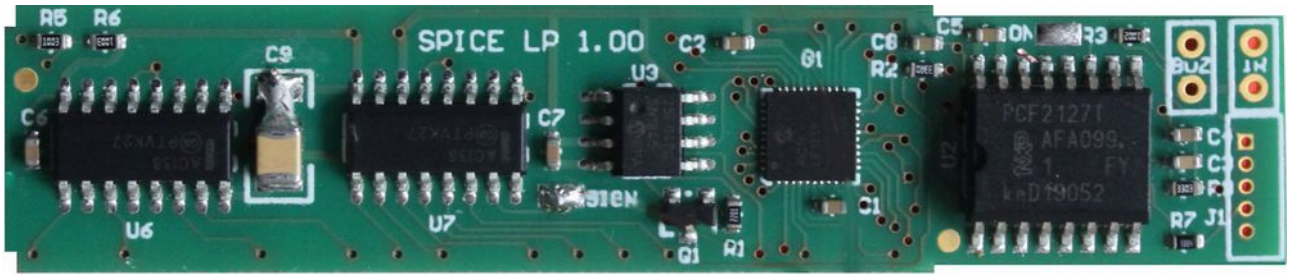
Spice Low Power

a new generation of LED calculator

repair kit for

HP-31E, HP-32E, HP-33E, HP-33C, HP-34C, HP-37E, HP-38E, HP-38C calculators



Bernhard Emese , July 2024, Rev. 1.04

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Manual Revisions

Rev 1.00 November 2019 prerelease version

Rev 1.01 June 2020 inital release version

Rev 1.02 July 2020 added Charger components

Rev 1.03 September 2020 release version, 1.03a Flags 8 9 removed

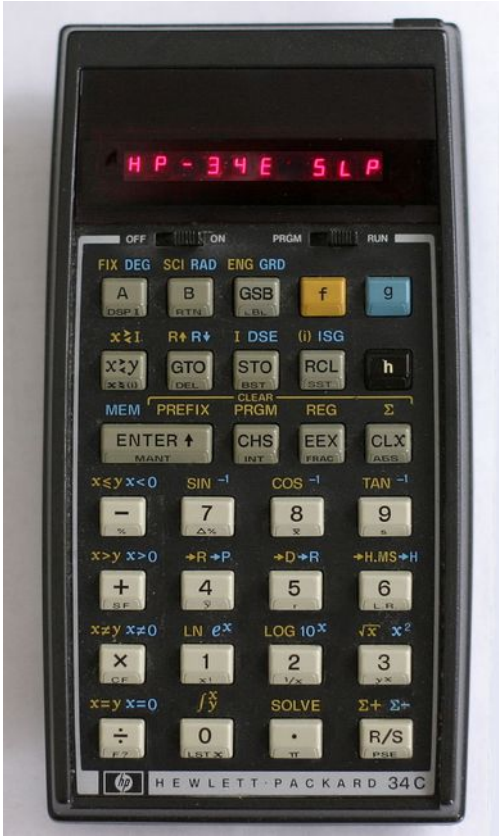
Rev 1.04 July 2024 HP-34 Key sequence summary Appl. Programs and some other corrections

Introduction

The HP-3x calculator series are commonly named the “SPICE” calculators after their internal code name durig their development in the 70th. The “SPICE Low Power” (SLP) circuit is a replacement of the electronics for your vintage Hewlett Packard “SPICE” calculator like HP-33C/HP-34C. It takes over all functions and adds new ones. Like the “Woodstock Low Power” circuit for the Woodstock calculators it can repair now your HP “SPICE” calculators in case the electronics should be damaged or has unreliable contacts.

For the first time there is repair kit for the SPICE calculators

For converting your HP calculator into the SLP version you just have to remove all chips and the power supply. Then you can place the new circuit inside. 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 removed. This unique feature gives the circuit its deserved name “SPICE Low Power”.



The “SPICE Low Power” circuit applies to
HP-31E, HP-32E, HP-33E, HP-33C, HP-34C, HP-37E, HP-38E and HP-38C calculators.

Contributions

Undoubtedly, the “SPICE *Low Power*” like the *“Woodstock Low Power”* could not have been built without the previous work of *Eric Smith*, who, over many years, explored these calculators and published 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 *“SPICE 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.

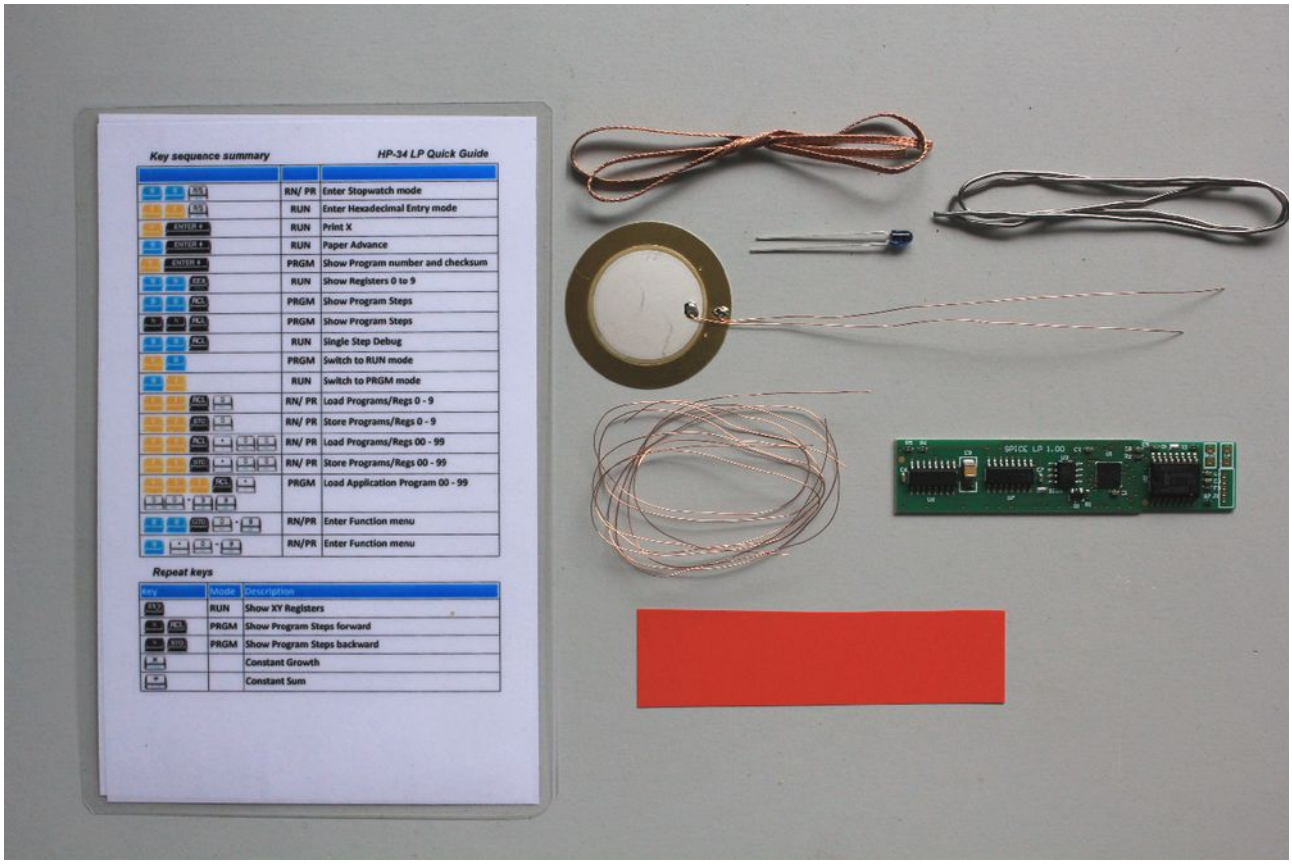
Many, many thanks and appreciation again to *Eric Smith* for his really great pioneer work!

There are many others to mention and give thanks, that have made previous reengineering research, which was helpful in understanding all these undocumented things.

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. Possibly you also found the *“SPICE Low Power” ,* the *“Woodstock Low Power”* and the *“new ACT“* somewhere here.

The “SPICE Low Power” repair kit

You have got the “SPICE Low Power” repair kit. Well decision! The repair kit consists of the “SPICE Low Power” circuit, a laminated Quick Guide card, an IR diode and piezo beeper. Also you will have got this manual as .pdf file.



Img. 1 SPICE Low Power repair kit

The new “SPICE Low Power” replaces the complete calculator electronics. It even replaces the internal power supply and drives the LED display and keyboard directly.

With this kit all “SPICE” calculators HP-31E/32E/33E/33C/34C/37E/38E/38C can be repaired. 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 250-1000 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.

You will never need to switch off your calculator

But this is not the only new feature. The Low Power circuit contains a Real Time Clock with Time, Date, Alarm and Stopwatch. This +-3 ppm accurate RTC runs all the year and keeps 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.

Following is the description of installing the “SPICE Low Power” circuit into your calculator and other chapters describe its remarkable new features.

Disclaimer:

When using these instructions for upgrading or repairing your calculator, or in any other case of using the “SPICE 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 “SPICE 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

Installing the SLP circuit

Solderless Version

The following description is for the solderless version of the “SPICE” calculator.

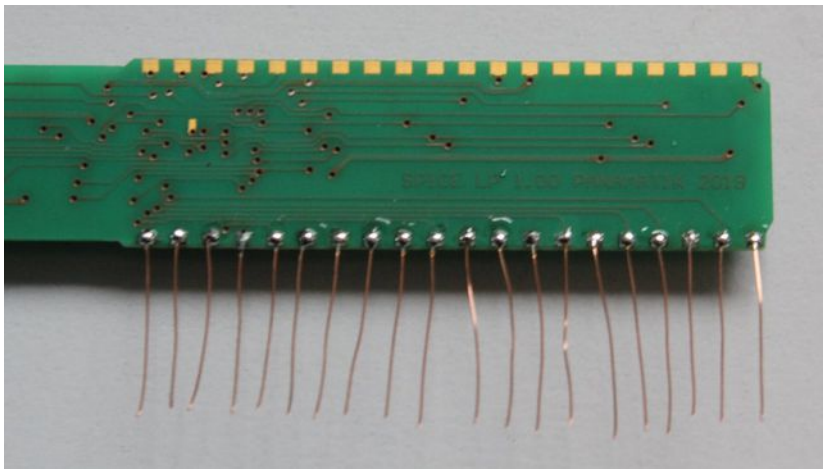
After you have opened the case (see Appendix C), you have to remove the inner carrier, which holds the integrated circuits. There are 6 lugs, three on each side. You have to bend them outwards on one side to release the carrier, but be aware they can break easily if you bend them too much. Perhaps you can get help by a small screw driver. Lift the carrier up and take it out.

Remove the LED display, which is not soldered. Next, seperate the key contacts and electronics board by removing the two metal spring clips at either side, then the integrated circuits will fall out. They are not used any longer, perhaps keep them as spare parts for another calculator repair. You can see the 40 pads of the largest circuit. We will connect the SLP to these pads later.

