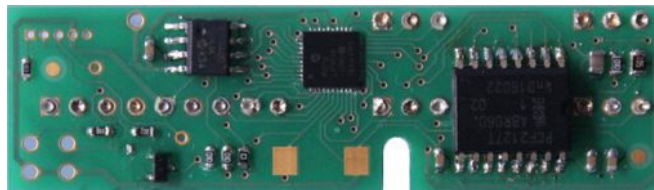


Woodstock Low Power

a new generation of LED calculator

Upgrade Kit for HP-21, HP-22, HP-25, HP-25C, HP-27, HP-29C calculators



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Introduction

The “Woodstock Low Power” circuit is a replacement of the electronics for your Hewlett Packard “Woodstock” calculator like HP-21/HP-25. It takes over all functions and adds new ones. Like its older brother the “new ACT” circuit, it can repair your HP calculator if it should be damaged. But it is not meant to replace the “new ACT”, its main purpose is to give you the freedom of low current consumption and preserving your registers and the calculation state at any time.

You don't have to switch off your LED calculator any more to save batteries.

For converting your HP calculator into the LP version you normally just remove the two display driver chips, which are located below the LED display. Then you can place the new circuit inside. You don't have to unsolder all components from the original board, but you can if you like. While none of the old components are needed any longer, any repair will be possible. And as an unexpected bonus, the calculator will not longer surge battery power because the old switching power supply is disconnected. This unique feature gives the circuit its deserved name “Woodstock Low Power”.



The “Woodstock Low Power” circuit applies to HP-21, HP-22, HP-25, HP-25C, HP-27 and HP-29C calculators.

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Contributions

Undoubtedly, the “*Woodstock Low Power*” like the “*new ACT*” could not have been built without the previous work of *Eric Smith*, who, over many years, explored these calculators and found out how they worked, he collected precious knowledge about ROMs, RAMs and the processor instruction set. Thus he wrote the first ACT emulator „nonpareil“ for HP calculators and put it into the public domain.

Emulators try to imitate the original chip as exactly as possible. They execute the original program of the calculator and show the results on the screen. The “*Woodstock Low Power*” is such an emulator. Although it has done many steps forward and invented some new ideas, it still has to be mentioned, that it stands on the shoulders of *Eric's* first emulator.

[Many, many thanks and appreciation again to *Eric Smith* for his really great pioneer work!](#)

There are many others to mention and give thanks, that have made previous reengineering research and found out hardware details, that were helpful in understanding all these undocumented things. I want to mention another name, late *Jaques Laporte*, who gave his excellent website with hardware, firmware and mathematics analysis of the “Classic” and the “Woodstock” calculators to the public.

Of course, I shouldn't forget to mention the “*Museum of HP Calculators*” as the central source of anything related to HP calculators. If you want to find something about HP calculators, you will find it here. Possible you also found the “*Woodstock Low Power*” and the “*new ACT*” somewhere here.

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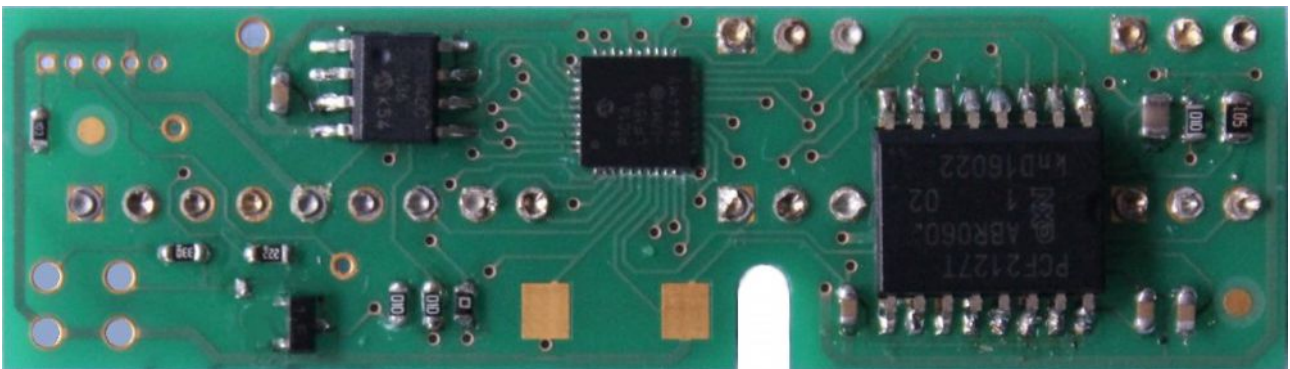
Sometimes scientists speak about a quantum leap they have made. Although a quantum leap literally could be no more than a picometer, which is a very small distance within an atom, it is the synonym for a very big progress with a single step. This is true because the quantum leap is the only step that can't be made in smaller steps.

With the introduction of the „Woodstock Low Power“ LP circuit such a quantum leap has been made. It shows that a new hardware can provide unexpected new features, that even the best software enhancements alone could never achieve. The „Woodstock Low Power“ circuit replaces the „new ACT“ in many ways, but hopefully doesn't make it obsolete. It is just a new approach for upgrading your „Woodstock“ calculator rather than just repairing it. The „new ACT“ repair is surely easier to handle, the LP circuit is more difficult to place inside the calculator, because you have to remove more chips from the PCB instead of just replacing the ACT. And you have to solder additional small wires, which lead from the display to the keyboard part of the calculator.

Which were the main goals of the LP version?

The „Woodstock LP“ circuit is a result of the idea to repair even those „Woodstock“ calculators, which do not have a defective ACT, but damaged display driver chips or both, or a non functioning power supply. Although it turned out, that there were not many of them in the past, finally there are still a few out there and they also deserve a new life like any other Woodstock calculator.

Another goal was to overcome the alphanumeric limits of the old HP display drivers, which could only display numbers and five letters, which in addition changed between the models and made it difficult to use the new ACT in different calculators. This led to a circuit which is placed at the top side of the HP calculator, because it should drive the many pins of the LED display, which are located here.



The first prototype „Woodstock Low Power“

Suddenly this concept became even more remarkable. Because no more PMOS chips are needed also the two voltages 6,4V and -12V were obsolete, the complete switching power supply was needless now. The circuit could be run directly from the battery voltage.

