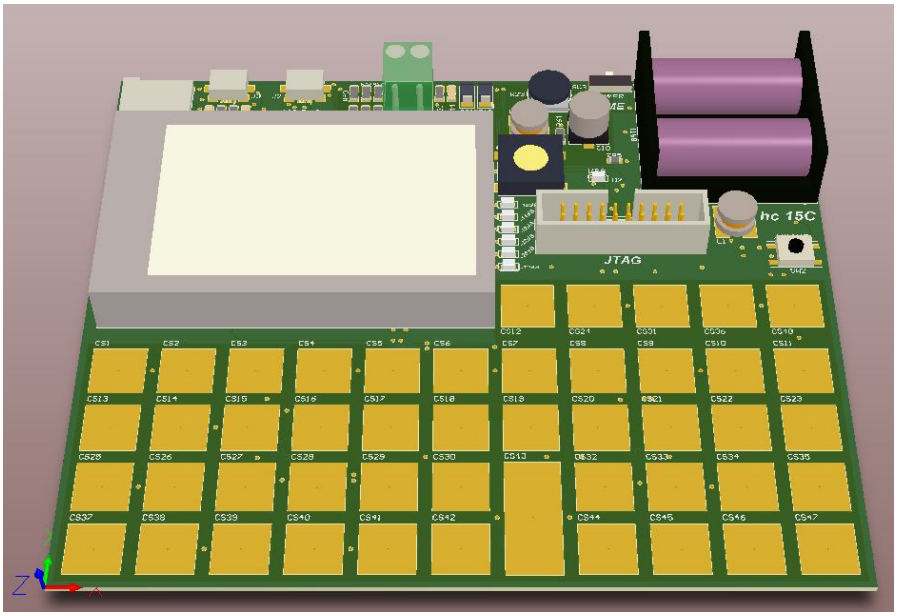
HC15C DEVICE

USER MANUAL AND TECHNICAL SPECIFICATION

CURRENT FIRMWARE REV: 1.1



Author: Hab S. Collector
Firmware Enginner: Hab S. Collector
Hardware Engineer: Hab S. Collector
Software Engineer: Hab S. Collector

ACKNOWLEDGEMENT

To the keeper of me, my beloved wife, I share everything with you. You are my strength in weakness, clarity in uncertainty and applause in victory. I accomplish nothing without your support, nor is anything of worth unless I can share it with you. I love you.

To my daughter Christina, we have had our challenges. In part, and in this, I hope one day in you the understanding of what I have been trying to say. Love is what you do. You are exceptional in so many ways; add to your gifts hard work and the world is yours.

To my daughter Faith, the Humanitarian, it is clear that you belong to the goodness of this world. You must remember that true greatness is only realized through service and that there are many ways to serve. Therein will be your pursuit – run to catch it. I hope I have shown you how to run.

To my daughter Trinity, the scientist, there is a clarity in the way you speak and think, in your questions and answers. You are to add to the scientific collective. Of the three, you are most like me. Don't be afraid, nor ashamed of whom you are; accept it, and work hard to be.

To God Almighty, it is you that have made me, and not me myself – thank you for the many blessings, may I be a better servant and steward.

DOCUMENT REVISION HISTORY		
DATE	**DESCRIPTION**	**EDIT BY**
10-Jul-12	Initial draft	HSC
29-Jul-12	Initial release	HSC
19-Aug-12	Revision 1.1	HSC

Table of Contents

1. **WELCOME:**

What is the measure of your life's work?

I believe I was born an engineer. Before I could put the word with the vocation I knew what I was and I have always been that. A degree and professional experiences may add credence to a title, but I am what I am. I have a passion for design.

I have learned that art means a lot of things to a lot of people. For me the purest, universal definition of art is something that excites your passion. When you find art you know it. The experience is always personal, beautiful, and difficult to communicate. I have always found art in hp calculators.

About a year ago I had a vision to create a device that would demonstrate the scope of my collective engineering experiences. In doing so I created art in the form of the HC15C engineering tool. Much more than a calculator, a multimeter, music player, clock, etc. but a collective representation of me, who I am, what I love to, and what I can do for you.

I have also learned it is impossible to have passion without pain. To passion is to suffer. But in the endeavor of struggle you answer the call of who you really are.