But first remove the power supply. Take it completely out of the compartment together with the flex PCB (Printed Circuit Board) and the battery adapter. The power supply will not longer be needed, but the flex PCB will. You have to unsolder the 12 pads from the power supply board. I recommend first to remove as much tin as possible with copper braid. Then with tweezers and soldering iron remove pad by pad. Unsoldering the power supply without damaging the pads is difficult if not impossible, because the pads are very long and thin and dissolve easily from the flex cable. Keep in mind, that you don't need the power supply any more. But try not to damage the flex cable pads and don't short circuit them with solder.

Now after we have disassembled everything, we have to add the SLP board. It was not possible to create a board with solderless contacts, therefore the SPICE LP board must be soldered with wires to the existing pads of the calculator.

The SLP board is delivered with some isolated copper wire of 0,20 mm in diameter. Cut the wire into 20 parts of 1,6 cm each and 8 pieces of 5 cm each. The shorter wires must be soldered to the 20 golden pads of the SLP board bottom side as shown in the image.



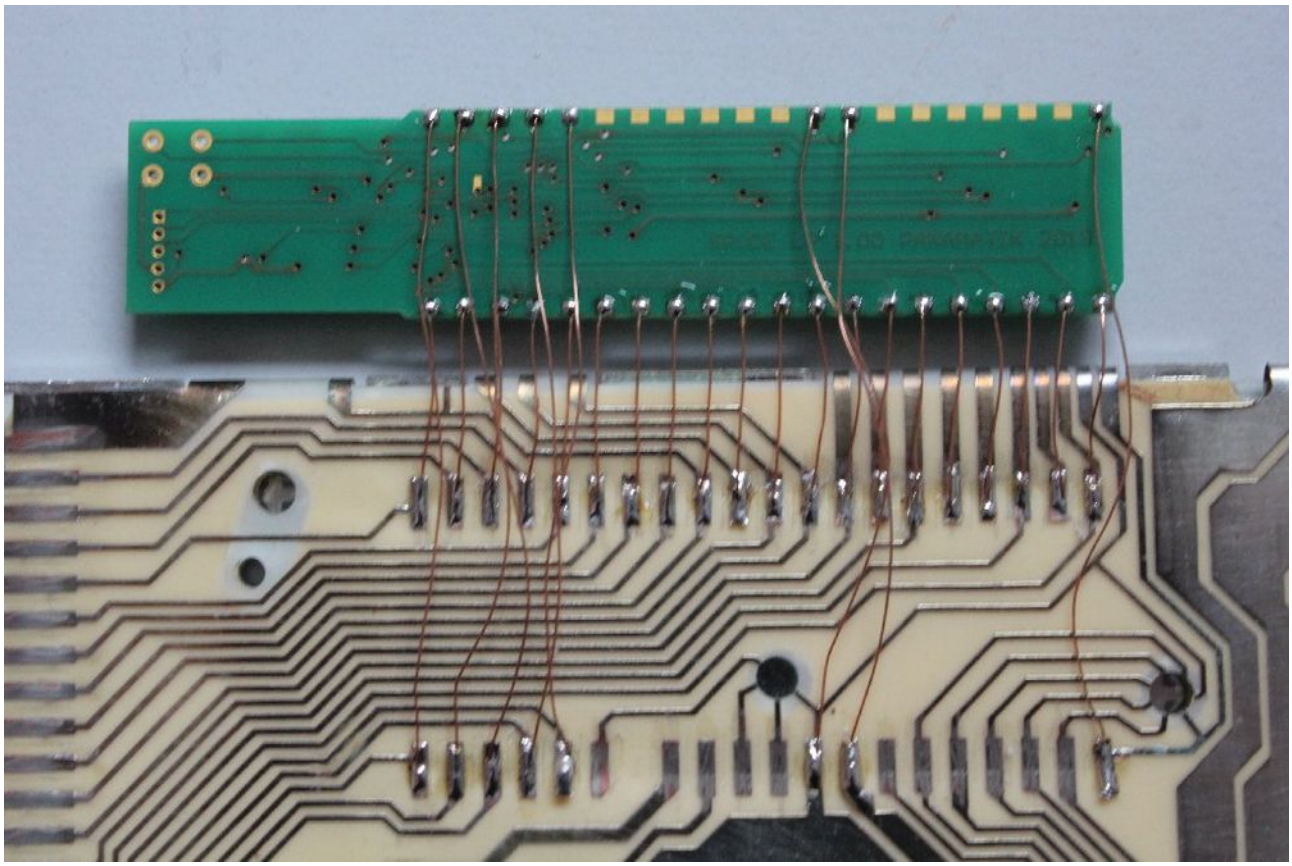
Img. 2 SLP with 20 short wires attached

Before you are soldering the wires you have to dissolve the isolation at the end of each by applying some solder and heating it up for some seconds at the tip of your soldering iron. Generally use solder with flux core or you should apply solder flux to the pads. Then attach the wires to the according pads.

If you have attached the 20 short wires, then add also the 8 longer wires to the pads as shown below.

Lay the SLP circuit bottom side near the calculator as shown in the next picture and first solder the 20 short wires to the pads of the calculator. Again first remove the isolation of each wire by heating it up for some seconds. Solder only for 1/2 second to not damage the soft plastic material. Avoid too much heat otherwise the pads can get also separated from the surface.

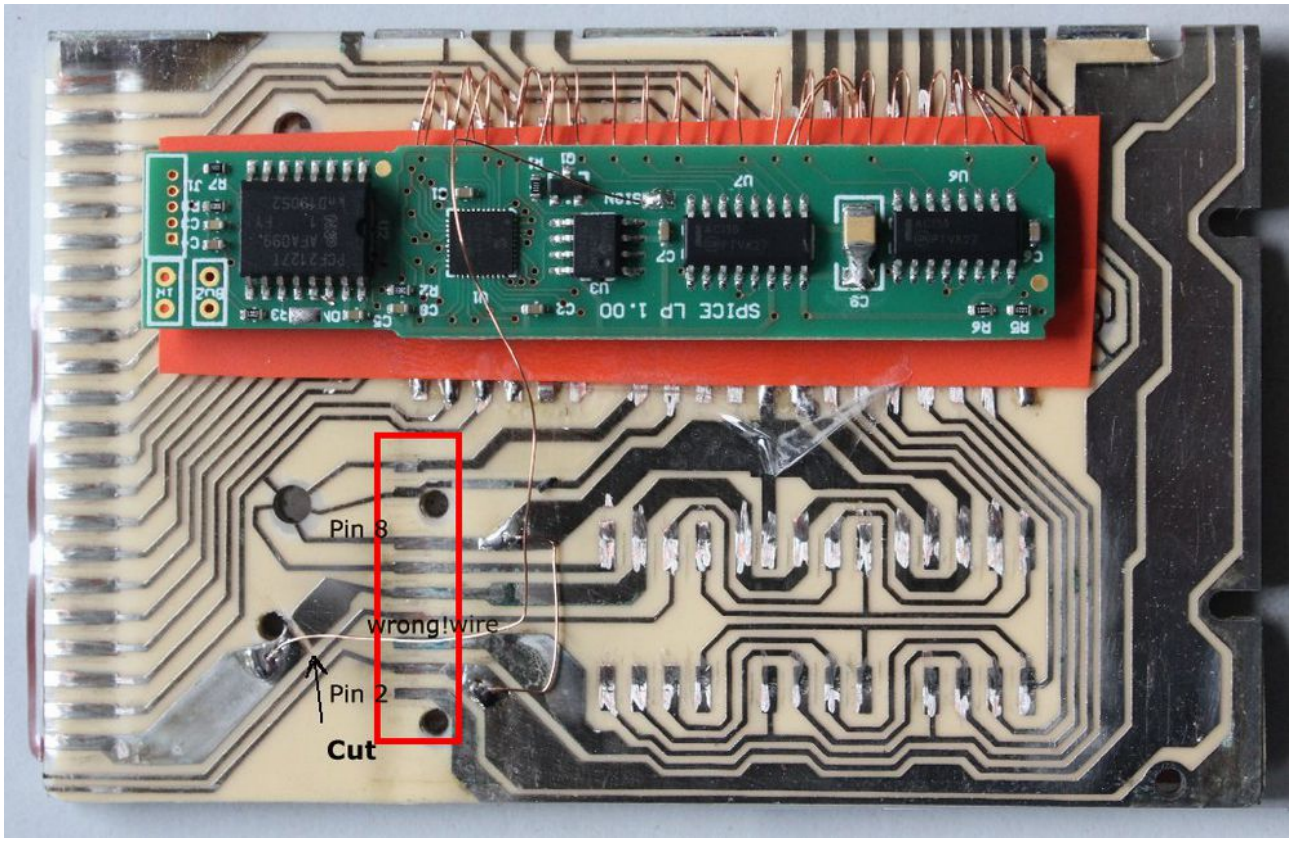
Next solder the eight longer wires to the opposite pads. See which pads are connected in the image below (1-5, 12 13, 20, see Appendix B for pinout description).



Img. 3 SLP attached to PCB with 28 wires

Fix the plastic sheet with a small piece of scotch tape to cover the electrical contacts. It is used to isolate the SLP board from the circuit paths. Now fold the wires with the board inwards to its final place.

Next you have to cut a trace and add three additional wires. The cut must be made in the trace leading to the SIGN digit (Display pin 22). The SIGN digit is a separate LED digit



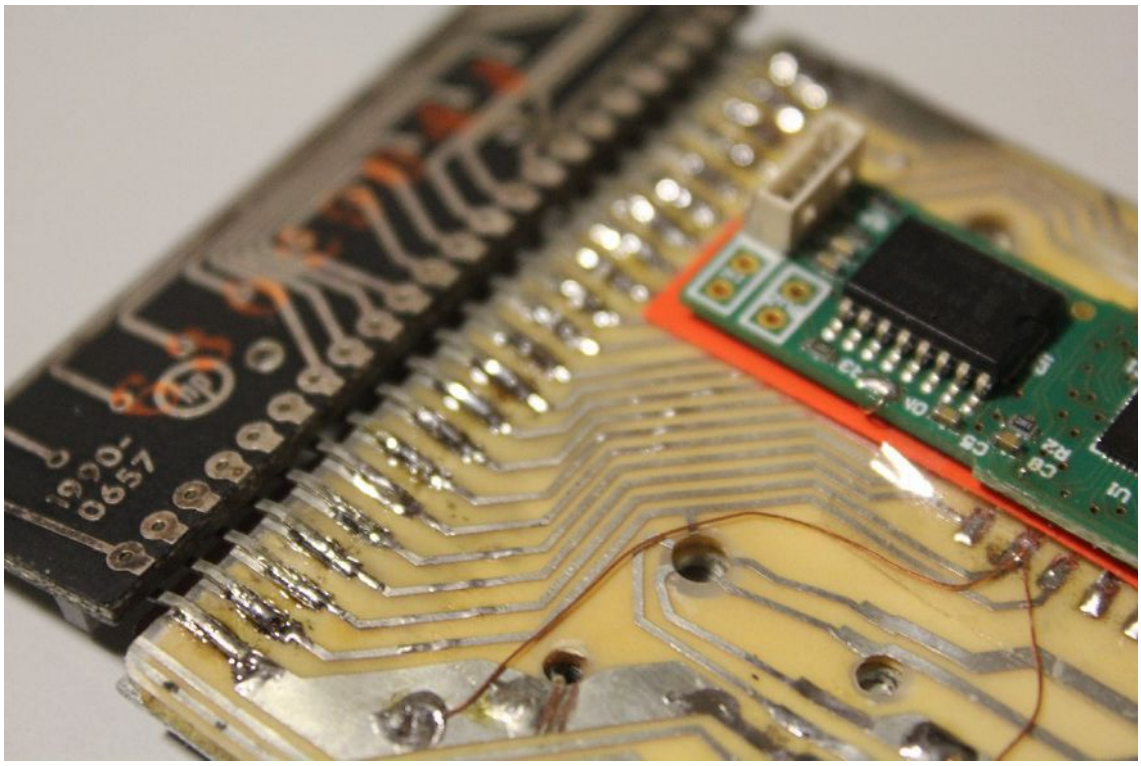
Img. 4 SLP folded to its place

which can only display the minus sign and is located at the leftmost pin of the display. When the cut is done (with a dremel tool or with a scalpel), solder a wire from here to the SIGN pad of the SLP. Then connect pin 3 with pin 8 of the power supply connector as shown in the image. The power supply connector are the 12 pads enclosed in red (notice that pin1, pin 9 and pin 12 are not present in the layout). Don't solder directly to the power connector pads, they will be used for solderless contacts to the power supply flex strip later. Also the wires may not cover the contacts. In the image above you can see a wrong placement of the SIGN wire, which covers pin 4, this is not allowed!