And last but not least by developing a new circuit, there was the opportunity to add some new hardware and give it more flash memory. In the above image you can see from left to right 512kByte flash memory, the PIC processor and the Real Time Clock.

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Which are the new features of the LP version?




Yes, there are many new features, but I have to mention, that it includes all features of the previous „new ACT“ chip.

First it is a “Low Power“ version, which is the heart of the quantum leap. The calculator needs only 2-20 mA, when display is on, compared to 110-180 mA of the original, and only microamps when the display is off. Equipped with two AA batteries the calculator will last for more than 100 hours and for years when in sleep mode and the processor register state is always saved. The calculator can be left ON all the time. What a crazy idea with a battery hungry LED calculator, you might think? No, not at all, because the 40 year old switching power supply, which had a lousy efficiency and was wasting the main part of power consumption, is not longer there, there is plenty of battery capacity left, more than we are used to have in our modern smart phones. To save even more power, after one minute without key press, it automatically enters sleep mode and consumes no more measurable current until a key press wakes it up again.

Next it contains a RTC chip, which will create a calculator with an integrated watch. It provides accurate time, date and alarm time. Also a piezo buzzer is attached for ringing the alarm. You can use the HP-25 LP to wake you up every morning, it is the first ever red LED calculator with integrated sound.

Number three: the stopwatch is controlled by the RTC and hence very accurate, it can count upwards, downwards and you can enter values via keyboard. It can be used as a countdown counter, which gives alarm when it reaches zero. There is no need for a calibration procedure any more.

Now we arrive at the visible part, the eyes of the quantum leap. The „Woodstock Low Power“ display has full alphanumeric capabilities. It can show any text in the LED display and is no longer limited by the display driver chips, because they are completely removed. The LP circuit has taken over the display and it can control each segment independently. This leads to the remarkable new feature: you can read your programs in plain text instead of looking at the cryptic keyboard row column code. This really changes your HP-25/HP-29 calculator a lot. Your debugging and stepping through the program becomes much easier and it is a joy to read the mnemonics of each possible program step. It works within PRGM

mode, and also in RUN mode when    are hold down.

And last but not least there is a new big brain as part of the quantum leap. The Flash ROM memory has 512 kByte capacity, compared to 2k ROM of the original HP-25, or four thousand times more capacity if you would use it exclusively for storing HP-25 programs. But its size makes it possible to contain all woodstock calculators in one, and the classics and the spice calculators too. You can switch between these calculators whenever you want, because the emulator can run each of them.

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The Low Power Upgrade kit

The upgrade repair kit consists of the “Woodstock Low Power” circuit, the manual as .pdf, some laminated Quick Guide cards, some solder, a piece of copper mesh wire and ultra low profile socket strips.

Image

The new “Woodstock Low Power” goes a big step further in repairing your valuable vintage calculator than the “new ACT” did. It does not just replace the ACT chip, but replaces the complete calculator electronics. It even bypasses the internal power supply and the display driver chips and drives the LED display and keyboard directly. It should be called “The Total Repair Kit”, but I decided to name it after its outstanding main feature: the “Low Power” consumption.

With this kit all “Woodstock” calculators HP-21/22/25/25C/27/29C can be repaired¹, even if all components should be damaged or removed (even if your LED display has missing segments you can replace it by a PANAMATIK HP-25 display, as long as stock will be available). The power consumption is only a tenth of the original calculator and if you include the sleep mode, it doesn't consume power at all. Only 2-20 mA are used to drive the display, compared to 110-180 mA of the original. With modern AA batteries and 2500 mAh capacity you can run your calculator for 250 hours without charging. Furthermore the calculator goes into sleep mode, whenever time passes without keystrokes or when you switch it OFF.

Interestingly even if you switch off the calculator, it is still running but consumes only 100 uA in sleep mode. Thus all data registers and the stack and display modes are kept for the next switch ON. It is like in modern LCD calculators. Everything changes. You will never need to switch off your calculator, it will instead be put into sleep mode after one minute. And you just press any key and the calculators display is lighting up again, showing the previous contents.

With this feature the new circuit has the right to be called “Woodstock Low Power”.

But this is not the only new feature. The Low Power circuit contains a Real Time Clock with

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Time, Date, Alarm and Stopwatch. This ± 3 ppm accurate RTC runs all the year and keeps the time and date as long as you have a battery inserted.

The time, date and stopwatch can be displayed even while your program is running. The stopwatch can be used to measure program run times or else.

The alarm time can be programmed to set an alarm and an internal buzzer will wake you up, when the time matches the alarm time. Never before existed a LED calculator with an alarm buzzer.

Following the description of replacing the ACT there is a chapter how to install the "Woodstock Low Power" circuit into your calculator and another chapter describes its remarkable new features.

¹ As the name tells, the "Woodstock Low Power" kit cannot be used in an HP-67 calculator, but it can emulate the HP-67 firmware on a woodstock calculator.

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Replacement

You have got the “Woodstock Low Power” upgrade kit. Well decision. What you need else is a small Phillips screw driver, tweezers, a soldering iron, a vacuum pump optional some flux means, and some moderate skill in soldering.

Please read the “Preparations” chapter in the “new ACT” manual to get a description how to use these tools.

In contrast to the replacement of the ACT, two other chips has to be removed: the anode and the cathode display driver. They are located below the LED display. All other chips including the ACT RAMS and ROMs can be left in place or they can be removed and used for repairing another calculator.

How to open the case and how to unsolder the chips is described in the “new ACT” manual. The “Woodstock Low Power” comes with some ultra low profile socket strips, which will be inserted into the free pins of the removed display drivers. Before you can insert the Low Power circuit, you have to cut some copper traces and to solder some wires to the calculators circuit board. Because the keyboard has no connection to the display drivers you have to solder seven extra wires. There is already a small cable tree delivered with a connector for this purpose. If you don't have additional hardware like the infrared printing or the GPS navigation module, you are already done.

Image

The image shows where to cut the copper trace which leads to the internal power supply and where to solder the cable tree. For using the ON/OFF switch and the PRGM/RUN switch you have to connect two keyboard pins with the cable tree.