2. **WHAT IS THE HC15C:**

The HC15C (*hc 15C as depicted on device)* was designed primarily to be a sales tool. It forms the basis of conversation as to how I sell my services. Beyond sales it is my personal engineering tool, something I use daily. Within its design I attempted to encapsulate:

- A device that could be the basis of a technical conversation
- Features that I use most often in my work and some things I thought my daughters would like

The device is characterized by its components / features:

- RPN Scientific Calculator
- Precision Volt Meter
- Precision Ohm Meter / Continuity Meter
- Clock Date with stop watch
- Alarm
- Windows application capable
- Music Player
- Data Storage Device

My intent was never to design the very best of its individual components, but instead to create a portable sales tool, a system, with features that I would use daily.

3. **MODES OF OPERATION:**

The device has eight basic modes of operation. The individual modes can be accessed via the function keys. The modes of operation are:

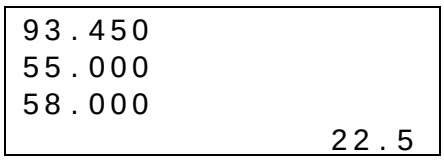
1. Calculator Mode: RPN, Scientific, 4 deep stack calculator
2. Setup Mode: Core calculator settings
3. Clock Mode: Time, Date, and a stop watch feature
4. Alarm Mode: Ability to set a time alarm

5. Volt Meter Mode: Volt meter utility with peak detect and reset
6. Ohm Meter Mode: Ohm Meter with continuity level set
7. Music Mode: Ability to play audio files
8. List Mode: Show the contents of the SD memory card

4. CALCULATOR MODE:

HOW TO GET THERE: 

WHAT IT LOOKS LIKE:



This fun description is taken from my Window's NextCal Software Application Help…
This calculator is based on the RPN (Reverse Polar Notation) methodology for calculations. The hp enthusiast will no doubt claim I have miss quoted the famous RPN acronym, but I haven't. RPN used with hp calculators refers to Reverse Polish Notation, but used here, I refer to it as Reverse Polar Notation. Why polar, because polar mathematically implies a direction. More so, within the context of my calculator it denotes the movement (up or down / pushed or popped) of the stack. Reverse Polar Notation differs from RPN in only a few minor ways. Reverse Polar Notation (here after referred to as RPN) always maintains a zero in a register (even if not displayed). The stack is defined as 4 levels deep.

Before we get too deep into it I need to explain a few terms:

- **Stack:** A stack can be thought of as a single dimensional array holding real numbers, more so, picture this array oriented vertically. The stack has four entries from the bottom to the top they are referred to as register 0 through register 3, or the X, Y, Z and T registers, where X corresponds to register 0 and T corresponds to register 3.
- **Loaded:** Loaded, or loaded value (as I sometimes refer to it) represents the X register, register 0 value.
- **Unloaded: Un**loaded or the **un**loaded value refers to a number that is presently being keyed into the calculator. In order for the input to be placed in the stack it must be "ENTERed". An unloaded value enters the stack at register 0 (X). Calculations can be performed on loaded and unloaded values in the same fashion. For now just think of it loosely as another register, "sorta" parallel to the X register.

With the definitions out of the way let's get started, BTW if my explanation does not help you can check out the hp meusum's definition on how to use an RPN calculator. I don't care which direction you follow, just as long as you use RPN (whatever P you want to use).

Getting started with an example

EG1 *REGISTER 3*

REGISTER 2

REGISTER 1

REGISTER 0

Register 0 (also known as X), is at the bottom of the stack while register 3 (the T register) is at the top. When a number is "ENTERed" (push onto the stack) it is pushed into register 0 (the number 9 in our example). This pushing operation causes the stack to shift up resulting in the lost of Register 3. Example 2:

EG2	*Register 3 = 0*		*Register 3 = 5*
	Register 2 = 5		*Register 2 = 3*
	Register 1 = 3		*Register 1 = 6*
	Register 0 = 6		*Register 0 = 9*
	(START)	***(Key: 9, ENTER)***	***(RESULT)***

Actions that require two arguments (arithmetic for example: x + y, x / y, x – y, etc.) operate on Register 0 (X) and Register 1 (Y). Such actions store the result into Register 0 and push down the stack. For example when working with loaded values.