Next attach the (optional) ON/OFF wire from the ON pad of the SLP to pin 2 of the power connector.

LED display

I would recommend also to solder the LED display to the 20 pads. This is not mandatory, but it is known that often some digits or segments are missing because of bad contacts here.



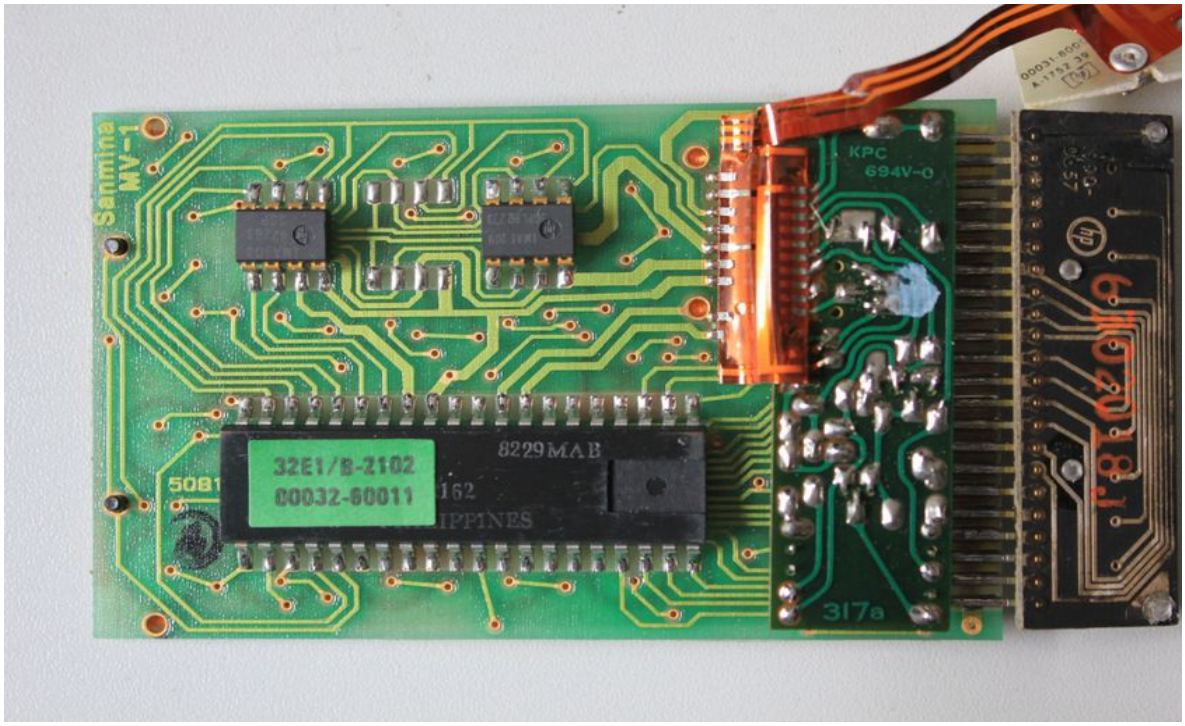
Img. 5 Display Soldered

The display pins must be cleaned from oxidation before soldered to the pads. Solder first the leftlost and the rightmost pin, to control the right angle and position of the display, then fix the other pins. Also the distance of the display from the board should be relatively close, otherwise the housing cannot be closed later. All pins must be soldered flat to their pads as shown in the image. Again don't solder longer as needed to no damage the material, just 1/2 seconds is enough for each pad.

Soldered Version

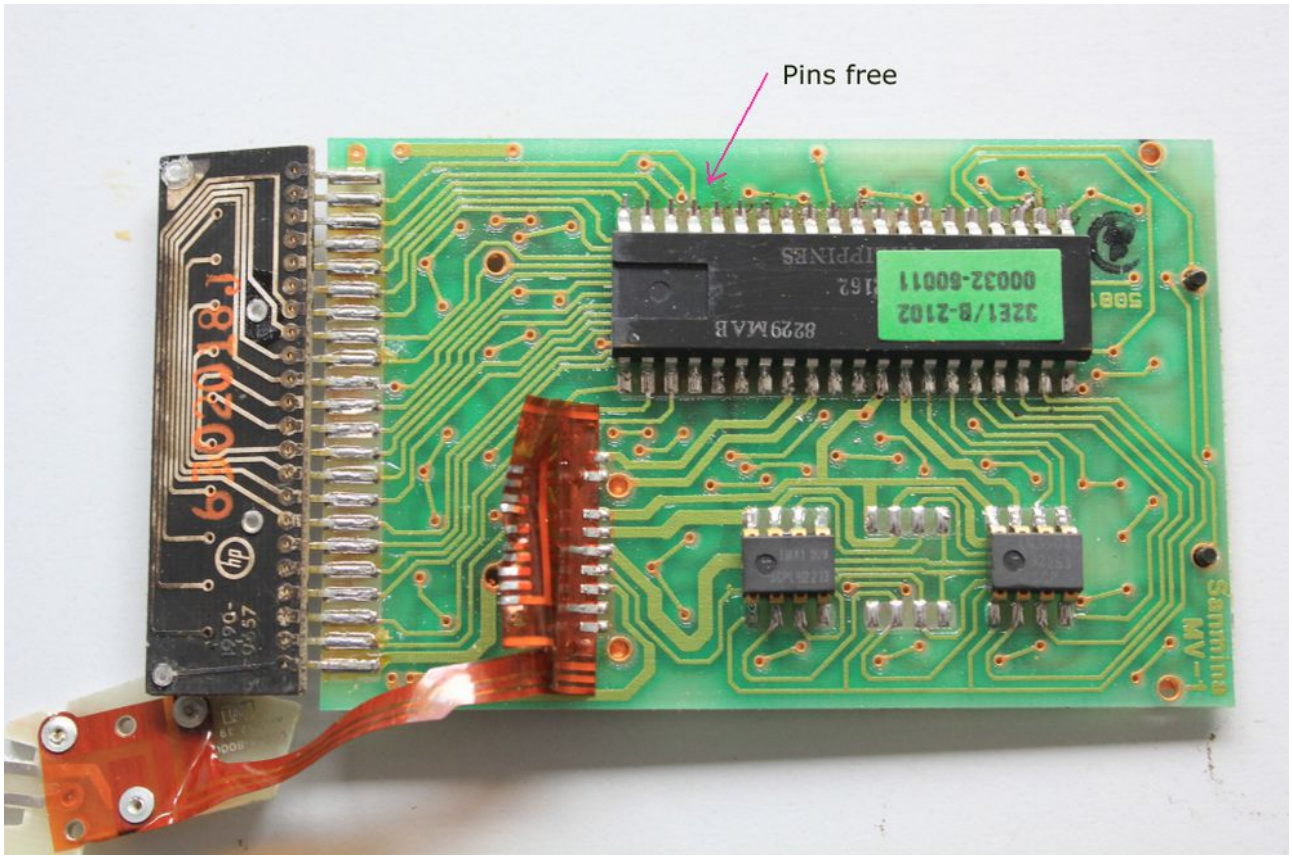
If you are lucky you own a soldered SPICE model, you have less work to insert the SLP circuit. The following description is for installing the “SPICE Low Power” into the soldered version of a SPICE calculator.

First remove the inner carrier from the PCB (Printed Circuit Board), which separates automatically when you release it from the upper housing. Then unsolder the flex cable from the power supply, but leave the other end of the cable soldered to the PCB. Unsoldering the power supply is the same ugly procedure as with the soldered version. It is difficult or impossible to remove the power supply without causing damage to the pads. But you don't need them later anyway. If the pads from the flex cable are affected, adjust them and check that there is no short between them after the unsoldering.

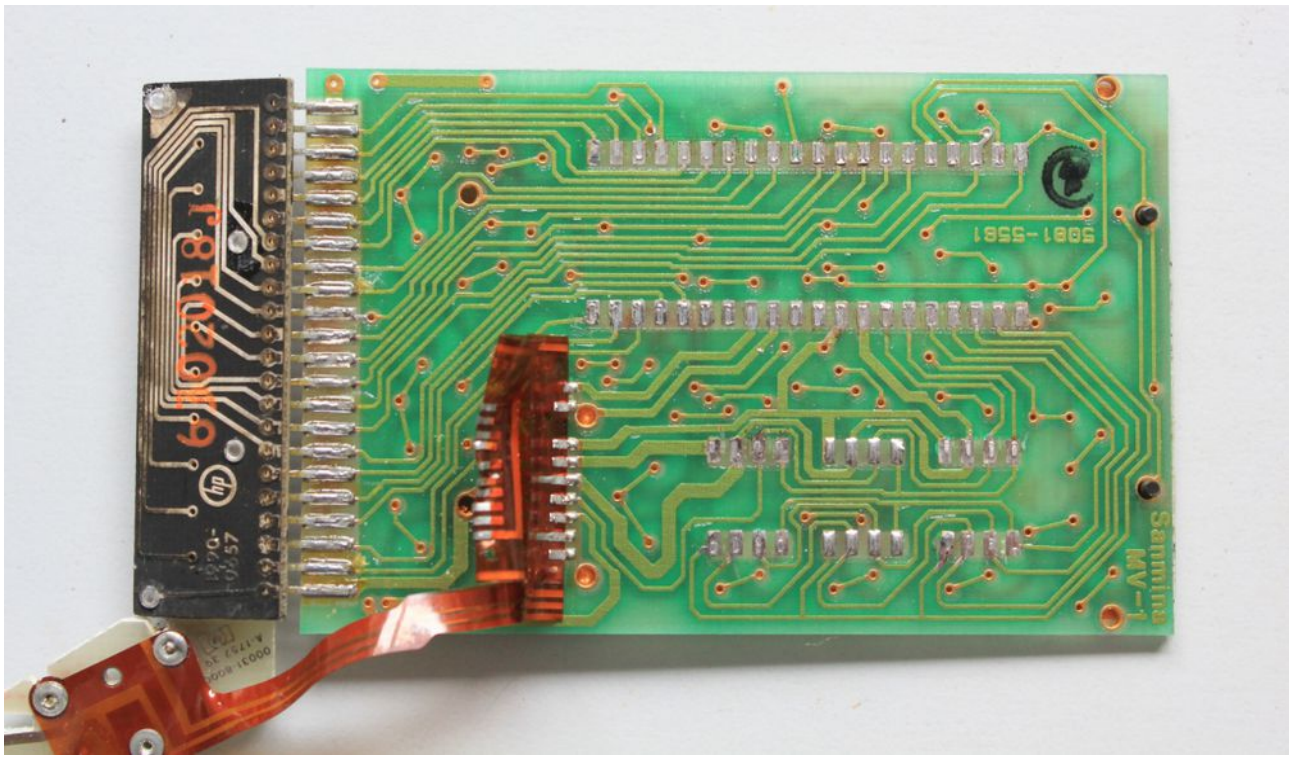


Img. 6 Soldered Printed Circuit Board

Next you have to remove all chips from the PCB. This must be done pin by pin, because the heat of hot air could possibly afflict the sensitive keyboard side. Remove as much tin as possible by repeatedly using the copper braid for each pin, until it is possible to bend the pin upwards with tweezers and become free from the pad. In the image below you can see that some pins are already free, others still to go.