If you have established all connections right you can close the calculator case and insert the batteries. Immediately the display should power up, regardless whether the calculator is switched OFF or ON, and welcomes you with the message like “**HP-25 LP**”, where LP stands for Low Power.

You will have to set the date and time and your personal configuration now. Please read the chapter about the key sequences of the “Woodstock Low Power”. It contains all the features of the new ACT and some remarkable new ones.

This chapter is under development.

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Disclaimer:

When using these instructions for upgrading or repairing your calculator, or in any other case of using the “Woodstock Low Power” circuit for any purpose, you are aware, that you alone have the responsibility. Due to the limited availability of vintage calculators and their versatility, PANAMATIK was not able to predict any possible circumstances, which may occur. Therefore it does NOT take responsibility for any damage that can occur directly or indirectly from using these instructions or using the new “Woodstock Low Power” circuit. We assure, that we tried to take care and took any precautions to provide you with all the information required for a successfully repair. Proceed only if you agree with these terms.

PANAMATIK


Features

For getting a detailed description of the new features of the “Woodstock Low Power” it is mandatory to read the “new ACT” manual first, because the LP circuit includes all features of the “new ACT” chip in its latest version.

But there are some unique new features, which the ACT never could perform. They are described in this manual. Some features just differ a little bit, because of the new alphanumeric possibilities or another reason, others are completely new. Lets start with the differences.





Differences between “new ACT” and “Woodstock LP”

1.) Power Up Keys

The LP circuit doesn't have Power Up keys. It will not check which key was pressed at Power Up, because there is no Power Up any more, and wake up from sleep mode is normally done always with the  key. All flags, which could be toggled by power up keys with the “new ACT” now can be set/reset by the flags function.


2.) Sleep Mode

The Sleep Mode replaces the Standby Mode of the “new ACT”. If you want to shut down your calculator to a minimal current consumption when you don't use it, then enable the sleep mode flag. The calculator will switch OFF after one minute automatically. If you want your display staying ON infinitely, that is until you switch it OFF manually, then deactivate this flag.





Sleep mode flag is toggled by pressing    .

If it is active, your calculator will enter SLeep mode after one or ten minutes without keyboard activity.



As soon as you press the  button, the display will show its previous contents. You can also select to wake up your calculator by any button if you set the appropriate flag, which is described later.

3.) HP Logo

You can tell the calculator to show the Logo if it wakes up from Sleep mode. This reminds you which calculator model actually is selected. You can show or hide this feature by toggling the HP Logo flag    .



4.) External/Internal ROM

There is no external ROM any more, even if you left the ROM chips in place, there is no communication between them and it is not needed any more. The new LP circuit always reads the HP firmware in its huge internal flash ROM.

5.) Slow/Fast Speed

There is no slow mode any more. The new LP always emulates the firmware as fast as it can. The speed depends on the selected calculator model and normally is about three to four times faster than the original calculator. Actually the emulator is written in pure assembler code. You will benefit from this optimizing by a very fast execution speed.

When a running program encounters a PAUSE instruction, it will automatically slow down for one second for you to have time for reading intermittent results.

6.) *Continuous Memory*

The “Woodstock LP” gives you back a real “Continuous Memory”. After wake up you will find any number, any display mode and trigonometric mode, the stack and your registers, and the actual program as it was when the calculator went to sleep. You don't have to switch the PRGM/RUN slider for storing the register contents, because it is stored in battery buffered internal RAM like the original 25C and 29C models.

This concept however differs from the “new ACT”. Other than the “new ACT” you will lose the register contents when you remove the battery pack for more than some seconds. But your program library and register sets are still saved in flash memory and will stay there even when you remove the batteries.

Not only your actually loaded program and your registers and display mode and trigonometric mode were saved in “Continuous Memory”, but also the stack contents and even a running program. If you switch ON the calculator, which went to sleep while a program was running, it will continue to run from where it was interrupted.

7.) Original mode

There is no original mode any more, the LP version doesn't want to hide its features any more.

8.) Stopwatch

There is only one stopwatch counter available and therefore the Chess Clock function had to be removed. It couldn't be implemented anymore, because the stopwatch is now

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hardware controlled and only one stopwatch register was available. However because the stopwatch is controlled by the RTC chip it is very accurate and calibration is not necessary anymore.

9.) *ROM Code*

“Show ROM Code” and “Show ROM checksum” are not longer part of the firmware. Because there are no external ROM chips connected showing their contents is obsolete.

What's new in “Woodstock LP”

1.) Ticker Text

You can enter any text up to 80 characters, which will be shown as ticker text whenever you want.

2.) Show program step mnemonics

Your program steps can be shown as mnemonics rather than as row column code.

3.) Real Time Clock

The accurate RTC chip allows you to show the time, date, weekday and to set an alarm time.

4.) Show Battery Voltage

You can show the actual battery voltage for monitoring the charge state.

5.) Show Temperature

Not very accurate, but at least an approximation of the ambient temperature will be displayed.

6.) Sleep Mode

Whenever no calculation is made, the calculator can enter sleep mode and doesn't consume battery power until waked up again.

7.) Beeper

The integrated piezo beeper can be programmed to wake you up when a calculation is finished or the programmed alarm time matches the actual time.

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3.) Show HP Logo



This feature gives you the possibility to show, which calculator you are currently running



4.) reserved



5.) reserved




6.) Show program checksum



If you call this function it shows the number of the currently loaded program and its checksum. The number, preceded by the letter **P**, is either a single digit from **0 - 9** if it is loaded from the “Program Memory”, or like in the picture a two digit number from **00 - 99** if it is loaded from the “Program Library”. The checksum is shown as a 4 digit octal number. This can be useful, if you want to compare it with your own recordings.

An empty program has checksum **0000** and even if it matches with another empty program somewhere in your storage, will display **P - -**. If your program doesn't match with any of the stored programs only the letter **P** is shown without number.





This function is also available by the shorter sequence  in PRGM mode.

7.) Show available Memory/ Register and Program usage







The HP-25 LP has a greatly improved version for showing the available memory compared to the “new ACT”, it gives you detailed information about your programs and registers. You can see which of them are free and which are occupied at one glance.


