one position until it returns to the top.

## The Button Redesign



The onscreen functionality of the button redesign is almost exactly the same as the touch screen redesign. In the case of the left-hand "Combined Setting/Displaying Mode" and right-hand "Alarm Arm Mode", what appears onscreen is exactly the same as the touch screen redesign. However, in the button design, the movement of mode selections is controlled by buttons directly above and below the related display element.

In the case of the "Number Section" the +/- buttons are also off-screen, and therefore there is no need for the numbers to change size regardless of the current "Combined Setting/Displaying Mode".

All of the buttons are all as large as possible given the other constraints of the device with breathing room between them. However, the "Open eye/Closed eye" button is shaped like an eye to help distinguish itself from the functionality of the AM/PM toggle button below it, which for the same reason is shaped like the letter "M", for "Meridian". The goal here is to emphasize their independence from one another and from the three four pairs of complementary buttons which surround them.

A final comment is probably required about this alleged "Atomic clock". Unfortunately this product is not really an "Atomic clock" at all. Even if it potentially could set itself, the current design doesn't work for many or most users who are unwilling to locate their alarm clock near a window which happens to be facing the source of the time signal. This is a ludicrous feature for a product. Therefore, the atomic clock features have been dropped from the redesigns. The clock is infinitely more useful with a single, simplified interface to set the time, and the complete absence of any controls related to daylight savings time, time zone, radio frequency signal strength, etc.

## Heuristic Analysis and GOMS Analysis

### Heuristic Analysis

In the field of human computer interaction (HCI), a heuristic analysis is one in which a user interface is reviewed by experts and its effectiveness is assessed in terms of broadly stated characteristics of a good user interface. In this case the current design of the RadioShack 1.8 Inch Big Digit Atomic Clock is being compared with the two alternative designs, a touch screen design and a button based design.

This narrative explores the three designs in terms of seven broadly stated characteristics of a good design:

- Don't Waste the User's Time
- User control
- Consistency
- Reduce short-term memory load
- Error Handling
- Universal Usability and Accessibility
- Pleasurable to Use

### Don't Waste the User's Time

The RadioShack Big Digit Atomic Clock seems to have pursued a design that is 100% based on trying to an initial impression of being simple. To this end it hides almost all of the controls out of sight. This design strategy adds unnecessary time and effort to using the device for anything other than observing the time and hitting snooze.

By comparison the Button Redesign and the Touch Screen Redesign put the entire range of alarm setting, time setting, and alarm arming controls in plain view.

### User Control

The RadioShack Big Digit Atomic Clock design makes a mess of the alarm arming control, first by locating it on the back of the unit and not even showing in some way from the front

where it approximately is. Second, the ability of a user to arm some combination of the two alarms depends on the state of the obscured 3-way switch. The task of setting the alarm also relies on the state of the 3-way switch. This makes the 3-way switch two modes at once, a "which alarm(s) will be armed" mode, and a "which alarm do you want to set mode".

Entering "Wave" mode while setting the time takes control of the user away suddenly and unpredictably, replacing the time with ":00" which is hard to interpret. The 4-position signal strength bar display which should appear to the left of these digits shows nothing for "no signal", which is even harder to interpret. Effectively users have to be familiar with the manual to know what to do to escape this mode and to understand what has happened to them.

By comparison the Button Redesign and the Touch Screen Redesign untangle this multiple mode nightmare by clearly labeling two arrays of controls which present to the user all the same options for arming and setting the two alarms.

### **Consistency**

The RadioShack Big Digit Atomic Clock places some controls on the back, in four different locations, and some controls on the front in two locations which are both out of sight behind a lid. This is really confusing, in part because the user can't ever look at all of them.

By comparison the Button Redesign and the Touch Screen Redesign locate all the controls in plain view at all times. All the controls related to alarm arming are located together. Likewise, the controls which affect whether an alarm of the clock is to be set are also located together. Both of sets of moded controls reveal the state of the mode selection at all times as well.

### **Reduce short-term memory load**

The RadioShack Big Digit Atomic Clock tests the user's memory in a variety of ways. First it demands that the user remember where the ALARM OFF switch setting is. Additionally, the dot symbol for alarm arming actually requires a memory action to make use of it. This is

because the dots symbolize how many alarms will be set, which alarms will be set, and from another point of view which alarms are set. However, the dots require that one knows which alarm they refer to. While this is fairly obvious up close, this isn't at all obvious from far away. This means that if a user takes a long nap it may be impossible to know whether it is 7pm or 7am. Likewise, if a user sees an alarm is set, the user may need to get a closer look to determine which alarm is set.

The time and alarm setting controls design forces the user to remember the position of the time setting controls, and denies them the ability to see the labels when they are operating the controls.

By comparison the Button Redesign and the Touch Screen Redesign makes it more obvious from a distance which alarms are armed and whether it is AM or PM.

### **Error Handling**

The RadioShack Big Digit Atomic Clock invites errors by making the HOUR/WAVE mode be determined by whether the TIME button is depressed or not. The reset button design would have been a much better choice for something as disruptive as triggering the clock to seek a new time signal.