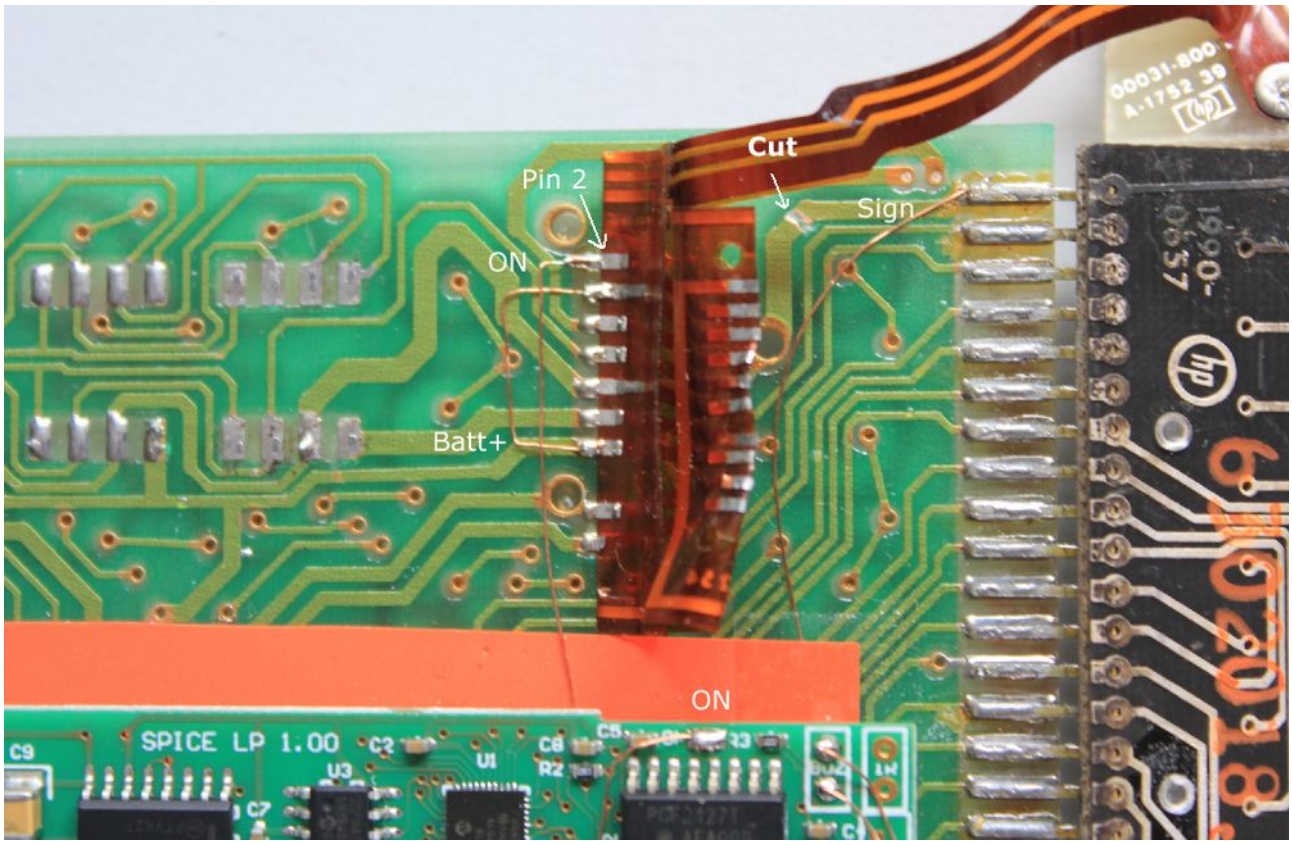
Img. 7 ICs still there



Img. 8 All ICs removed

Adding the SLP circuit to the PCB with 28 wires is the same process as in the solderless version (read there first), but it is easier to perform, because the epoxy PCB is less sensitive to damage.

First solder the short wires (1,6 cm length) to the pads. Next solder the longer wires (5 cm length) to the opposite pads. Then cut the copper trace at the leftmost display pin and connect a wire from here to the SIGN pad. Connect pin 3 and 8 (Batt+) at the Flex connector and connect pin 2 to the ON pad of the SLP circuit.



Img. 9 Additional wires

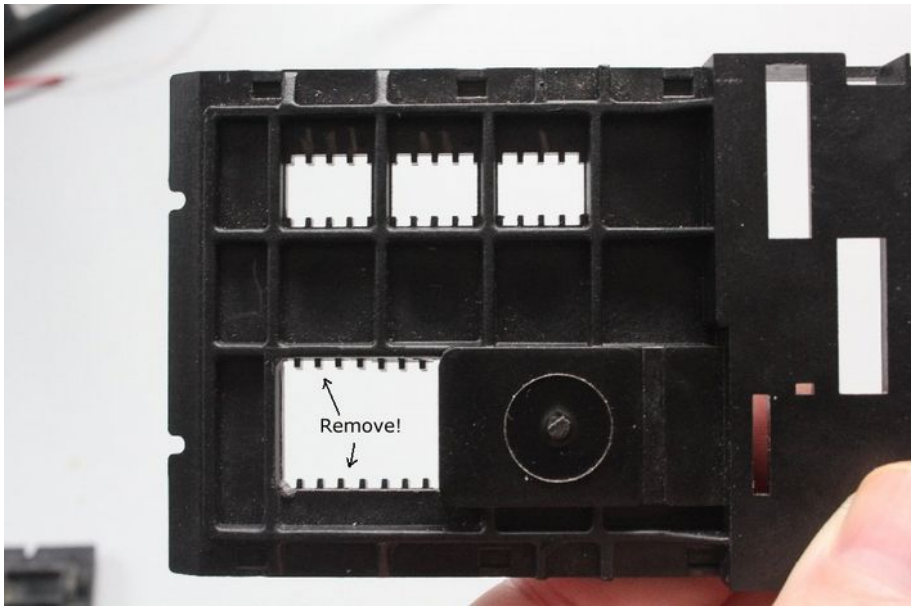
Fold the SLP into its final position. Don't forget to add the orange plastic isolation sheet.

The LED display is already soldered, there is nothing to do.

Assembling

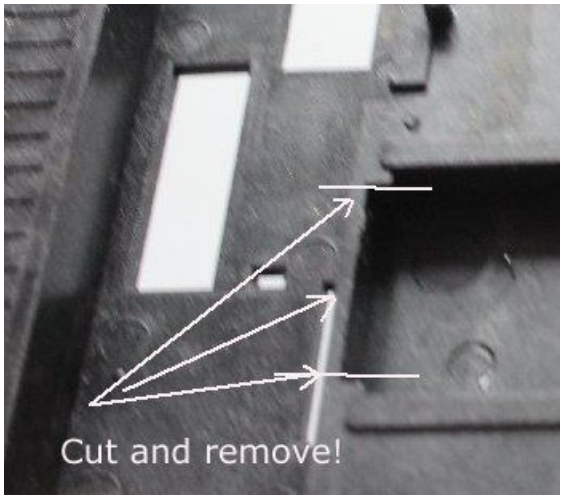
The SLP circuit is now complete (if you want to install the optional beeper and the Infrared diode read the next chapter first). Now you can assemble the calculator.

There were different versions of the black cover made. One has many gibs for each pin of the ICs, another has already flat outlines, and this is what the SLP board is made for. The soldered version has a carrier where the holes are even bigger and therefore it is best suited for the SLP. If you have the first version you need to remove all these little plastic parts from the 40-pin slot, which is easy to perform with a small diagonal pliers or a knife.

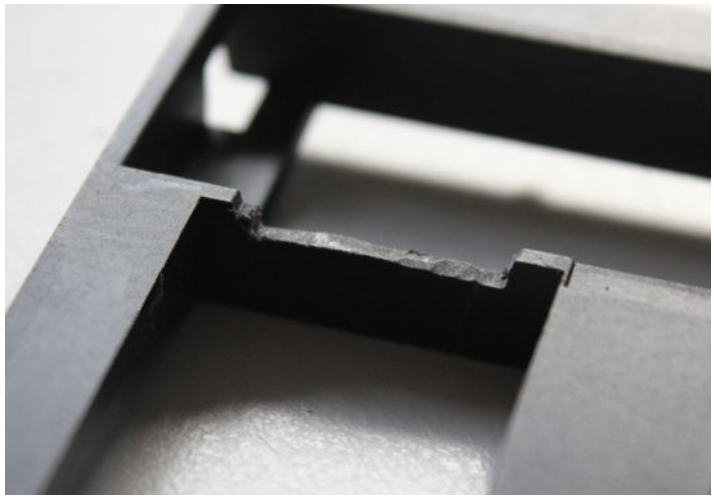


Img. 10 Pin fixation to be removed

You also have to cut a space into the carrier and remove the obstacle between the 40-pin slot and the power supply compartment as shown in the image below, because the SLP board needs more space than the original IC.