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When you use the  or  key you will see numbers and dots like in the following image. They represent occupied registers or programs.





In the above example register set 0 “r0” is displayed. The digits show the used registers which were previously saved by    and indicate, that registers 0,3,6,7 of this register set are used, hence 1,2,4,5 are free and contain value zero. The additional dots show the registers 8-15 if available depending on the calculator. Registers 8-10 are free and 11-15 (the statistical registers of HP-29) are occupied in this example.

With the  button the next register set will be displayed, up to 10 register sets (80/160 registers) are available.

But you will also need a quick overview for your programs. You can easily show the program usage by pressing the  button. You will see a program set with up to ten numbers.



If “Pr.” is shown, the numbers show the occupied fast access programs 0-9, which were saved by   followed by a number. In the above example Program 1 and 3 are used, 2 and 4-9 are free. Each line beginning with “Pn.” where n is a number from 0-9, represents 10 programs of your available up to 100 HP-25 library programs. In the above example “P5.”, the programs 50 to 59 are shown; 50,51,53,55 and 59 are occupied, the remaining programs are empty and free to use.

Program sets “P0.” and “P1.” are never shown because they are always occupied with the preloaded HP-25 program collection and cannot be cleared. Programs 20-55 are not longer write protected, you can overwrite their contents by your own programs if you ever should run out of free program space.


[With this improved function you get a quick overview of your register and program usage and you can find free locations for your next program in one second.](#)

8.) Operating time and battery time



There are two timer counters, that are counting the operating time in hours and minutes, when you are using your calculator. Whenever you switch on, the operating time is

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counting up. The first timer value can be up to 99999 hours, is not resettable, and will be stored in Flash Memory. The second operating time counter is thought for any purpose like measuring how long the battery life time was since the last full charge or how long you used your calculator in one week. Its range is up to 99 hours. This second counter is resettable by the  key.



9.) Flash write Cycles



Every time, when you save a program or registers the data is written into Flash memory. Each Flash memory has a limited amount of guaranteed write cycles. For transparency the total number of actually performed write cycles can be shown here with this function. It will be incremented whenever you save a program or register set.



There is a special area of high endurance flash memory used in the hardware of your ACT for the „*Continuous Memory*“. It guarantees at least 100000 write cycles, before writing could become unreliable. You will not get to this limit within years and the limit can be exceeded normally several times beyond the guaranteed value, before it really fails to write.

The “Program Library” and your “Constants collection” are written into a normal Flash memory area which is much bigger, but offers only 10000 guaranteed write cycles. But a single write cycle into this area occurs only when you store a program or registers or constant with their dedicated keystrokes. And you can write each program or register location separately 10000 times. I'm sure there will be a lifetime necessary for going beyond the limit of write cycles.

10.) LED Test








After invoking the LED Test function by number 8, all segments of all digits must be on, showing the digits “8.8.8.8.8.8.8.8.8.8.8.”, including their decimal points. If the same segment of all digits is not showing up, this is a contact problem with the display connector, you have to open the calculator and wiggle the display connector a little bit. Then, normally it will work again. If there is missing only one segment missing of only *one* digit, this is a more severe problem inside the segment module, and cannot be repaired easily.







11.) Ticker Text entry



With this function you will be given the possibility to “personalize” your vintage HP-25 LP calculator and let him display your text message on the display. You may create any text of up to 80 characters. Finally I could build a complete alphanumerical calculator for you, because the LP circuit has control over all LED segments. This was not possible with the “new ACT”.

When you enter this function you will be shown the actual “Welcome message”. An underline cursor is blinking. You can advance the cursor by  or go back one digit with . If you just want to show the text, use the   keys and press  to leave the menu.

If you want to edit the message you can just type your message by using the number keys and the additional alpha keys, add a Minus sign by  or toggle the decimal point with .

With   you can move the cursor to the location you want to edit. If it reaches the rightmost or leftmost digit of the display the text will be automatically scrolled in the desired direction. Other than in the “new ACT”s welcome string these keys have repeat functionality which is comfortable for the much larger array of characters.

You can enter the numbers  -  the hexadecimal characters A - F and some others and the minus sign and space directly with the appropriate keys:







A B C D E F O I, L Z S G





Space Minus Dot

For access to all available characters there are two new buttons available.

Use the   keys to step through the alphabet forward or backward until the right character is found. Then press  to advance to the next character location. You can toggle a decimal dot to each character with  if you like. Finally you need to determine the end of your text, unless you want use the complete 80 character buffer. Place the
















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cursor to the end of your text and press the  key. This will insert the EOT character (End Of Text), which is shown as all segments on during text entry. When the ticker text is displayed and encounters the EOT character it will start from the beginning. Press  to leave the text entry without changing the end of text marker.







Woodstock Low Power Manual



Flags

The flags have the following meaning:

-  “**Sleep mode**” This flag will activate or deactivate automatic sleep mode. Sleep mode will be entered after one minute without key entry.
-  “**HP Logo**” Shows the selected calculator logo message at wake up.
-  “**Battery check**” Switching off this flag can be used to suppress HPs low battery indicator: inverting all decimals points. If your calculator has a battery detection, that shows too often low battery, then you can switch off “Battery check”. However you will not be warned, when the battery is going to get empty.
-  “**Show annunciators**” Shows annunciators for current trigonometric mode and prefix keys.
-  “**Repeat keys**” Activates auto repeat for SST BST and some other keys like XY and ROLL.
-  “**Right aligned display**” When activated, shows the numbers right aligned in the display. Other than in normal mode, when all digits start from the left, the number is entered from the right. Only numbers with exponent or with many decimals need the whole display and start from the left.
-  “**Symbolic display**” When activated the mathematical constants “**PI**” and “**E**” were shown by its name instead by its value.
-  “**Show Mnemonics**” With this flag you decide whether you want to show plain text instead of row column code in your program steps. Highly recommended!
-  “**Date format US**” When this flag is set the date will be shown mm-dd-yy, if not set it will use the european dd-mm-yy format.
-  “**time AM PM**” When activated shows time and alarm time in 12 hour AM/PM format, otherwise in 24 hour.
-  “**Infrared Print Mode**” Toggle Infrared printing mode. When set printing is enabled and after power up “**HP-25 Ir**” is shown if “HP Logo” is enabled.
-  “**Norm mode**” When printing is enabled, this flag switches on Norm mode, where all of your manual calculations are printed on paper.
-  “**Trace Mode**” When this flag is set and printing is enabled, the result of your is printed automatically after each calculation.
-  “**Wakeup all keys**” If this flag is set, each key press will wake up your calculator. If not set, only the  key will wake up