By comparison the Button Redesign and the Touch Screen Redesign do away entirely all the irritating confusion and uncertainty related to automatic time setting. In the redesigns only one mode of operation allows a user to change the time/alarm.

### **Universal Usability and Accessibility (Learnable)**

The RadioShack Big Digit Atomic Clock is a usability nightmare. Even while concentrating on it, the TIME SET/ALARM SET buttons are hard to keep pushed in consistently while trying to set a time. One can only imagine that small children or seniors would find the task nearly impossible. Additionally the location of the alarm set control out of sight means that only people familiar with the alarm can turn it off. This presents a severe and unnecessary obstacle to learning the system.

By comparison the Button Redesign and the Touch Screen Redesign puts all the controls on the front of the clock and never requires a user to push more than one button at a time.

### **Pleasurable to Use**

The RadioShack Big Digit Atomic Clock is extraordinarily unpleasant to use. Its darkest moments occur literally when one attempts to use it in the dark. Setting the alarm is especially difficult because the time setting controls are not lit in any way and all feel exactly the same. This means that it is not uncommon to accidentally change the time while trying to set the alarm. It is also noisy to have the lid opening and closing and to have to pick the clock up and put it down to change the alarm.

By comparison the Button Redesign and the Touch Screen Redesign are much more pleasant to use.

## GOMS Analysis

A GOMS (Goals, Operators, Methods, and Selection Rules) analysis is an analysis of a task which reduces it into categorized units of activity that are scored according to an aggregate time of use. The activity is idealized in the sense that it studies perfect successful completion of a task, rather than considering how hard a task is for users. Thus, the goal of the GOMS analysis is to resolve a task to a measurement of time, the implication of which is that activities that take shorter amounts of time are better, or at least more efficient.

The traditional GOMS system reduces all tasks in an activity to five metrics:

K = Keying (.2 seconds)  
P = Pointing (1.1 seconds)  
H = Homing (.4 seconds)  
M = Mentally Preparing (1.35 seconds)  
R = Responding (1 second)

Then a complicated set of rules remove Ms for a variety of exceptions: anticipated Ms, Ms that interrupt cognitive units, Ms before consecutive terminators, Ms that are terminators of commands, and Ms that overlap.

In this implementation of GOMS since there is no mouse, and all operations are being performed with fingers some adjustments will be made to the traditional GOMS model. Homing will be redefined as the act of moving the locus of attention from one set of controls to another, such as picking up the clock, doing something involved and physical with it, rather than moving between keyboard and mouse and will be scored at 2 seconds. Pointing will be redefined as putting one's finger on a control and pressing or sliding it -- this sounds at first like it should be an example of keying, but keying is supposed to be almost effortless, and the buttons on this device need to be pushed precisely and firmly, i.e. consciously; this is much more like pointing. The scoring for pointing remains the same. Keying will be reserved for nearly effortless button pushing which comes into play mostly for the two redesigns.

Revised scoring for alarm clock operation:

- K = Keying (.2 seconds)
- P = Pointing (1.1 seconds)
- H = Homing (2 seconds)
- M = Mentally Preparing (1.35 seconds)
- R = Responding (1 second)

The task to be analyzed is: **Reset Alarm 1 from one value to another (10:00am to 7am), and then arm the alarm.**

**Existing Design GOMS Analysis (Control)**

Action	Operation	Action Time
Observe ALM1 dot and store dot state in short term memory.	M	1.35
Observe ALM2 dot and store dot state in short term memory.	M	1.35
Evaluate by dot count if the 3-way switch is switched to Alarm 1 only; it is.	M	1.35
Pick up clock.	H	2
Make sure cord doesn't impinge on anything else close to the alarm clock.	M	1.35
Observe whether lid opened properly; it did.	M	1.35
Identify ALARM SET button within closely grouped set of time control buttons.	M	1.35
Push and hold down ALARM SET.	P	1.1
Observe [alarm] time; it is 10:00am.	M	1.35
Evaluate whether to first use a press and hold strategy to speed around the hours, or to only use a button pushing strategy by repeatedly striking and releasing the HOUR/WAVE button.	M	1.35
Push and hold hour for 2 seconds. This is an approximate guess for the user to try to get mostly around the 24 hour cycle without shooting past the target number (amazingly, 24 hours take just 3 seconds to go through). The user is aiming for 2/3 of the way from 10am to 9am, i.e. 18 hours, to 3am.	KRRK	$.2 + 2 + .2 = 2.4$
Switch to button striking mode to cover the remaining 4 hours to 7am.	M K K K K	$1.35 + .8 = 2.15$
Release depressed ALARM SET button.	P	1.1

Grasp the upper right hand corner of the clock and feel the alarm arm switch on the back.	H	2
Move the switch to the ON position.	P	1.1
Observe the ALM1 dot light up.	M	1.35
Put down the clock.	H	2