Img. 11 Space needed

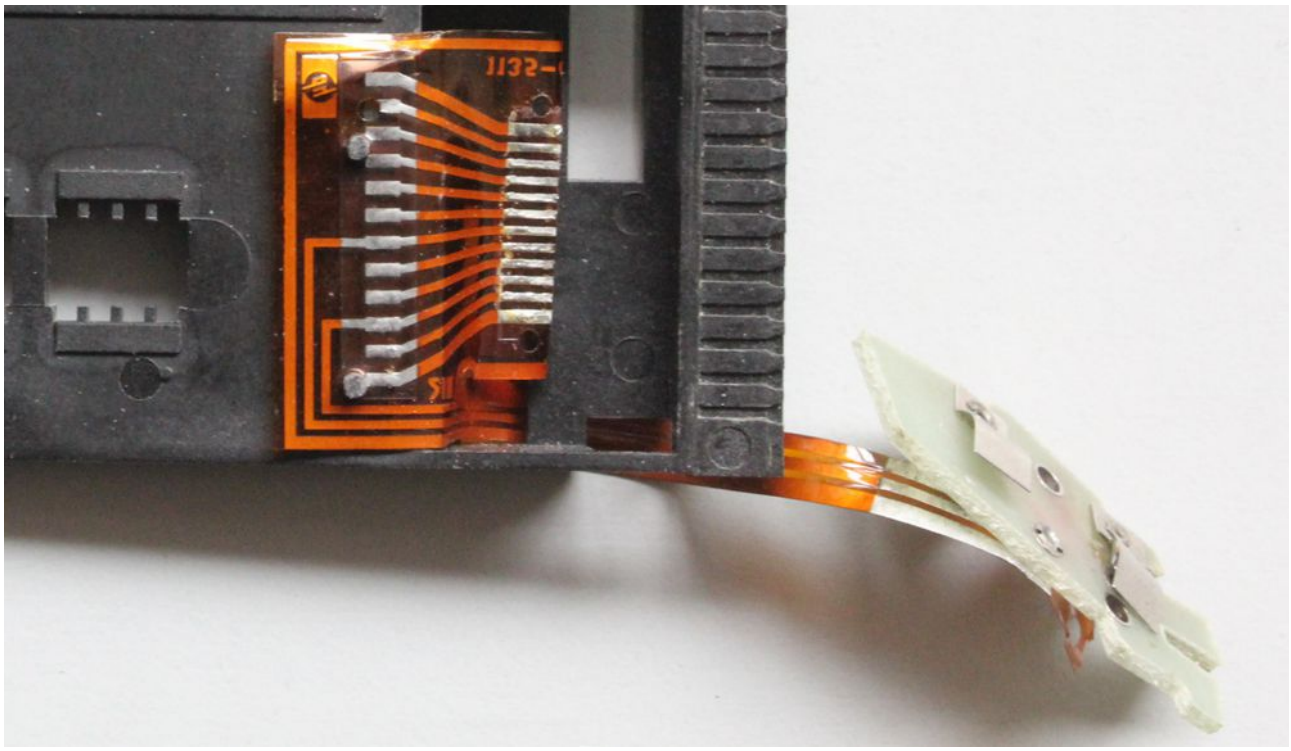


Img. 12 Cutout

When you combine the PCB with the black cover, the SLP board must exactly fit into the 40-pin PDIP cutout. You can easily adjust it because the copper wires can be bended and will hold the circuit in place. Arrange the SLP board and its many wires as best as possible not to be pressed together too much.

Even if the board is at the right place, there is maybe some force necessary to close the two halves for the first time, because the copper wires will be pressed together.

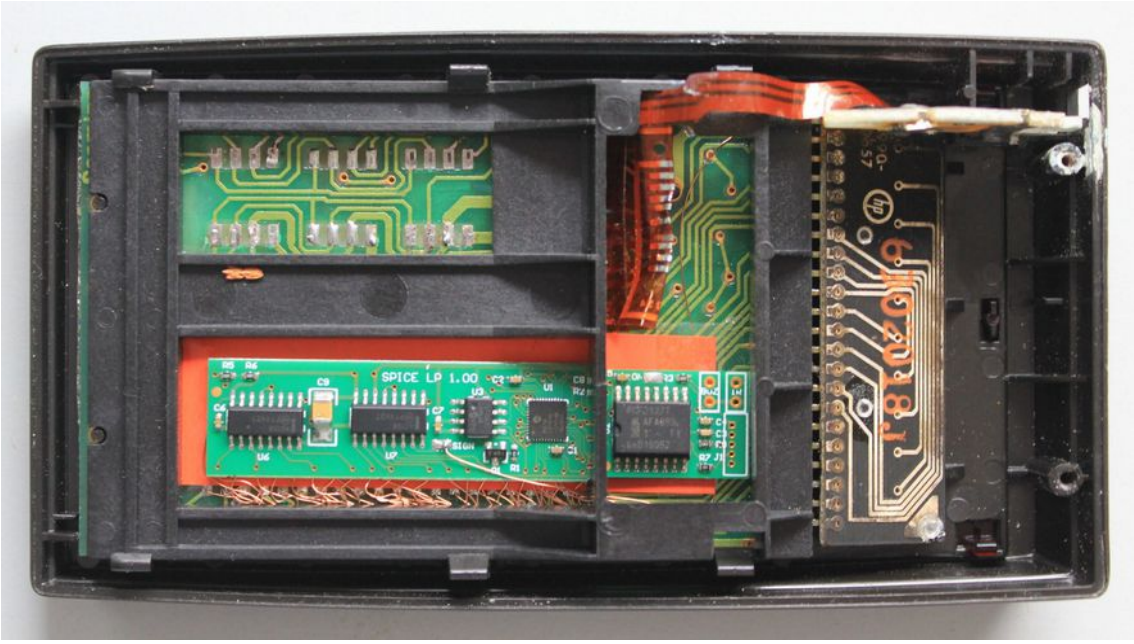
For the solderless version place the power supply flex cable correctly and attach the two spring clips again. They are assymmetric, the shorter ends must be used for the keyboard side.



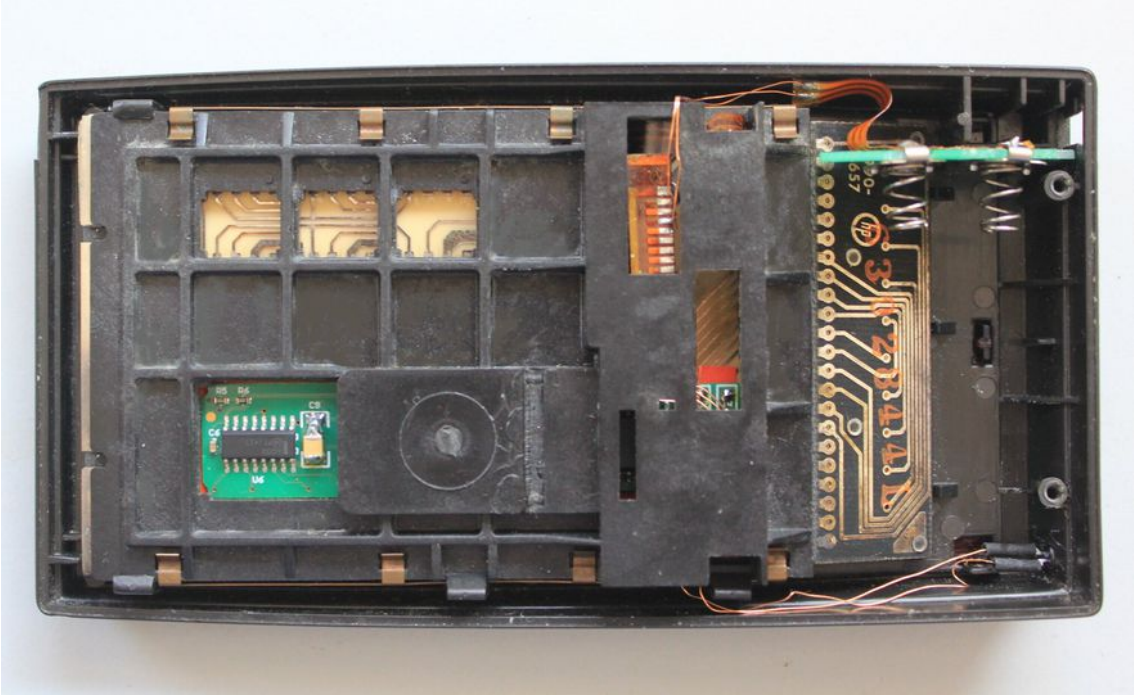
Img. 13 Flex cable attached

If you did not get good contact between the Flex cable and the PCB, disassemble the parts again you can put some solder into the PCB pads to elevate the contacts by 1/2 mm.

After you are ready your board should look like in the next images



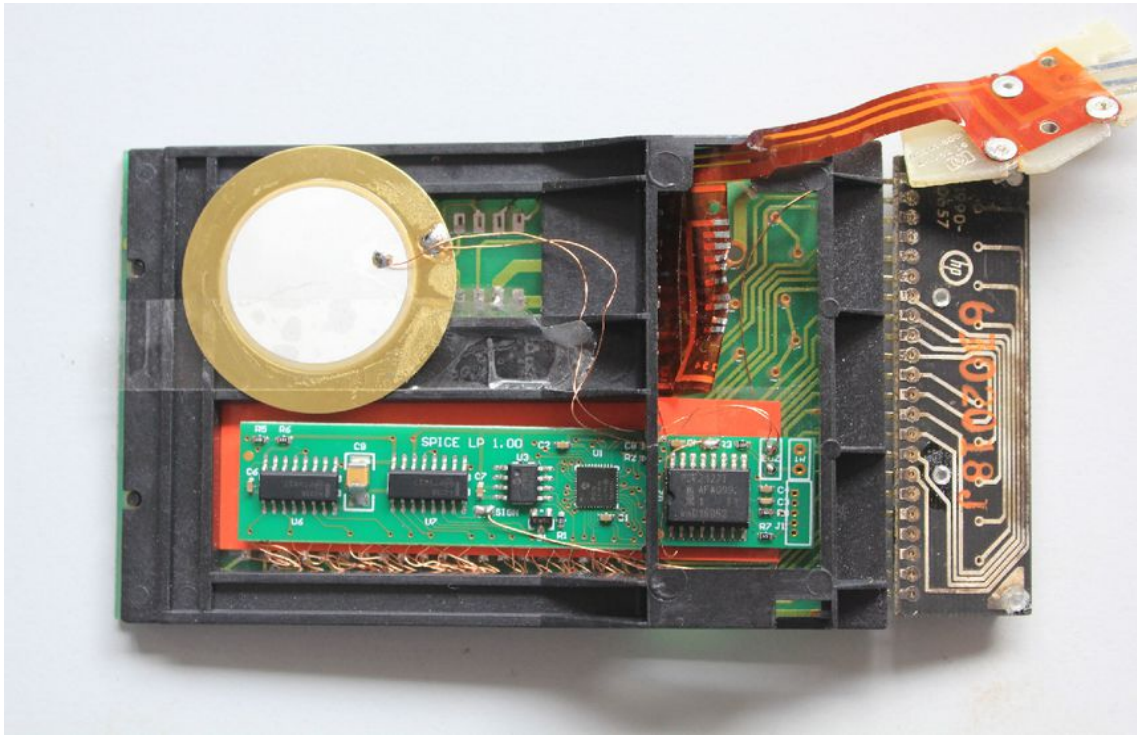
Img. 14 Soldered version



Img. 15 Solderless version

Beeper

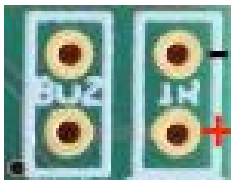
The optional piezo beeper will be connected by two wires to the according pins on the SLP circuit, labeled with „BUZ“; the polarity doesn't matter. Fix it with some scotch tape as shown in the image.



Img 16. Beeper

IR Diode

The best place for the IR diode is at the opposite side of the charger connector. Fix the IR diode with epoxy glue and connect it with two wires to the SLP board before assembly. Check the correct polarity, anode (plus + red) is the longer pin of the IR diode.



Img. 17 Infrared printing diode

Now close the case by reverting the openprocedure and insert the two black screws. Don't apply too much force to the screws, the case can break very easily, as so many case have already damages and cannot be repaired.

If you want to have less problems to open the case again, I made some good experience to remove some material from the sharp edge hook at the front, but only very slightly, otherwise the case would't close any more at all. This is your own risk.