EG3	*Register 3 = 0*		*Register 3 = 0*
	Register 2 = 5		*Register 2 = 0*
	Register 1 = 3		*Register 1 = 5*
	Register 0 = 6		*Register 0 = 9*
	(START)	***(Key: +)***	***(RESULT)***

Thus with the stack a number must first be entered before another number can operate upon it. To add 3 and 6 according to the above example: ***3, ENTER, 6, ENTER, +.*** That's 5 keystrokes, one more than the conventional ***3, +, 6, =.*** Keep reading… Actions that require a single argument (x squared, square root, etc) operate on X and store the result in X. For example:

EG4	*Register 3 = 0*		*Register 3 = 0*
	Register 2 = 5		*Register 2 = 5*
	Register 1 = 3		*Register 1 = 3*
	Register 0 =6		*Register 0 = 36*
	(START)	***(Key: x^2)***	***(RESULT)***

We're almost done, now the concept of Loaded vs Unloaded values. If you "ENTER" a number it is said to be loaded and will appear left justified. If you are entering a number it is considered to be unloaded and will appear right justified. Until this number is ENTERed it is considered the X and the value in Register 0 the Y. You can likewise operate on unloaded numbers. The difference between operations that act upon loaded and unloaded values is how they affect the stack. *EG3* added the contents of X and Y. When operating with unloaded values, it is the unloaded value that is considered the X, and register 0 is considered the Y.

EG5	*Register 3 = 0*	*Register 3 = 0*

Register 2 = 5		*Register 2 = 5*
Register 1 = 3		*Register 1 = 3*
Register 0 =6		*Register 0 =9*
(START)	***(Key: 3, +)***	***(RESULT)***

Notice the stack (with the exception of register 0) is unaffected. When operating with unloaded values we can perform the same addition operation as: ***3, ENTER, 6, +.*** That's 4 keystrokes - so you're now thinking, OK it's equal (number of keystrokes wise) to a conventional (aka algebraic) calculator with a "real goofy" way of adding numbers, but wait there's more (sounds like a television commercial for Ginsu Stake Knives). The idea of a stack comes into play when working with elaborate equations. Consider this calculation: 2+(5*6) / (3-1) * 2. On a conventional calculator (generally referred to as an algebraic calculator) you would enter:

ALGEBRAIC CALULATOR:

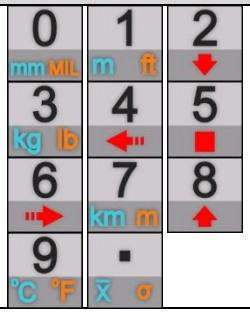
(2+(5*6)) / ((3-1)*2) = That's 20 key strokes

RPN CALCULATOR:

5, ENTER, 6, *, 2, +, 3, ENTER, 1, -, 2, *, / That's only 13 keystrokes!

Notice, the more complex the equation the more keystrokes you save. The registers acts as a temporary result much like the way we think. Most people can't glance at the above equation and see a result of 8. However you can see the numerator 2+(5*6), 32 and the denominator (3-1) *2, 4 separately. Hence 32 / 4, and that's what RPN does for you – it works the way we think. Think of the registers as temporary results that you can use as needed. Start using RPN, and keep using it. Though awkward at first, I guarantee you that in a very short while everything else will seem dim by comparison. BTW the hp museum's site to learn RPN is here

A. Input Keys:

SYMBOL	NUMERIC KEYS	SYMBOL	HEXIDECIMAL KEYS
	0 through 9 and decimal point		A through F

The numeric digits 0 through 9, the decimal point, and the hexadecimal digits A through F form the calculator entry keys.

B. Input Functions:

SYMBOL	INPUT FUNCTION	SYMBOL	INPUT FUNCTION
	EXP		2πx
	±,		2π

X<>Y	X<>Y	+ X<>Y	3<>2
<< CLRx	<<	+ << CLRx	CLRx
DROP FLUSH	DROP	+ DROP FLUSH	FLUSH
π 2π 2πx	π	+ π 2π 2πx	2□
ENTER LSTx	ENTER	+ ENTER LSTx	Last X

The function ± inverts the polarity of the value of loaded and unloaded values. It also works in conjunction with EXP (Exponent) which represents the unloaded value $x10^{\#\#\#}$. Note, EXP works only on unloaded values.

The functions X<>Y and 3<>2 swap the respective stack locations (3 and 2 are analogues to T and Z, while X and Y are analogues to 0 and 1). Note that while X<>Y works with both loaded and unloaded values, 3<>2 works only on loaded values.

The function << works only on unloaded values to delete the last digit entered, while the function CLRx (Clear X) works on both loaded and unloaded values to clear the X register. If the value is unloaded CLRx removes the unloaded value and restores the stack pre-unloaded value. If the value is loaded CLRx zero's the X register.

The functions DROP and FLUSH work both on loaded and unloaded values. In the case of DROP, if unloaded the unloaded value is dropped and the stack is restored. If the value is loaded, then the stack is pushed down one level. Register T is always cleared, register Z becomes the previous value of register T, register Y becomes the previous value of register Z, register X becomes the previous value of register Y. The function FLUSH, clears all registers to their uninitialized state (loaded with 0's but not displayed).