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-  “Sleep time” When activated the time before going to sleep is ten minutes instead of one minute without key stroke .
-  “Flicker supression” When this flag is set a running program is shown without the characteristic original flickering display and intermediate results remain stable in the display until the next value is shown.
-  This button enables the automatic program time measurement. If your program is running also the stopwatch is running and will be stopped automatically when the program ends. Thus you can measure exact calculation times.
-  reserved for future use
-  reserved for future use
-  reserved for future use

The Flags display mode will be quit and the flags will be saved when the  or  key is pressed.

Show Free memory



This function informs you about the amount of free program memory and register memory. There are a maximum of 90 programs available for your own self-written programs, 10 directly accessible in the “Program Memory” and 80 in the “Program Library”, each up to 49 steps. If a programs contains at least one program step, it is considered as used. Hence the memory usage can show you “P-00” to “P-90”. If “P-00” is shown, all programs are occupied.



There are a maximum of 88 registers available. The number of free registers are shown right of the free programs. If all programs and registers are free you will be informed by “P-90 88 FrEE” in the display 5.

Real Time Clock


The Real Time Clock is running all the time, also when the calculator is in sleep mode. It consumes nearly no current, because it is made for these kind of standalone applications. The chosen PFC2127T chip is a so called "Accurate Real Time Clock" with integrated temperature compensated quartz. The specification according to the data sheet is ± 3 ppm from $-30\text{ }^{\circ}\text{C}$ to $+80\text{ }^{\circ}\text{C}$. What does this mean? It means after 1 million seconds it will deviate by ± 3 seconds. As a year has 31,5 million seconds, the deviation will be about 1 1/2 minute per year or 8 seconds per month. These are theoretical values and I don't know yet the real accuracy, which also depends on environment influences and rapid temperature changes. A normal clock quartz has specification of ± 20 ppm and is 6 times less accurate.



It delivers five different functions: date, time, alarm time, weekday and stopwatch. Following chapter describes the key sequences for accessing the Real Time Clock functions, which can be shown in RUN mode.

1.) Date



The actual date will be shown. It can be set from any date from 01-01-2000 to 12-31-2099.


With  you can change between dd-mm-yy and mm-dd-yy format.


If you want to enter a new date, just enter 6 digits and  and the new date will be written into the RTC. First two digits are always day, then month, then year. You can't enter the century. With the  button you can reset your entry or you can leave the date display and return to the calculator.

2.) Time




The actual running time will be shown with hours minutes and seconds.

With  you can change between 24h and 12h AM/PM format. This affects also the alarm time display mode.

If you want to enter a new time, just enter up to 6 digits followed by . The first two digits are hours, then minutes, then seconds. You always have to enter 24h time, even when AM/PM mode is displayed. Thus if you want to enter 5:34 PM you have to enter 1734. You don't need to enter minutes or seconds, if you want to set the time to the full


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hour or minute. At the moment when the  key is pressed, the time will be set within one second accuracy.

With the  button you can reset or discard your entry and you can leave the time display and return to calculator mode.

3.) Alarm




The alarm time is shown or can be set like the normal time, but the separators are not the dot, but dot and minus. If the alarm is armed, there is a minus sign shown at the right end of the display. When you just press  without having entered a time, the alarm activation will be changed as you can see on the minus sign. If you press again and you see a minus and a dot on the right this indicated the daily alarm.



If the daily alarm is not activated and the alarm is triggered, it will be automatically disarmed and you have to activate it for the next day.

4.) Weekday



You should never forget which day it is. For this reason you can set the weekday of the RTC. it will automatically count with the date every day. The display shows you actual weekday in plain text. If you want to change it just enter a number key from 0 to 6 followed by .

5.) Stopwatch





Just press   in RUN mode¹ and a stopwatch with minutes at the left and 1/100 seconds at the right will appear. Only if the time exceeds one hour also the hours are shown.



You can Start/Stop the timer, and reset it to zero. When the stopwatch is active, all calculator keyboard entries are bypassed and interpreted by the stopwatch.

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Start/Stop/Reset

Start and Stop function is placed on the  button. Reset to zero is naturally done by the  Button after the stopwatch has been stopped. If you switch back to calculator mode² with another  , while the stopwatch is running, it is still counting in the background and you can switch back whenever you want and read the elapsed time. Probably it tells you how much time you have needed to solve your actual mathematical problem?

Storing and Recalling Lap Times

You can store up to eight lap times with   to . Recalling these values is possible with   to .

The stored lap times can be read in calculator mode and you can do calculations with them. The storage format is the same as used for the ->HMS function. Digits before the decimal point are hours, then followed by minutes and seconds and 1/100 seconds.





¹ g NOP is still available in HP-25 PRGM mode. HP-21 is always in RUN mode and uses g DSP button.

² also switching the PRGM/RUN button returns to calculator mode



The stopwatch of the Low Power circuit is different to the stopwatch of the ACT. The LP circuit has only one stopwatch and cannot be used as a game watch. But don't be disappointed. This has some reason. The reason for only having one stopwatch is, that it is a hardware stopwatch, which is located inside the RTC clock and there is only one stopwatch possible.

But what do you get for it: First this stopwatch is very accurate, it does not need a calibration procedure like the ACTs stopwatch. And it can be run as a countdown, giving an alarm when it reaches zero. And not least it can be run also when the calculator is switched off. This should be worth the missing of two timers.

You can start the stopwatch from zero or stop with the  key. Or you can enter a starting time just by keying in 6 numbers, hours minutes seconds, and , which sets the stopwatch to a start value. Then you can decide to count forward with  or backward with the  key. If the stopwatch counts backwards and reaches zero it will trigger an alarm and the beeper will be heard for one minute.