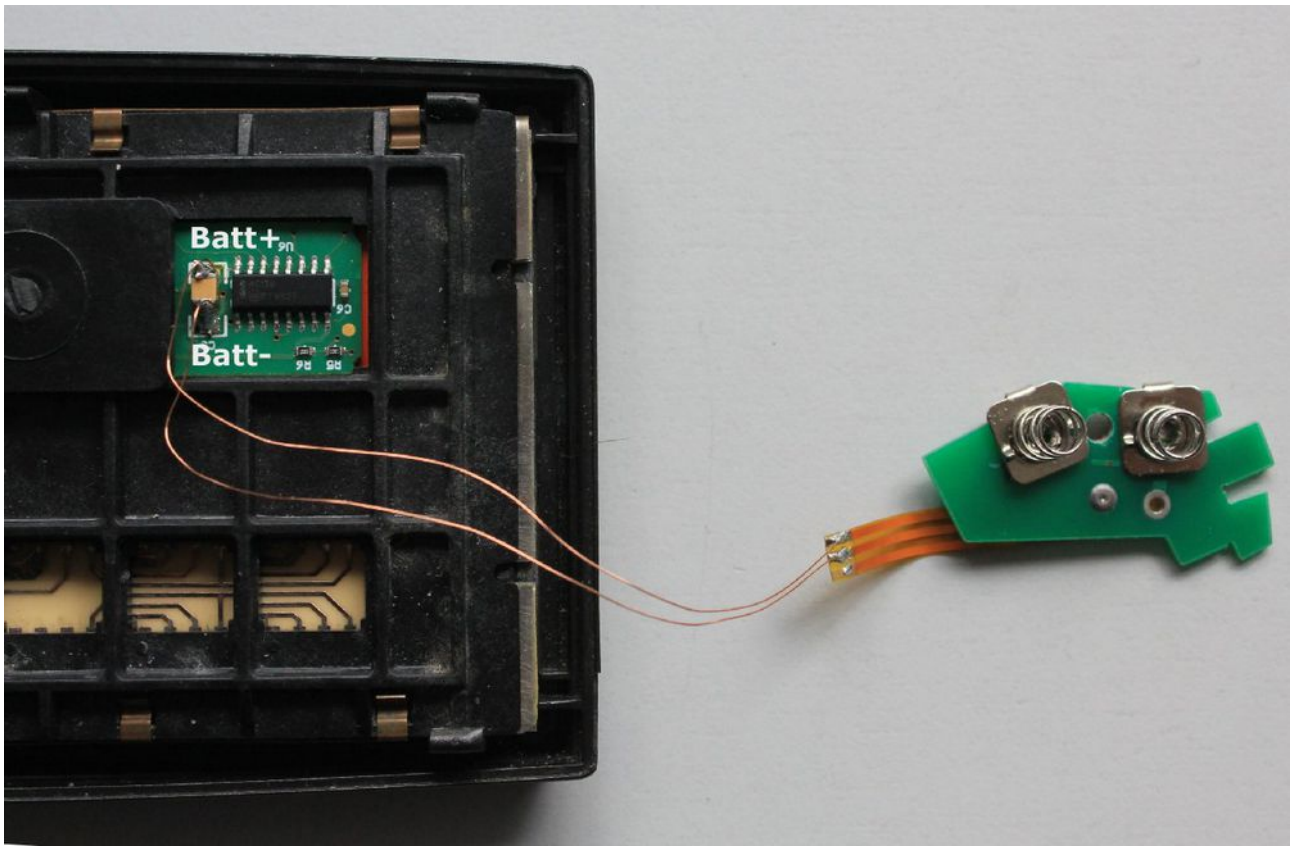
Ready!

After you have successfully assembled the calculator and inserted the batteries you will be welcomed by the “SPICE Low Power” logo. The default calculator will be the HP-33E, but you can change to any other SPICE calculator.

Congratulations! You made it.

You can set the date and time and your personal configuration now.

If you don't get a display after power up, most likely for the solderless version, there is no contact from the battery to the board of the flex cable. In this case I recommend to solder the two wires Batt+ Batt- directly from the battery adapter to the SLP board. There is a brown capacitor where you can easily solder the wires as shown in the image below. This will solve the contact problems.



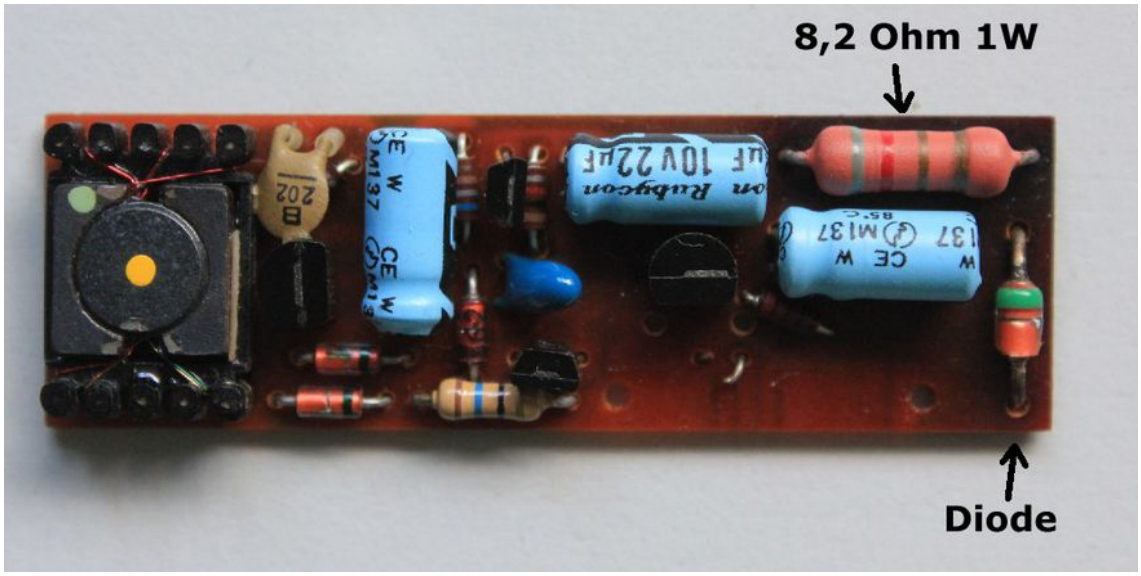
ON/OFF switch

The ON/OFF switch is used to switch OFF and ON the calculator. You can do this also by the  key sequence and wake up with the  button. But it does not really switch OFFwhen you move the slider to the left side, it causes the calculator going to sleep and keeps all its data registers, which you will see again when you switch ON the calculator again.

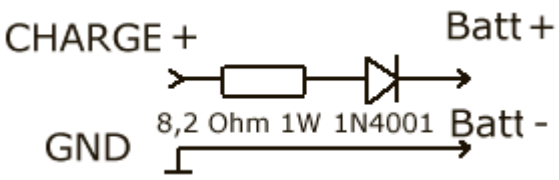
Charger

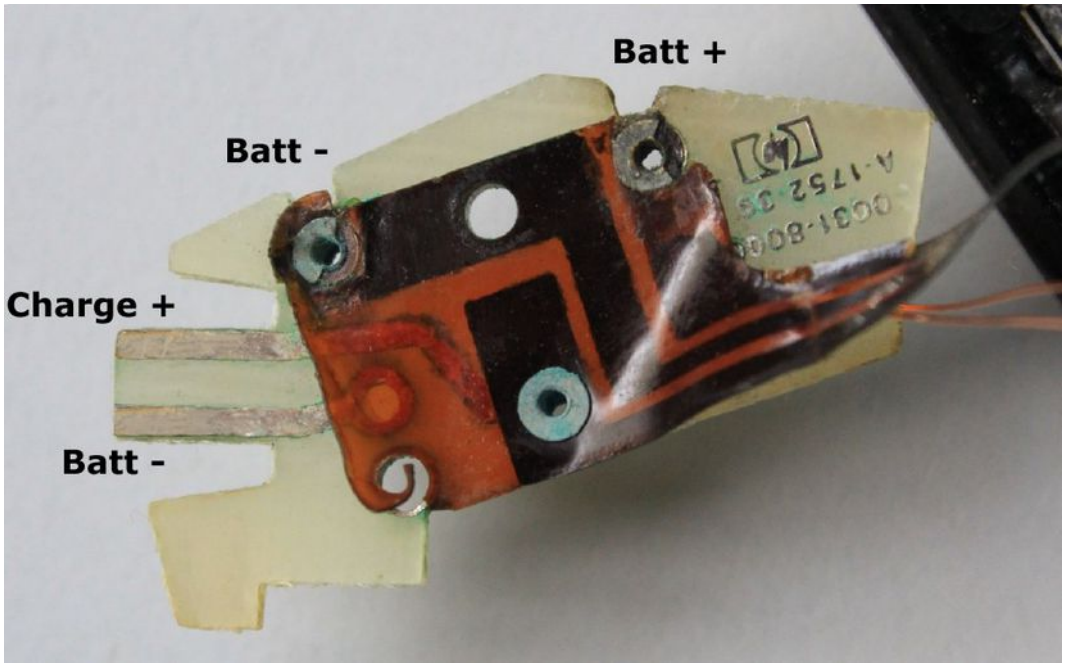
The original charger does not work with the SLP circuit when the internal power supply is completely removed. If you plug in the charger, there is no contact to the battery any more. This is no problem, because the battery has much longer lifetime now and can be charged externally with any AA battery charger.

If you want to charge your batteries with original charger you can add only two components, a diode and a resistor 8,2 Ohm 1W, to make charging possible again. These two parts can be found in the power supply as shown below, the green ring of the diode is the cathode. You can unsolder and reuse them or you can buy new parts from an electronic shop. As diode I would recommend 1N4001. I leave it to you to find a place inside the calculator for these two parts and where they will be connected.



Img. 18 Power supply board





Img. 19 SPICE Battery connector

The original “SPICE” battery connector seen from the outer side. The charger is connected to the two electrical contacts on the left when plugged in. Follow the “Charge +“ flex wire to the other end of the flex cable, this is normally pin 2. Solder the resistor and anode of the diode to this end.

Often the flex cable of Spice calculators is in bad condition as seen above. There is the PANAMATIK SPICE battery connector for replacement.

Features

Differences between “new ACT” and “SPICE LP”

For getting a detailled description of the “SPICE Low Power” features it is mandatory to read the “new ACT” manual, because the SLP circuit includes nearly all features of the “new ACT” chip. Some of them are obsolete, some are different and some are completely new. Let's start with the differences.

1.) Power Up Keys

The SLP circuit doesn't have “Power Up” keys, because in OFF position the batteries remain still connected. All flags, which could be toggled by power up keys with the “new ACT” can be set/reset by the “Set Flags” function. There is only one power up key left, the emergency “Reset” (see chapter “Reset”)

2.) Sleep Mode

The Sleep Mode replaces the Standby Mode of the “new ACT”. You enter Sleep Mode manually by pressing  or move the ON/OFF slide switch to the OFF position, if you want to shut down your calculator to a minimal current consumption.

If you have set the “AUTO SLEEP” flag, the calculator will automatically go to Sleep after one minute without keyboard activity. If you want your display staying ON infinitely, that is until you switch it OFF manually, then deactivate this flag.