The functions π and 2πx load the respective numeric values directly to the X register pushing the stack up.

The function Last X loads the last entered value to the X register pushing up the stack.

C. **Navigation Keys:**

SYMBOL	MODE NAVIGATION FUNCTION	SYMBOL	MODE NAVIGATION FUNCTION
2 ↓	**ALARM**: Time parameter decrement **CLOCK**: Enable download of HC15C Win App clock set WITH APP LINK **MUSIC**: Scroll list down **OHM METER**: Continuity resistance decrement **LIST**: Scroll list down	8 ↑	**ALARM**: Time parameter increment **MUSIC**: Scroll list up **OHM METER**: Continuity resistance increment **LIST**: Scroll list up

4	**ALARM**: Move time set cursor left **CLOCK**: Reset stopwatch to 0 **VOLT METER**: Reset max volt read	6	**ALARM**: Move time set cursor right **CLOCK**: Start / Continue stopwatch
5	**CLOCK**: Stop / Pause stopwatch **MUSIC**: Stop play		

Depending on the mode of operation (Clock, Volt Meter, Ohm Meter, SD List, Music) the following keys have different meaning depending on the context / mode of operation. Within each Mode Section these keys are referred to throughout this document as the navigation keys. Though the meaning differs, there is an overall general theme to each key:

- ▲ Up or Increase
- ▼ Down, Down Load or Decrease
- ◄ Move Left, Back, or Reset
- ► Move Right, Forward, or Start
- ■ Stop or Clear

D. **Shift Keys :**

SYMBOL	KEY SELECT	SYMBOL	KEY SELECT
	LEFT Shift		RIGHT Shift

There are functions which can only be accessed via the left shift and right shift functions keys. The functions are denoted by their respective (left and right shift) color. To access a given function, identify the associated key, and press first the (left or right shift) followed by the associated key. For functions NOT in the left or right shift colors, simply pressing the key by itself will produce that function. The exception here is the navigation keys (red) which only become viable when in modes other than calculator mode.

E. **Display Functions:**

SYMBOL	DISPLAY FUNCTION	SYMBOL	DISPLAY FUNCTION
+ A DEG	Degree Measure	+ D ENG	Engg Notation
+ B RAD	Radian Measure	+ E DEC	Decimal / Base 10
+ C FIX	Fix Decimal Notation	+ F HEX	Hexadecimal / Base 16

Display functions effect how the register values are displayed or computed. DEG and RAD will place the calculator in angular measure DEGREE or RADIAN. When in RAD mode the “radiant” thermometer icon is displayed. The angular measure effects all trigonometric and most complex operations.

FIX and ENG notations place the calculator in fixed decimal notation (a fixed number of digits are displayed after the decimal) or in Engineering notation (values are displayed in exponential form). It should be noted here that if in FIX mode the absolute value of the number exceeds $1x10^{10}$ said value will be automatically converted to ENG notation. Notation operates on both loaded and unloaded values. To use key in a value between 1 and 5 and press the desired

mode, values greater than or less than the specified range will automatically load a fix value of 2.

It is possible for the calculator to display values in base 10 (DEC, or decimal) or base 16 (HEX, or hexadecimal). Note there are no fractional displays in HEX notation. Values are displayed in the form 0x1E8480 (2.000E6) integer form only.

F. Arithmetic Functions: Add, Subtract Multiply Divide:

SYMBOL	INPUT FUNCTION	SYMBOL	INPUT FUNCTION
÷ kph mph	DIVIDE	− / gal	SUBTRACT
X mps fps	MULTIPLY	+ cm in	ADD

For loaded values performs the arithmetic operation on the X and Y register, with the result in the X register and the stack being dropped. For Unloaded values performs the operation on X and unloaded value with the result being placed in the X register, otherwise not affecting the stack.

G. Calculator Store & Recall Memory:

SYMBOL	KEY SELECT	SYMBOL	KEY SELECT
RCL STO	Store to Memory	← + RCL STO	Recall from Memory

The calculator has 100 built in “smart” memory locations (00 to 99). These locations can be used to store and subsequently recall frequently used numbers. To store a number touch the store key then enter the desired two digit storage location. The recall of a storage location is conducted in similar fashion. Note, to use either Store or Recall there cannot be an unloaded value on the stack.