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The stopwatch will count also in sleep mode and will wakeup automatically if the countdown reaches zero.

How the stopwatch is implemented?

Getting the stopwatch running also in sleep mode is done in a rather tricky way.

As the RTC chip does not have a stopwatch function, neither the PIC processor does have one, nor the other chips of the LP circuit, how is it done then? In fact when the time will be set, it will be written into the RTC and the RTC will do the counting. Also the date is managed stand alone in the RTC. The RTC chip also offers an alarm time register, which perfectly fulfill our needs, it can wake up the PIC processor if the activated alarm matches the actual time. But none of them can handle a stopwatch. And it is impossible to emulate a running stopwatch if the RTC has no stopwatch or with a sleeping processor. There was only one solution. They had to help each other.

If the PIC processor has shutdown all its clocks and has fallen deep asleep, it still accepts a single external clock signal at one of its input pins, which is able to count an internal 16-bit timer register upwards. And the RTC is able to deliver that accurate clock signal, which can be connected to this external clock input. So both together can build a counting unit, which does not need to wake up the processor when counting. As the stopwatch counts in 1/100 seconds, it would be desirable to have a 100 Hz clock from the RTC. But according to the data sheet this is not possible, it can generate either a 1 Hz or 1024 Hz signal. 1 Hz is too slow, 1024 Hz is too fast. But by using a 1:8 prescaler in the PIC timer module, the 1024 Hz can be divided to 128 Hz and voila, this is a good approximation. 128 pulses represent one second of stopwatch count. Now it is easy to calculate the 1/100 seconds from 1/128 seconds just by making a multiplication. In fact, there have to be done some more calculations to get the actual stopwatch displayed from the timer value, as the stopwatch is able also to count downwards and the 16-bit hardware timer can only count upwards and it can count only 512 seconds (8 minutes 32 seconds) before it overflows. Fortunately the overflow can be programmed to wake up the processor. If a wakeup occurs by timer overflow, which happens about every 8 minutes if stopwatch is running, the processor just adds or subtracts 512 seconds to the stopwatch base value and goes to sleep again. If a button is pressed the display shows the stopwatch as the stopwatch base value plus the actual timer value. That's it.

Theoretically the stopwatch could count for years with only one battery charge, but in reality it will overflow any 99 hours.


Special Functions

1.) Battery Voltage



This new display shows the actually measured battery voltage within 50 mV accuracy.



You will normally get displayed between 2,5 and 3,0 Volts and this assures you that the batteries are still OK. However if the battery voltage gets below 2,2 Volts you can estimate that you need to change your batteries soon. It is an additional battery information to the standard low voltage dots, which are shown in calculator mode. The dots appear when the voltage has dropped below 2,3 Volts and are enabled by .


You will return to the calculator display with the  key.

2.) Temperature



Similar to the new voltage display also the actual temperature can be shown. There is an internal Temperature sensor in the PIC processor, which gives an rough estimate of the actual ambient temperature.



Because the temperature measurement circuit has different characteristics for each chip, use the  keys to calibrate the sensor when you know the actual ambient temperature. The calibration value will be stored in flash memory and no further calibration is necessary.

Press  key to change between °C (Celsius) and °F (Fahrenheit).

Try to run your calculator in your refrigerator, I promise your programs will not slow down, but don't go below zero degrees, only positive temperatures will be displayed correctly.



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
3.) Ticker Text



When you call this key sequence the actual „Ticker Text“ is shown. Because the text can be up to 80 characters, it is shown as a running ticker text.

The Ticker Text replaces the steady 12-digit „Welcome Text“ of the ACT by a much larger text size. It was worth to increase the text size, because of the improved alphanumeric possibilities of the new LP circuit.

If you like to show your text slower or faster, just press  or  keys to adjust the ticker speed. If you slow down to the very extent, the text will stop and will show only the first twelve characters. This allows you to show also a steady text, if you want.

You can enter your personal „Ticker text“ by   .

4.) Sleep Mode



If you want to enter Sleep mode, i.e. when you don't need the calculator for the next time, you have three possibilities. First you can wait one minute and the calculator automatically switches off the display and goes to sleep. It will show **“SLEEP”** for some seconds and then switch off. Or you enter this key sequence and you will send your calculator to sleep manually.

The automatic Sleep Mode needs the “Sleep Mode flag” to be enabled by




And you have the possibility to chose between one minute or ten minutes as ON time. The longer time is selected by setting the “Long Goto Sleep” flag with



Or you just switch OFF the calculator with the ON/OFF slider switch. The display will show **“OFF”** for some seconds then shuts off. It will show **“SLEEP”** for some seconds and the switch off. There is no difference between “OFF” and **“SLEEP”**. While this text is displayed you can press any key to abort the sleeping and just go on calculating.

5.) Wake Up

To wake up the calculator just press the  key. You can also configure your HP-25 LP to wake up by any key, if you set flag 13 by using    .

Alternatively you can wake up the calculator with the ON/OFF switch.

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If you have entered Sleep Mode there are two events, which will wake up your calculator automatically - if the alarm time is activated and the time matches the alarm time - or if the stopwatch countdown timer is activated and reaches zero.

In both cases the text “**Alarm**” appears in the display and the beeper will intermittently beep for about one minute. You can stop the alarm beep by pressing any key. If you do not press a key, because you are not there, the calculator will goto sleep again after the alarm stops .

6.) Beep



This key sequence was already a programmable step in the original HP-25, shown as “15 25” in PRGM mode. But it executed no operation and was perhaps only a relict of programming for a feature that never was implemented or just a bug, because the key did not have a blue function printed on the slanted side.

Now it has find its destiny and invokes the beeper for one second. You can enter the keys in RUN mode directly or use it in your program. It does not slow down the calculation, because the program is executing the next steps while the beeper is active. Often you can compine a STOP instruction with beeper if you have longer calculations and you are waiting for the result.

The beeper will also be used when an alarm is triggered or when the countdown timer reaches zero.

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Mnemonics

As a result of replacing the display drivers, the new „Woodstock Low Power“ circuit has become the ability to show alphanumeric texts. It has finally overcome the limitations of having only 5 characters available due to the hard coded display drivers.