“AUTO SLEEP” flag is toggled by pressing  .

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

3.) HP Calculator

You can tell the “SPICE Low Power” circuit to show the calculators name 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 Calculator flag  .

4.) External/Internal ROM

There is no external ROM any more, even if you leave the original ROM chips in place, there is no communication to them and they are not needed any more. The new SLP circuit always reads the HP firmware from its internal flash ROM.

5.) Slow/Fast Speed

There is no slow mode any more. The new SLP 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 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 to give you time for reading intermittent results.

6.) Continuous memory

The “SPICE 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 33C and 34C models.

This concept 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.

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 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 longer necessary.

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.

10.) Program Library

There are many preprogrammed application programs for HP-25C, HP-29C, HP-33C, HP-34C and HP-67 (see chapter Application Programs). Additionally you can store 110 user programs in flash memory for each of them.

11.) GPS

The SPICE calculators have not enough space inside the case to install a GPS (Global Positioning System) module, therefore the GPS functionality, which is available in “Woodstock LP” and “new ACT”, is not implemented in the SPICE LP circuit.

What's totally new?

After having mentioned some differences of already known features, here is a list of the completely new features, which were not present in the previous “new ACT” firmware.

1.) Real Time Clock

The accurate RTC chip allows you to show the time, date, weekday and to set an alarm time. The clock is running as long batteries are inserted. It will keep the accurate time for you and the alarm can even wake you up in the morning.

2.) Show program step mnemonics

Your program steps can be shown as mnemonics rather than as row column code. Generally all possible texts can now be shown, because the 7-segment display is not longer limited by the original display driver chips, and can show each combination of segments, which includes the full alphanumeric character set.

3.) Ticker Text

You can enter any text up to 64 characters, which will be shown as ticker text whenever you want. This nice feature improves the previous 12-digit welcome text, which was limited to only a few alphanumeric characters.

4.) Show Battery Voltage

You can show the actual battery voltage for monitoring the charge state. This improves the original low battery display by showing all the dots. You can keep track of the charge state just by reading its actual voltage.

5.) Show Temperature

Not very accurate, but at least an approximation of the ambient temperature will be displayed. Sometimes however it shows a temperature way off. It seems the temperature sensor of the PIC processor doesn't behave according to the data sheet. Perhaps an update is necessary.

6.) Beeper

The integrated piezo beeper can be programmed to wake you up when the programmed alarm time matches the actual time.

9.) Program Directory

You can enter names for your programs. When you want to load one of them, you can step through the directory of program names and load it with one click. Also saving a new program is much easier, you step through the directory until you find a free slot and save your program with one click.

10.) PC Communication

Even more possibilities are given, when you connect your calculator via USB/TTL serial converter with the HP25LP PC application. You can upload/download programs and data and perform a complete backup in less than a minute.

11.) Many calculators in one

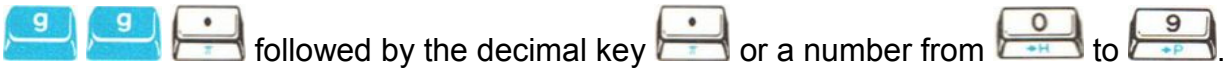
As mentioned before, you can switch between all SPICE calculator models. Other HP models like the “Classics” and “Woodstocks” and HP-67 are not available, because they need a bigger display, the SPICE calculators only have 10 digits.

The following chapter, which describes the key sequences for the above mentioned new features in detail, are valid for the HP-34C calculator. Most of them are the same for other calculators, but some might differ due to the different available physical keys. All key sequences, separately listed for each calculator model, are shown in Appendix A.

Functions

The “SLP” has quite the same set of function keys as the “new ACT”. These are not mathematical function keys, but some additional routines, which display useful information.

All Functions are called by the key sequence:



followed by the decimal key or a number from to .

All Function menus either show some text or you can edit something within. The menu will stay there as long as you want and waits for keyboard entry. You can leave and close all functions and return to calculator mode when you press the 

key.

1.) Show Revision and Serial Number

If you press these keys you will get displayed the revision and serial number of your SLP circuit.

The Firmware Revision Number is shown at the left as **“r 1.08”** for example, on the right appears the serial number, **“Sr 0001“** in this case. This display is shown until you press any key.

2.) Show Flags

When you press the last key of this sequence the text “**FLAGS**“ is shown until the button is released, then all 10 digits are used for showing the flags. There are 20 flags available, which were represented by ten dots and ten minus signs. The dots from left to right show flags 0-9, the minus signs show flags 10-19. Each flag has a special meaning and can be toggled here by pressing its key. The new state will be reflected in the display. If you hold down the button for more than 1 s the meaning of the flag is shown als text.

The flags are described in detail in the following chapter.

3.) Show HP Calculator

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

If the Infrared printing mode is enabled the display will show

Also you can switch to another calculator by stepping through the available calculators.

4.) Show Free memory

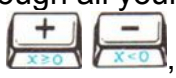
This function informs you about the amount of free program memory and register memory. There are a maximum of 110 programs available for your own self-written programs, 10 directly accessible in the *"Program Memory"* and 100 in the *"Program Library" (*each up to 210 steps for HP-34C). If a programs contains at least one program step, it is considered as used. If a register contains a value different from zero it is considered as used.

The leftmost number shows the free programs (up to 110), followed by the number of free registers. There are a maximum of 176 (depending on calculator) registers available.

If all programs and registers are free you will be informed by:

5.) Program directory

There is a surprising new feature implemented in this menu, unique to a LED calculator: You can give your program a name. Each program can be labeled with a text of up to 10 characters, which makes it easy to identify. Whenever you load a program from your library its name will be shown in the display.

You can step through all your 110 programs (where 100-109 are the fast access programs) by holding down  , or pressing  for fast forward/backward.

You will see your program names and you can decide to load this program into your memory by just pressing the  key. If you want to save your actual program to this memory location then press the  button.

If the actually shown program is a free slot, the text **„EMPTY“** is shown instead of the program name. Stepping to the next free slot makes sure, that you don't accidentally overwrite one of your other programs.

Alternatively to the program name you can show the program number by pressing the 

button.

To enter a new name for your program press the 

button. A cursor appears and the text can be altered like the ticker text. If you press 

again the program name of the actually loaded program will be updated, or press 

to leave the name unchanged.

6.) Show program checksum

If you call this function it shows the number of the currently loaded program and its checksum. The number is either a single digit from **Pr. 0** - **Pr. 9** if it is loaded from the “Fast Access Program Memory”, or like in the picture below 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** will not show a number.

If your actual program doesn't match with any of the stored programs only the checksum is shown.

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

7.) Show available Memory/ Register and Program usage

g g . 5

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

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 is displayed (a register set is either 8 or 16 registers) The digits show the used registers 0-7 (the dots show used registers 8-15 if available), which were previously saved by f STO 0 and indicate, that registers 0,3,6,7 of this register set are used.

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

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

While you hold down the key the text **“Programs”** is shown followed by the numbers of the occupied programs. If only “**Programs**” is shown, the numbers show the occupied 10 fast access programs, which were saved by f STO followed by a number. If “**Programs 0-9**” is shown, then 10 programs of your available 100 library programs are shown. In the above example programs 50 51 and 53 55 59 are used, 52 54 and 56 57 58 are empty.

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 to store.

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 counting up. The first timer value can be up to 10000 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 100 hours. This second counter is resettable by the 

key.

9.) Flash write Cycles

Every time, when your save a program or register set, 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.

The flash memory used in the hardware of your SLP circuit 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.

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, all segments of all digits must be on, showing the digits **"- 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 a little bit. Then, normally it will work again. If there is missing only *one* segment of only *one* digit, this is a more severe problem inside the display module, and cannot be repaired easily.

11.) Ticker Text entry

With this function you have the possibility to "personalize" your vintage HP-34 SLP calculator and display your text message on the display. You may create any text of up to 64 characters. Finally I could build a complete alphanumerical calculator for you, because the SLP 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 Ticker Text. An underline cursor is blinking.

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 

and some characters and minus sign and space directly with the appropriate keys:

A B C D E F O I 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 

or 

to advance to the next/previous 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 64 character buffer. Place the cursor to the end of your text and press the 

key. This will insert the EOT (End Of Text) character, which is shown as **"8."** (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 save the text to flash memory or 

to leave the text entry without saving.

Flags

There are twenty flags. The flags have the following meaning:

-  "Auto Sleep" This flag will activate or deactivate automatic sleep mode. Sleep mode will be entered after one minute without key entry.
-  "Show Logo" When set shows the selected calculator every time at wake up.
-  "Check Battery" Switching off this flag can be used to suppress HPs low battery indicator: inverting all decimals points. The battery threshold voltage is set to 2,3 Volt. If you switch off "Battery check" you will not be warned, when the battery is going to get empty.
-  "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 Align" 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.
-  "Symbols" When activated the mathematical constants "**PI**" and "**Euler**" were shown by its name instead by its value.
-  "Mnemonics" With this flag you decide whether you want to show plain text intsead of row column code in your program steps. Highly recommended!
-  "Infrared Print" toggles Infrared printing mode. When set printing is enabled and after wake up "**HP-34 Ir**" is shown if "HP Calculator" is enabled.
-  "Print Norm" When printing is enabled, this flag switches on Norm mode, where all of your manual calculations are printed on paper. All calculations are printed except the result to save paper lines.
-  "Print Trace" When this flag is set and printing is enabled, the result of your is printed automatically after each calculation.
-  "Wakeup All" If this flag is set, each key in the last row will wake up your calculator. If not set, only the  key will wake up
-  or  "Long Awake" When activated the time before going to sleep is about five minutes instead of one minute without key stroke .

- 

"Steady Display" 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.
- 

"Time Measurement" This button enables the automatic program time measurement. If your program is started also the stopwatch will be started and will be stopped automatically when the program ends. Thus you can measure exact calculation times.
- 

"Keep registers" When switching to another calculator, normally all storage registers will change their value to the new calculators workspace. If you have set this bit registers 0-7 will keep their value and thus can be interchanged between the calculators.
- 

"Show Keys" When you have activated this flag and hold down a key, which is associated to a mathematical function, the function name will appear on the display.
- 

"Write Protect" When this flag is set, you are not allowed to save programs. You can use this as a precaution for accidentally overwriting your programs.

The Flags display will be quit and the flags will be saved when the 

or 

key is pressed.

Application Programs

Like in the “HP-25E new ACT”, where the original “HP-25 Applications Programs” are preprogrammed, the SLP has predefined programs available für HP-33E/C and HP-34C.

The application programs have predefined names like

MOONLANDER

The programs are taken from the original HP-33E/33C and HP-34C applications books from 1979, which can be downloaded from PANAMATIKs website. You need the books for the register usage description. All programs are carefully typed from the scanned books and considered to be type error free.