H. Attention and Off / Deep Sleep

SYMBOL	KEY SELECT	SYMBOL	KEY SELECT
ⓘ OFF	Attention	← + ⓘ OFF	Deep Sleep

While operating the calculator you will undoubtedly have errors. Generally speaking there are two types of errors: input errors, and calculation errors. Either type of error condition will signal the calculator to display the error and blink the attention icon. While in this mode all keys with the exception of the Attention Key are disabled. Press the Attention key to recognize the error and return to calculation.

If you will not be using the HC15C for in a while, it is suggested you turn it off from the power switch. You can also place it into a state of deep sleep by touching the off key. Note, power off is the absolutely lowest power consumption state. Putting the calculator to deep sleep, while low power, is not your lowest power consumption state.

I. Power Functions:

SYMBOL	FUNCTION	SYMBOL	FUNCTION
x^2 √x	x^2	← + x^2 √x	√x

e^x ln(x)	e^x	+ e^x ln(x)	ln(x)
10^x log(x)	10^x	+ 10^x log(x)	log(x),
y^x $y^{1/x}$	y^x	+ y^x $y^{1/x}$	$y^{1/x}$
1 / X X!	x^{-1}		

For loaded values performs the power operation on the X register, with the result in the X register and the stack un-moved. For Unloaded values performs the operation on the unloaded value with the result being placed in the X register, pushing the stack up.

J. Trigonometric Functions:

SYMBOL	FUNCTION	SYMBOL	FUNCTION
SIN ASIN	sin(x)	+ SIN ASIN	$\sin^{-1}(x)$
COS ACOS	cos(x)	+ COS ACOS	$\cos^{-1}(x)$
TAN ATAN	tan(x)	+ TAN ATAN	$\tan^{-1}(x)$

Trigonometric values are affected by the angular measure (RADIAN or DEGREES). When in RAD mode, the thermometer icon will be displayed. When in degree mode there will be no thermometer icon. For loaded values performs the power operation on the X register, with the result in the X register and the stack un-moved. For Unloaded values performs the operation on the unloaded value with the result being placed in the X register, pushing the stack up.

K. Conversion Functions:

METRIC SYMBOL	CONVERT TO	ENGLISH SYMBOL	CONVERT TO
+ 0 mm MIL	MILS to Millimeter: mm	+ 0 mm MIL	Millimeter to Mils: mil
+ + cm in	Inch to Centimeter: cm	+ + cm in	Centimeter to Inch: in
+ 1 m ft	Feet to Meter: m	+ 1 m ft	Meter to Foot: ft
+ 7 km mi	Mile to Kilometer: km	+ 7 km mi	Kilometer to Mile: mi
+ 3 kg lb	Pound to Kilogram: kg	+ 3 kg lb	Kilogram to Pound: lb
+ X mps fps	Feet/second to Meters/second: mps	+ X mps fps	Meter/second to Feet/second: fps
+ ÷ kph mph	Miles/hour to Kilometer/hour: kph	+ ÷ kph mph	Kilometer/hour to Miles/hour: mph

+	Gallon to Liter: l	+	Liter to Gallon: gal
+	Fahrenheit °F to Centigrade: °C	+	Centigrade °C to Fahrenheit: °F

For loaded values performs the conversion operation to the specified unit of measure on the X register, with the result in the X register and the stack un-moved. For Unloaded values performs the operation on the unloaded value with the result being placed in the X register, pushing the stack up.

L. **Statistical Functions:**

SYMBOL	STAT FUNCTION	SYMBOL	STAT FUNCTION
	∑+ (Add to Stat sum)	+	$\sum_{CLR}$ (Clear the Stat)
+	$\bar{x}$ Stat mean	+	□ Standard Deviation
+	Δ% Percent Change between X and Y	+	Factorial of X

The Mean ($\bar{x}$) and Standard Deviation (σ) can be computed by use of the ∑+, $\sum_{CLR,}$ functions. Use $\sum_{CLR}$ (Clear Sums) to start by clearing out the statistical accumulator. Use ∑+ (Add to Sum) to input the values. With each value entered the X register displays the total items entered (n). The mean can be access from $\bar{x}$, and the standard deviation via σ.

A Δ% (Percent Delta) can be calculated on loaded and unloaded values. The result is calculated to the formula ((X – Y)/Y) x 100% (for loaded values). The factorial computes as expected on loaded and unloaded values.

M. **Complex Functions:**

SYMBOL	COMPLEX ACTION	SYMBOL	COMPLEX ACTION
	-jXC Reactive Capacitance	+	jXL Reactive Inducance
	Polar to Rectangular Coordinates	+	Rectangular to Polar Coordinates

Complex functions are functions that have an implied imaginary result. The functions jXL and –jXC calculate the respective inductance and capacitance impedance. The functions work on loaded and unloaded values. For loaded values load the frequency and reactive component to the X and Y registers (the order of load does not matter). The value is calculated, the stack is dropped and the result is loaded to the X register. For an unloaded value the result is placed in the X register, otherwise the stack remains as is.