Using these new alphanumeric possibilities, the display can show your program steps in plain text. This is done for the first time with an HP LED calculator. You don't have to translate the keyboard row and column codes any more. Each program step shows near the line number its real mnemonic like a printer. This changes a lot. It makes your calculator much more readable. And it makes you smile when you see it.



last forty years

now

The implementation of showing the program steps as text, which previously only the printer could perform, is not just a side effect of alphanumeric possibilities, it is an obvious and very welcome feature.

You can activate the mnemonic display with setting flag 7 with 

Upload/Download Data

The Low Power circuit can be connected to a PC via an USB/TTL serial converter. It is the same converter that is used for transferring updates to the new ACT chip. But now a firmware update can be made without needing to enter the bootloader at power up. It can be invoked from the normal running calculator at any time.

And the PC connector is not only used for software updates, but can be used to upload your programs and register data from the calculator to the PC or download them in the other direction.

The PC application for using all the communication features of the „Woodstock Low Power“ is in development. The detailed description of how to perform all these operations will be part of the users manual of the PC application.

Remote Control

Besides the data transfer capability of the USB/serial interface, there is a remote control included. When you press buttons on the PC emulator, these buttons will be executed on the real calculator. Also the other direction is possible. Any keystroke and the calculation result on the real calculator will be shown on the PC screen. The PC emulator will be a copy of the real calculator.

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512kB Flash memory

Many of the new enhancements of the „Woodstock Low Power“ are only possible because there is a big Flash memory on board. Its size is thousand times bigger than the program memory of the original HP-25 and it can store all your programs and data registers you ever will have written. But it would be overkill to use it just for storing some 49 step programs. No, the concept of the „Woodstock Low Power“ uses this big data area to store the original firmware of all Classic, Woodstock and Spice calculators models and even the HP-01. This can be expanded in the future even to the voyager models HP-11C or HP-15C, which could make these models running on a LED calculator.

It contains also the mnemonics used for printing and thus saves valuable program space inside the PIC processor. Indeed, the big flash memory cannot be used to store executable programs, only emulatable programs, thus the program area for executable code is still inside the PIC flash memory and limited to 16k words of the PIC16LF1619 processor.

Execution Speed

The execution speed of the the Low Power circuit is significantly faster than the „new ACT“. This is not apparently visible, because the PAUSE function does not seem to be faster. Yes, because it is artificially prolonged to show the value for quite the same time as the original. But if you execute a trigonometric function or run a program, then you can estimate the new speed. The main reason for a speed increase compared to the new ACT is that the LP circuit does not need to send display information serially to some old HP chips with slow data rates.

But there are also some new tasks, which slow down the calculation. The concept of the new „Woodstock Low Power“ contains the big 512 kByte flash memory, which contains the firmware of all woodstock calculators. But it is an external serially addressed flash memory. During execution of the HP firmware, it has to be read serially from the flash, because it cannot be stored internally in the PIC chip. But with a high speed rate of 4 MHz there can be read up to 50000 instructions per second, compared to 3000 in the original calculator. You will not suffer from a slow calculation speed.




With the advent of the „Woodstock Low Power“ there has been made also an upgrade of the new ACT firmware to version 1.12, which main features are the Flicker Supression, Multitasking and the deatilled Memory Usage Display as described in an earlier chapter

[Needless to say, that the „Woodstock Low Power“ also features these new functions.](#)

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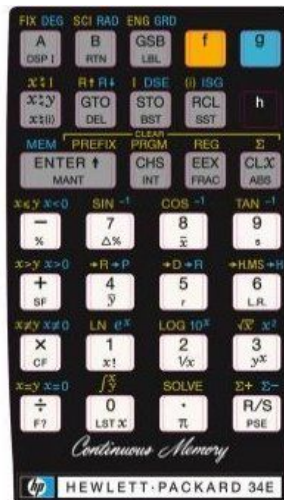
Switching between calculators



The existence of plenty of HP calculator firmware in the Low Power flash memory allows you to run many of them just by selecting a new calculator. This key sequence, which shows the actual calculator logo, can be followed by  or  keys to select another calculator type. If you leave the menu by  the new calculator will be started. Be aware, that your saved program and register data cannot be converted, if the calculator has different data sizes and locations. They will be untouched however, in case you want to switch back to the previous calculator, unless you save new data.

You don't need a PC connection for switching to another calculator. However you need to change the keyboard or apply a vinyl overlay which matches the chosen calculator, if it differs from the original. Or at least you have to know the buttons and their functions.

There are four vinyl overlays available which can be applied to any woodstock calculator. These are HP-25C, HP-29C, HP-34C and HP-67. But they are self adhesive and cannot be changed after they once are applied.



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Vinyl Overlays

If you transformed a common woodstock calculator into a higher model like the HP-29C or into another model like HP-34C or HP-67 by programming the HP-34E or HP-67E update, you need an overlay sticker to label each button with its new function. These overlays are available for the HP-29C, HP-34C and HP-67. They are nearly perfect copies of the original labeling. I didn't add any new functions, because they would clearly overload the design and who knows, perhaps you like to use only the original mode.

Normally your donator calculator will be an HP-21 or HP-25 because these are the most common models and therefore more easily to purchase.

To apply an overlay just remove it from its paper and try to still leave the vinyl buttons where they are. Perhaps use a small screw driver or anything similar to get the buttons separated while removing the overlay from its background. Then remove the superfluous frames from the buttons and holes and then place the self adhesive overlay carefully adjusted over the buttons of your calculator. My experience was that it is rather easy to adjust everything before fixing it by pressing firmly. Then you should transfer the button labels calmly one by one, very accurately adjusted, to the buttons. I recommend to bend the buttons by 90 degrees at the edge with your fingers before attaching them.



Three at one go

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



























































There could be interference with the original printed labels, when removing the self adhesive overlays. PANAMATIK will not take any responsibility for using the vinyl overlays. If you decide to apply them, you agree to do this on your own responsibility, otherwise don't apply them!

But anyway, you most likely will never go back, once you made an HP-25C, HP-29C, HP-34E or a HP-67E calculator from an ordinary HP-21/25.