**Existing Design GOMS Score**

$9 \times M (1.35) = 13.5$

$3 \times H (2) = 6$

$3 \times P (1.1) = 3.3$

$2 \times R (1) = 2$

$6 \times K (.2) = 1.2$

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Total = 26

**Touch Screen Redesign GOMS Analysis**

Action	Operation	Action Time
Observe the "Combined Setting/Displaying Mode"; it has "Lock" selected.	M	1.35
Move finger to the "Combined Setting/Displaying Mode" control.	P	1.1
Push "Combined Setting/Displaying Mode" control 1 time (switching it from Lock to Alarm1).	K	.2
Move finger to hour 10s up button control.	H	2
Push hour 10s up button 1 time (switching it from 1 to nothing).	K	.2
Move finger to hour 1s up button control.	H	2
Push hour 1s up button 7 times.	KKKKKKK	1.4
Move finger to the "Combined Setting/Displaying Mode" control.	H	2
Push "Combined Setting/Displaying Mode" control 3 times (switching it from Alarm1 to Lock).	KKK	.6
Observe "Alarm Armed Mode" lock status; it is not armed.	M	1.35
Move finger to "Alarm Armed Mode" control.	H	2
Push "Alarm Armed Mode" control 3 times.	KKK	.6

**Touch Screen Redesign GOMS Score**

$2 \times M (1.35) = 2.7$

$4 \times H (2) = 8$

$1 \times P (1.1) = 1.1$

$0 \times R (1) = 4$

$15 \times K (.2) = 3$

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Total = 18.8

**Button Redesign GOMS Analysis**

Action	Operation	Action Time
Observe the "Combined Setting/Displaying Mode"; it has "Lock" selected.	M	1.35
Choose to make the "Combined Setting/Displaying Mode" selection go up or down.	M	1.35
Move finger to the "Combined Setting/Displaying Mode" down arrow.	H	2
Push "Combined Setting/Displaying Mode" down arrow 1 time.	K	.2
Choose to make the hour 10s go up or down.	M	1.35
Move finger to hour 10s up button.	H	2
Push hour 10s up button 1 time (switching it from 1 to nothing).	K	.2
Choose to make the hour 1s go up or down.	M	1.35
Move finger to hour 1s down button.	H	2
Push hour 1s down button 3 times.	KKK	.6
Observe "Alarm Armed Mode" Alarm1 status; it is not armed.	M	1.35
Choose to make the "Alarm Armed Mode" selection go up or down.	M	1.35
Move finger to "Alarm Armed Mode" down arrow.	H	2
Push "Alarm Armed Mode" down arrow 1 time.	K	.2

**Button Redesign GOMS Score**

6 x M (1.35) = 8.1  
 4 x H (2) = 8  
 0 x P (1.1) = 0  
 0 x R (1) = 0

$$\begin{array}{r}
 5 \times K (.2) = 1 \\
 \hline
 \text{Total} = 17.1
 \end{array}$$

## GOMS Analysis Conclusion

The traditional GOMS scoring system is really being pushed beyond its limits with this exercise. This is due to its orientation toward more standardized interface elements, focusing on highly operationalized keyboard and mouse actions. The clock is really a world unto itself, with its white-knuckle, two-handed, dual-thumb operated simultaneous button pushing, and expert-oriented interface which demands users look at the front of it while operating controls on the back. This analysis can only underestimate the difficulty that a user faces with this clock in doing something as seemingly simple as changing the Alarm1 time.

However, the modified GOMS system still succeeds in imposing an idealized, arbitrary and data-driven scoring system on these three designs. The result is a measurement of time for idealized operation of the different interfaces. Interestingly, the touch screen has a slight disadvantage over the button interface – at least with this particular task. The button interface imposes many questions on the operator who has to choose between all those up or down arrows to find the most efficient path to their intended data entry. By comparison, the touch screen has many more key events, which are the least expensive interaction units.

Existing Design	Touch Screen Redesign	Button Redesign
10 x M (1.35) = 13.5	2 x M (1.35) = 2.7	6 x M (1.35) = 8.1
3 x H (2) = 6	4 x H (2) = 8	4 x H (2) = 8
3 x P (1.1) = 3.3	1 x P (1.1) = 1.1	0 x P (1.1) = 0
2 x R (1) = 2	4 x R (1) = 4	0 x R (1) = 0
6 x K (.2) = 1.2	15 x K (.2) = 3	5 x K (.2) = 1
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Total = 26	Total = 18.8	Total = 17.1

## Conclusion

The RadioShack 1.8 Inch Big Digit Atomic Clock suffers from numerous design flaws which make it unpleasant to use and consume a relatively large amount of time operating it. Happily the Touch Screen Redesign and the Button Redesign resolve many problems in the RadioShack design, locating all the controls on the front of the unit in plain sight. By focusing on minimizing and clarifying modes, all the functions of the 3-way switch have been subsumed into two discrete modes: time/alarm set mode and alarm arm mode.

Another design choice was to remove all features related to having the clock seek and be set by the NIST time signal. The user instructions direct the user at one point to wait 20 minutes for the clock to be automatically set, while simultaneously conceding that this may not ever happen. This is not a reasonable way to treat a user, and overall the atomic clock signal features (if they exist at all) introduce a huge amount of indecision and complexity to the design (including time zones and daylight savings time issues). Clearly, the goal of having a decent alarm clock does not depend on these features.

### The Touch Screen Redesign



### The Button Redesign



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