The function RtoP (Rectangular To Polar) and PtoR (Polar to Rectangular) convert between the real / imaginary coordinate system and the polar coordinate system. The functions work on loaded and unloaded values. When computing RtoP, for loaded values, load the Y register with the imaginary component and the X register with the real. The function loads the Y register with the angle and X register with the resultant.

When computing PtoR, for loaded values, load the Y register with the angle component and the X register with the resultant. For unloaded values, load the X register with the angle component and the unloaded value with the resultant component. The function loads the Y register with the imaginary component and the X value with the real.

5. **SETUP MODE:**

HOW TO GET THERE:  + 

WHAT IT LOOKS LIKE:

```
USER SETUP:
1. BL TIME OUT: 10
2. CAL VERBOSE: 3
3. TIME 2DREAM: 90
```

Setup mode allows three base parameters of the HC15C to be configured. When in setup mode the mail icon is displayed. To change a configuration press the number associated with the parameter (1, 2, or 3) until the desired level is set. Note the calculator will always save these values upon mode exit to non-volatile, permanent memory. The "BL TIME OUT" parameter represents the time, from last key touch until the backlight turns off. The value can be set from 10 to 60 seconds in increments of 10 seconds. It should be noted before the backlight is completely shut off it is dimmed at even time intervals that correspond to 90% (full on), 70%, and 30%. The "CAL VERBOSE" parameter represents the audio feedback level the calculator is set for:

0. No sound
1. Core Sound: Key touch, Play audio
2. Basic Help: Key touch, Play audio, Help with error conditions
3. Full Interactive: Full audio capability

The "TIME 2DREAM" parameter represents the time, after last key touch until the HC15C enters its power conservation mode (Deep Sleep). The value can be set from 60 to 200 seconds in 10 second increments.

6. **APP LINK MODE:**

HOW TO GET THERE: 

The App Link Mode shows no unique display screen. However when engaged the icon ↑↓ will be displayed. The App Link connects the device (via its "USB" port {J3}) to the HC15C Windows Software Application (Win App). What the application (and the HC15C device) does is dependent on its mode of operation. The App Link Mode is valid in only the CLOCK, VOLT METER, and OHM METER modes; outside of these modes the key will not be active. When Connected to the app:

- In Clock Mode the user can set the HC15C device clock to Windows System Time and date.

- In Volt Meter Mode the Win App Volt Meter Tab will display a digital volt meter that reflects the measured voltage of the device. The screen also displays the raw packet data that is transmitted by the device to the win app.
- In Ohm Meter Mode the Win App Ohm Meter Tab will display an ohm meter that reflects the measured voltage of the device. The screen also displays the raw packet data that is transmitted by the device to the win app.

To disconnect from the HC15 Windows Application press the EJECT key: 

. For additional information on the APP Link Mode users should consult the HC15C Windows Application Software and the Software Description Document.

7. CLOCK MODE:

HOW TO GET THERE: 

WHAT IT LOOKS LIKE:

```
TIME:  02:28:13 PM
DATE:  JUL 17, 2012

SWAT:  00:05:12:20
```

CLOCK MODE NAVIGATION KEYS:			
SYMBOL	**CLOCK MODE NAVIGATION**	**SYMBOL**	**CLOCK MODE NAVIGATION**
2	CLOCK: Enable download of HC15C Win App clock set WITH APP LINK	6	CLOCK: Start / Continue stopwatch
4	CLOCK: Reset stopwatch to 0	ALINK EJECT	HC15C WIN APP ENABLED WITH APP LINK
5	CLOCK: Stop / Pause stopwatch		

Clock mode displays the date and time of day. There is also a stopwatch feature capable of time measurements to 10^{th} of a second interval. The stop watch is controlled via the navigation keys: Start, Stop / PAUSE, Reset – self-described.

Clock Mode uses the App Link option to set the device time and date. To set the date and time, connect the "USB" port to the computer. While in Clock Mode press the App Link key. After the device connects to Windows (as a Virtual COMM port), from the Setup Tab of the Windows App Software connect to the device at the designated port. Once connected you will note the Set Time button on the Win App is disabled. Press the download Time navigation key on the HC15C, you will note the Set Time key on the Win app is now enabled. Press the Set Time button and the Windows System Time and Date is loaded to the HC15C.