Appendix A







1.) Key sequence summary

HP-25 LP














Key sequence	Mode	Description
 	RUN	Enter stopwatch mode
 	RUN	Enter Hexadecimal entry mode
   	RUN	Store register set in Storage Memory 0 to 9
   	RUN	Recall register set from Storage Memory 0 to 9
    	RUN	Recall constant 0-99 from Constant Collection
    	RUN	Store constant 20-99 to Constant Collection
 	RUN	Show mantissa/Print X (HP-25 Ir)
 	PRGM	Show program number and checksum
 	RUN	Free Memory/Paper Advance (HP-25 Ir)
 	RUN	Show registers 0 to 7
 	RUN	Sound Beep
 	RUN	Enter GPS Mode (HP-25 GPS)
 	PRGM	Insert program step
 	PRGM	Delete program step
 	PRGM	Show program steps/Print program (HP-25 Ir)
 	RUN	Single Step Debug
 	RUN	Undo restore stack registers
 	PRGM	Undo restore program step
   	PRGM	Goto program step 00 to 49
 	PRGM	Switch to RUN mode
 	RUN	Switch to PRGM mode
   	PRGM	Load program 00 to 99 from Program Library
    	PRGM	Store program 20 to 99 to Program Library

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Repeat keys














Key	Description
	Show stack
	Show XY registers
	Show program steps forward in PRGM mode
	Show program steps backward in PRGM mode
	constant growth
	constant sum

Function summary













Function	Description
 	Enter Function Menu
	Show firmware revision and serial number
	Toggle flags 1-20
	Show calculator logo/ select calculator
	Show program number and checksum (  PRGM)
	Show memory usage programs and registers
	Show operating time
	Show Flash write cycles
	LED Test
	Enter Ticker Text

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





Real Time Clock keys

Key	Description
 	Show date,  toggles date format
 	Show time,  toggles time format
 	Show alarm time, activate with 
 	Show weekday, Set with  - 

Stopwatch keys




































Key	Description
 	Enter and leave stopwatch mode
	Start and stop stopwatch
	Start and stop countdown
	Reset stopwatch or countdown
	Enter countdown or stopwatch time
  - 	Store Lap Times 0 - 7, Recall with   - 

Special keys

Key	Description
 	Show battery voltage
 	Show temperature
 	Show ticker text
 	Goto Sleep, Wakeup from Sleep with 


















2.) Key sequence summary

HP-21 LP

Key sequence	Mode	Description
 	RUN	Enter stopwatch mode
 	RUN	Enter Hexadecimal entry
    - 	RUN	Store register set in Storage Memory
    - 	RUN	Recall register set from Storage Memory
     	RUN	Recall constant 0-99
     	RUN	Store constant 20-99
 	RUN	Show mantissa/PrintX
  	RUN	Paper Advance
   - 	RUN	Enter function 0-9 (see function table)




































3.) Key sequence summary

HP-22 LP

Key sequence	Mode	Description
  	BEGIN/END	Enter stopwatch mode
 	END	Enter Hexadecimal entry
 	END	Show mantissa/Print X
  	END	Paper Advance
  	END	Show registers 0 to 9
   - 	END	Enter function 0-9 (see function table)






4.) Key sequence summary

HP-34 LP

Key sequence	Mode	Description
  	RUN/ PRGM	Enter stopwatch mode
 	RUN	Enter Hexadecimal entry mode
 	RUN	Print X (HP-34E Ir)
 	RUN	Paper Advance (HP-34E Ir)
 	RUN	Show registers 0 to 9
  	PRGM	Show program steps
  	RUN	Single Step Debug
 	PRGM	Switch to RUN mode
 	RUN	Switch to PRGM mode
    	RUN/ PRGM	Load program/regs 00 to 17
    	RUN/ PRGM	Store program/regs 00 to 17
   - 	RUN/PRGM	Enter function 0-9




























































Repeat keys

HP-34 LP

Key	Mode	Description
	RUN	Show XY registers
 	PRGM	Show program steps forward in PRGM mode
 	PRGM	Show program steps backward in PRGM mode

5.) Key sequence summary

HP-67 LP

Key sequence	Mode	Description
  	RUN/PRGM	Enter stopwatch mode
 	RUN	Enter Hexadecimal entry mode
    - 	RUN	Store register set in Memory
    - 	RUN	Recall register set from Memory
 	RUN	Show Mantissa/Print X (HP-67E Ir)
 	RUN	Paper Advance (HP-67E Ir)
 	RUN/PRGM	-x- Print X (HP-67E Ir)
 	RUN/PRGM	STK Print Stack (HP-67E Ir)
 	RUN/PRGM	SPACE Paper Advance (HP-67E Ir)
  	PRGM	Show program steps
  	RUN	Single Step Debug
 	PRGM	Switch to RUN mode
 	RUN	Switch to PRGM mode
    	PRGM	Store program 00 to 10 to Library
    	PRGM	Recall program 00 to 10 from Library
    - 	PRGM	Store program to Memory
    - 	PRGM	Recall program from Memory
   - 	RUN/PRGM	Enter function 0-9























Repeat keys

HP-67 LP





















Key	Description
	Show program steps forward in PRGM mode

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6.) Print keys

Key	Mode	Description
 	RUN	Paper Advance, HP-21E   
 	RUN	Print X, HP-21E  
 	PRGM	Print Program, HP-29E   
   	RUN/PRGM	Toggle Print Mode enable
   	RUN/PRGM	Toggle "Trace mode" flag

7.) GPS keys

Key	Mode	Description
 	RUN/GPS	Enter/Leave GPS Mode, HP-29E   
 	GPS	Select value to display
	GPS	Next value to display
	GPS	Automatic value display
	GPS	GPS power On/Off
	GPS	Stop dynamic storage to register 0-7
	GPS	toggle between knots and km/h
	GPS	Show Position Latitude, Longitude
  	GPS	Store value to register 0-7
   	GPS	Store value to register 0-7 dynamically

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Appendix B

1.) Woodstock Low Power Pinout

Pin	Name	Description	Pin	Name	Description
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Woodstock Low Power Manual

2.) Woodstock Low Power Schematic