8. **ALARM MODE:**

HOW TO GET THERE:  + 

WHAT IT LOOKS LIKE:

```
SET ALARM:
DATE: JUL 17, 2012

ALARM: 12:05 AM
```

ALARM MODE NAVIGATION KEYS:			
SYMBOL	**ALARM MODE NAVIGATION**	**SYMBOL**	**ALARM MODE NAVIGATION**
2	ALARM: Time parameter decrement	8	ALARM: Time parameter increment
4	ALARM: Move time set cursor left	6	ALARM: Move time set cursor right
ENTER LSTx	ALARM: Set Alarm		

Use the forward and back navigation keys to select the hour, minute, and day / night settings. The active time to be set is indicated by the blinking cursor. To change the active time use the up and down navigation keys. Once the desired alarm time has been established press the ENTER key to set the alarm. The alarm is set when the bell icon is displayed. To turn off the alarm press the Stop Navigation key.

9. **VOLT METER MODE:**

HOW TO GET THERE: 

WHAT IT LOOKS LIKE:

```
VMAX: 1.996
RANGE 00-10V

      1.995V
```

VOLT METER MODE NAVIGATION KEYS:			
SYMBOL	**VOLT METER MODE NAVIGATION**	**SYMBOL**	**VOLT METER MODE NAVIGATION**
4	ALARM: Move time set cursor left CLOCK: Reset stopwatch to 0 VOLT METER: Reset max volt read	ALINK EJECT	HC15C WIN APP ENABLED WITH APP LINK

Volt Meter Mode allows the device to measure voltage by way of the METER (J5) connection. The voltmeter is: a three stage auto ranging meter, with resettable maximum value detection. The stated accuracy of measure is 0.5% across all ranges. The range of measurement is from 0-10V, 10-20V, and 20-29.90V. The Vmax value is the maximum value the meter has read since its last Vmax reset. To reset this value press the reset key. The meter measures only positive polarity signals. For additional specifics concerning the meter's specifications consult the Technical Specification section of this document.

The Volt Meter also supports the App Link Mode. Pressing the App Link Key while in Volt Meter Mode will cause the meter to transmit the meter's measurements to the Win App. The HC15C Windows Application Volt Meter Tab will display a digital volt meter that reflects the measured voltage of the device. The screen also displays the raw packet data that is transmitted by the device to the Win App. Users should consult the HC15C Windows Application documentation for additional information.

10. **OHM METER MODE:**

HOW TO GET THERE:  + 

WHAT IT LOOKS LIKE:

```
SET LIMIT: 25 OHMS
RX: 34

**OPEN**
```

OHM METER MODE NAVIGATION KEYS:			
SYMBOL	**OHM METER MODE NAVIGATION**	**SYMBOL**	**OHM METER MODE NAVIGATION**
	OHM METER: Continuity resistance decrement		OHM METER: Continuity resistance increment
	HC15C WIN APP ENABLED WITH APP LINK		

Ohm Meter Mode allows the device to measure dry resistance by way of the METER connection (J5). The ohm meter is: a continuity meter with a settable resistance value for continuity. The settable resistance value can be changed in increments of 25Ω from 25-1000Ω by use of the increment and decrement keys. The stated accuracy of measure is 1%. The range of measurement is from 0-5KΩ for real, dry resistance measurements. For additional specifics concerning the meter's specifications consult the Technical Specification section of this document.

The Ohm Meter also supports the App Link Mode. Pressing the App Link Key while in Ohm Meter Mode will cause the meter to transmit the meter's measurements to the Win App. The HC15C Windows Application Ohm Meter Tab will display a digital Ohm meter that reflects the measured resistance of the device and the presence of a direct short circuit. The screen also

displays the raw packet data that is transmitted by the device to the Win App. Users should consult the HC15C Windows Application documentation for additional information.

11. MUSIC:

HOW TO GET THERE: 

WHAT IT LOOKS LIKE:

```
MUSIC LISTING:
  We are the world
 *Billy Jean
  Jazz Sounds
```

MUSIC MODE NAVIGATION KEYS:			
SYMBOL	**MUSIC MODE NAVIGATION**	**SYMBOL**	**MUSIC MODE NAVIGATION**
2	MUSIC: Scroll list down	8	MUSIC: Scroll list up
6 OR ENTER LSTx	MUSIC: PLAY / PAUSE	5	MUSIC: STOP

Music List mode allows the user to play selected audio files from the MUSIC_FILES directory. The music list can be scrolled and the desired tune selected. While playing, the song can be paused or stopped.

12. DIRECTORY LIST:

HOW TO GET THERE:  + 

WHAT IT LOOKS LIKE:

```
DIRECTORY LISTING:
   <Hardware>
   <Firmware>
   Lpc17xxADC.c
```

DIRECTLRY LIST NAVIGATION KESY:			
SYMBOL	**LIST MODE NAVIGATION**	**SYMBOL**	**LIST MODE NAVIGATION**
2	LIST: Scroll list down	8	LIST: Scroll list up

The directory list mode allows the user to see the contents of the removable SD drive. The scrollable list shows files and directories.

13. APPENDIX:

A. KNOWN FIMWARE BUGS:

FIRMWARE REV 1.1		
DESCRIPTION	**HOW TO FIND**	**PLANNED FIX**
On POR the touch of A or B keys does not register on the first touch. Touches are not registered until the second touch.	Turn on HC15C and touch a key	Maybe
If running from battery power, and USB connect the hardware switch occurs, however a lockup state may occur as a result of the USB serialization. You can however disconnect from USB power and run from battery power without issue	Only on connecting to USB while running from battery.	Maybe
On deep sleep, wake from sleep runs until first normal sleep then a POR occurs	Go directly to sleep or allow to dream	Yes
While in volt meter mode measuring voltage will increase the battery level voltage	This has not been fully confirmed to be a firmware	Yes

B. KNOWN HARDWARE BUGS

PCB REV 2		
DESCRIPTION	**POSSIBLE FIX**	**PLANNED FIX**
SD connector J4 protrudes too far out from PCB, as a result the SD card is often non-intentionally ejected.	Change layout and move SD back 100-200MIL	No
C22 too close to rubber foot – and rubber foot is slightly larger than intended	Move C22 away from foot	No
LCD does not fully match footprint	Will off set the LCD	No
Silk screen of meter specs state 1% for accuracy. Accuracy is actually 0.5%	Edit silk screen	No
U10 output should have bulk capacitance. Bulk capacitance would allow for battery change without a lost in system time	Add Cap sized for 10-20s lost batteries	No

C. TECHNICAL SPECIFATIONS:

ABSOLUTE MAX RATINGS					
PARAMETER	**CONDITION**	**Min**	**Typ**	**Max**	**UNIT**
ENVIRONMENTAL					
Operating Temperature		-20		78	^{o}C
Storage Temperature		-40		85	^{o}C
Relative Humidity	Non-condensing			97	%
VOLT METER					
Input		-20		40	V
OHM / CONTINUNITY METER					
Input	Ohm mode is dry only contact	0		5	V

OPERATIONAL SPECIFICATIONS					
PARAMETER	**CONDITION**	**Min**	**Typ**	**Max**	**UNIT**
ENVIRONMENTAL					
Temperature		-20		78	^{o}C
Relative Humidity	Non-condensing	0		95	%
PHYSCIAL DIMENSIONS					
Length			142.24		mm
Width			120.65		mm
Height			12.57		mm
BATTERY TYPE					
Size	½ AA				-
Capacity	Run Time specs based on Typ		1000		mAh
Chemistry	Lithium				-
RUN TIME DURATION					
Typical Use profile	[1]Based on 10min per day		152		hr
High Usage profile	[2]Based on 1hr per day		29		hr
POWER CONSUMPTION					
LCD Backlight full on	[3]Average power (waiting for input)		33		mA
LCD Backlight 70% on			30		mA
LCD Backlight 30% on			26		mA
LCD Backlight 00%			22		mA
Deep Sleep			5		mA
Power Switch to off position	Battery Backup power consumption		1.1		uA
VOLT METER					
Range		0		29.95	V
Accuracy ≤ 300mV Max Error	Percent of reading			0.6	%
Accuracy > 300mV Max Error	Percent of reading			0.5	%
OHM / CONTINUNITY METER					
Range		0		5000	Ω
Continuity Set Range	Continuity Increment is 25Ω	25		1000	Ω
Accuracy Max Error	Percent of reading			1%	%

NOTES:

[1]Based on 20s back light timeout, 60s time to deep sleep, 1000mAh cell capacity. (On time x minutes per day) + Sleep time is total power consumed. Switch to power off current consumption is ignored. On time minutes per day is 10. Sleep time in minutes per day is 30.

[2]Based on 20s back light timeout, 60s time to deep sleep, 1000mAh cell capacity. (On time x minutes per day) + Sleep time is total power consumed. Switch to power off current consumption is ignored. On time minutes per day is 60. Sleep time in minutes per day is 120.

[3]Key has been pressed, no audio playing, no SD card access, no EEPROM access