All HP-33E/C HP-34C programs can be recalled from the read only application program library by

00 to 70

HP-33E/C

HP-33E/C Applications

Nr	Name	Program Steps
00	Plotting	29
01	Count Down Timer	30
02	Calendar	45
03	Biorhythms	47
04	Moon Landing Simulator	45
05	Nimb	36
06	Mortgage Loan: Accumulated Interest/Remaining Balance	37
07	Mortgage Loan: Payment, Present Value, Number of Periods	39
08	Mortgage Loan: Interst Rate	47
09	Periodic Savings: Payment Future Value, Number of Periods	46
10	Triangles Program A: SSA, AAS, ASA & SAS	48
11	Triangles Program B: SSS & SAS	38

HP-33E Mathematics Applications

Nr	Name	Program Steps
12	Quadratic Equation	35
13	Complex Arithmetics	31
14	Complex Functions	39
15	Determinant and Inverse of a 2 x 2 Matrix	26
16	Equations in2 Unknown	26
17	Number in Base b to Base 10	27
18	Number in Base 10 to Base b	39
19	Vector Cross Product	23
20	Angle between Norm and Dot Product of Vectors	19
21	Newton's Method	49
22	Numerical Integration	22
23	Hyperbolic Functions	23
24	Inverse Hyperbolic Functions	30
25	Circle determined by Three Points	47
26	Intersection of Line and Line	47

HP-33E Statistics Applications

Nr	Name	Program Steps
27	Covariance and Correlation Coefficient	14
28	Moments and Skewness	44
29	Partial Correlation Coefficients	24
30	Factorial	29
31	Permutation	44
32	Combination	32
33	Random Number Generator	7
34	Normal Distribution	39
35	Inverse Normal Integral	31
36	Exponential Curve Fit	13
37	Logarithmic Curve Fit	12
38	Power Curve Fit	15
39	Chi-Square Evaluation	26
40	Paired t Statistic	18
41	t Statistics for Two Means	48
42	One Sample Test Statistics for the Mean	18

HP-33E Student Engineering Applications

Nr	Name	Program Steps
43	Ohms Law and Reactance Chart	35
44	Resistors in Series or Parallel	23
45	Exponential Growth or Decay	44
46	Black Body Thermal Radiation	37
47	Ideal Gas Equation of State	32
48	Equations of Motion	44
49	Natural Frequency of Oscillators	38
50	Kinetic Energy	37
51	RPM/Torque/Power	41
52	Static Equilibrium at a Point	48
53	Vector Cross Product	23
54	Angle Between, Norm and Dot Product of Vectors	19
55	Discounted Cash Flow, Net Present Value, Internal Rate of Return	23
56	Compound Amount	47

HP-33E Surveying Applications

Nr	Name	Program Steps
57	Azimuth-Bearing Conversions	39
58	Bearing Traverse	49
59	Field Angle Traverse	48
60	Inverse from Coordinates	49
61	Compass Rule Adjustment	43
62	Sideshots	49
63	Bearing-Bearing Intersection	40
64	Bearing-Distance Intersection	48
65	Distance-Distance Intersection	42
66	Offset from a Point to a Line	47
67	Curve Solutions	41
68	Elevations Along A Vertical Curve	46
69	Earthwork: Volume by Average End Area	39
70	Coordinate Transformation	44

HP-34C

There are 51 HP-34C application programs available; 33 programs share the space with your user programs in the program library. They will be recalled by the sequence 

followed by a number from 67 to 99.

18 more programs can be recalled from the read only application program library by

00 to 17

HP-34C Applications

Nr	Name	Program Steps
67	Curve Fitting	51
68	Hyperbolic Functions	164
69	Polynomial Evaluation	58
70	Annuities and Compound Amounts	116
71	Discounted Cash Flow Analysis	77
72	Moon Rocket Lander	91
73	Nimb	63
74	Timers	63
75	Random Number Generator	57
76	Moving Average	45

HP-34C Mathematics Applications

Nr	Name	Program Steps
77	System of Linear Equations with Three Unknows	80
78	Determinant and Inverse of a 3x3 Matrix	97
79	Numerical Integration by Discrete Points	59
80	Differential Equations 1	59
81	Differential Equations 2	90
82	Vector Operations	88
83	Triangle Solutions	127
84	Coordinate Transformation	42
85	Circle Determined by Three Points	84
86	Complex Operations	129
87	Base Conversions	121

HP-34C Statistics Applications

Nr	Name	Program Steps
88	Basic Statistics for Two Variables	124
89	Factorial, Permutations and Combinations	118
90	Moments, Skewness and Kurtosis	99
91	Normal Distribution	27
92	Inverse Normal Distribution	52
93	Chi-Square Distribution	59
94	t Distribution	100
95	F Distribution	96
96	t Statistics	84
97	Chi-Square Evaluation	39
98	Contingency Table	99
99	Azimuth-Bearing Conversions	38

HP-34C Surveying Applications

Nr	Name	Program Steps
00	Traverse, Inverse, and Sideshots	140
01	Traverse Adjustment	106
02	Bearing-Bearing and Distance-Distance Intersections	132
03	Offset and Bearing-Distance Intersections	125
04	Curve Solutions	173
05	Horizontal Curve Layout	119

HP-34C Student Engeneering Applications

Nr	Name	Program Steps
06	Ohm's Law	57
07	Reactans Chart	37
08	Impedance of a Ladder Network	65
09	Series-Parallel Resistor Adding and Standard Resistor Values	93
10	Ideal Gas Equation of State	38
11	Conduit Flow	119
12	Equations of Motion	180
13	Kinetic energy	42
14	Mohr Circle for Stress	38
15	Simply Supported Beams	156
16	Section Properties	107
17	Equilibrium	53

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 °C to +80 °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 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, you can see a minus sign 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 at the right. If you press again and you see a minus and a dot on the right this indicates the daily alarm.

If the daily alarm is activated the alarm is triggered every day at the same time. If daily alarm is not activated, the alarm will be automatically disarmed after the first match and you have to activate it for the next day manually.

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 the current weekday in plain text. If you want to change it just enter a number key from 0 to 6.

Perhaps you have a free weekend, then you can press 

which is

5.) Stopwatch

Just press 

in RUN mode 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.

Start/Stop/Reset

Start and Stop function is placed on the R/S button. Reset to zero is naturally done by the CLx Button after the stopwatch has been stopped. If you switch back to calculator mode[1] with another g R/S , 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 STO 0 to 7 . Recalling these values is possible with RCL 0 to 7 .

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

g R/S

The stopwatch of the Low Power circuit is different to the stopwatch of the ACT. The SLP 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 ot stop with the R/S key. Or you can enter a starting time just by keying in 6 numbers, hours minutes seconds, and ENTER, which sets the stopwatch to a start value. Then you can decide to count forward with R/S or

backward with the 

key. If the stopwatch counts backwards and reaches zero it will trigger an alarm and the beeper will be heared for one minute.

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

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.

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.

3.) Ticker Text

When you call this key sequence the actual „Ticker Text“ is shown. Because the text can be up to 64 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 capabilities of the new SLP 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.) Random Quote of the day

The “SPICE LP” holds more than 300 inspirational quotes for you. They are related to mathematics, physics, the universe and god and everything. The author's name follows each quote. Enjoy what you discover.

If you like to show your text slower or faster, just press  or  keys to adjust the ticker speed.

5.) Sleep Mode

If you want to enter Sleep mode, when you don't need the calculator for the next time, you have four possibilities.

a.) Enter this key sequence to send your calculator to sleep manually. It will show “**SLEEP**” for some seconds and then switch off.

b.) Wait one minute (or 5 minutes if “Long Awake” flag is activated) and the calculator automatically will go to sleep. It will show “**SLEEP**” for some seconds and then switch off.

c.) Move the ON/OFF slider to the OFF position. The display will show “**OFF**” for some seconds then shuts off. There is no difference between “**OFF**” and “**SLEEP**”.

d.) Press  for 3 seconds.

The shutdown after some minutes needs the “Sleep Mode” flag to be enabled by

.

You have the possibility to choose between one minute or five minutes as ON time. The longer time is selected by setting the “Long Awake” flag with

.

If you are running a user program, the calculator assumes, that you want to get the result before the calculator goes to sleep, therefore “Auto Sleep” is suspended until the program stops.

If you get an unexpected “**SLEEP**” message, because the minute is over while you are contemplating about some calculation results, you can abort the sleeping process by pressing any key and just go on contemplating.

6.) Wake Up

To wake up the calculator just press the 

key.

You can also configure your SLP to wake up by any of keys in the last row, if you set flag “Wakeup All” by using 

.

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

7.) Beep

This sequence will invoke a short beep sound. Regrettably it is not programmable for the SPICE calculators. For other models the sequence may differ.

Special Features

1.) Key Text

When you press any key, which for example executes a mathematical function, you will see the result on the display. But if you keep holding down the key for more than one second its function name will be displayed. After you release the key the result will again be shown in the X register. In this example the keys  were pressed, which calculated the inverse sinus function. Or the ENTER key was pressed.

This remarkable use of the alphanumeric capabilities of the SLP circuit can be activated by the „Show Keys“ user flag  .

2.) Reset

Because the context of each calculator is stored in flash memory, which keeps its data even when battery is removed, you could be worried about what happens, if a calculator hangs somehow. Even when taking out the batteries nothing will change. For this purpose you can reset all calculators to the state as if they were just switched ON. Most of them will just show “**0.00**” in the display, others could show **“Pr Error”** when they are used the next time.

You have to remove the battery pack, hold down the  key and then insert the battery pack again. You will see the display shows “Reset” for some seconds then the actual calculator will start.

3.) Error Messages

There are only a few possible „Error“ messages, which could be displayed by the SLP firmware after trying some wrong key sequences. The messages are shown as text in the display. The calculators themselves can show more errors under different circumstances, which are described in their respective manual.

Loading a program which number doesn't exist

Trying to store a constant in the fixed constant area 0-19.

Trying to store a program when „Write Protect“ flag is set.

4.) Alarm

If you have entered Sleep Mode there are two events, which will wake up your calculator automatically:

1.) If the alarm time is activated and the time matches the alarm time.

2.) If the stopwatch countdown timer is activated and reaches zero.

In the first case the text “**Alarm**” appeares in the display and in both cases 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 .

5.) Mnemonics

As a result of replacing the display drivers, the new SLP circuit has become the ability to show alphanumeric texts. It has finally overcome the limitations of the original Spice calculators .

Using these new alphanumeric possibilities, the display can show your program steps in plain text. 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 fourty 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 flag 7 

6.) 512kB Flash memory

Many of the new enhancements of the „SPICE 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-34C 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 210 step programs. No, the concept of the „SPICE Low Power“ uses this big data area to store the original ROM firmware of all SPICE calculators.

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 the executable PIC program, only emulatable calculator ROM code, thus the program area for executable code is still inside the PIC flash memory and limited to 16k words of the PIC16LF1619 processor.

Here is a brief list, which data is stored in the flash memory.

110 programs per calculator from 49 steps HP-33 to 210 steps of HP-34C

10 register sets per calculator, either 8 registers or 16 registers in some models

100 constants recallable and writable shared among all calculators.

“Continuous Memory” and register context for every calculator.

The original HP ROM code for emulating every calculator.

Keyboard codes for every button for every calculator.

List of key sequences for all extended functions for every calculator.

Printer Mnemonics for program listings of every calculator

Display Mnemonics for program steps of every calculator.

Texts to display like “Error”, “Sleep”, “Sunday” “Monday” etc.

Print Norm/Trace Mnemonics for every button function to be printed.

There is still a lot of free memory left. New calculators could be added in the future to the SLP circuit just by writing new data into the external flash memory without changing the PIC program. But if necessary also the PIC program can be changed when an update is available.

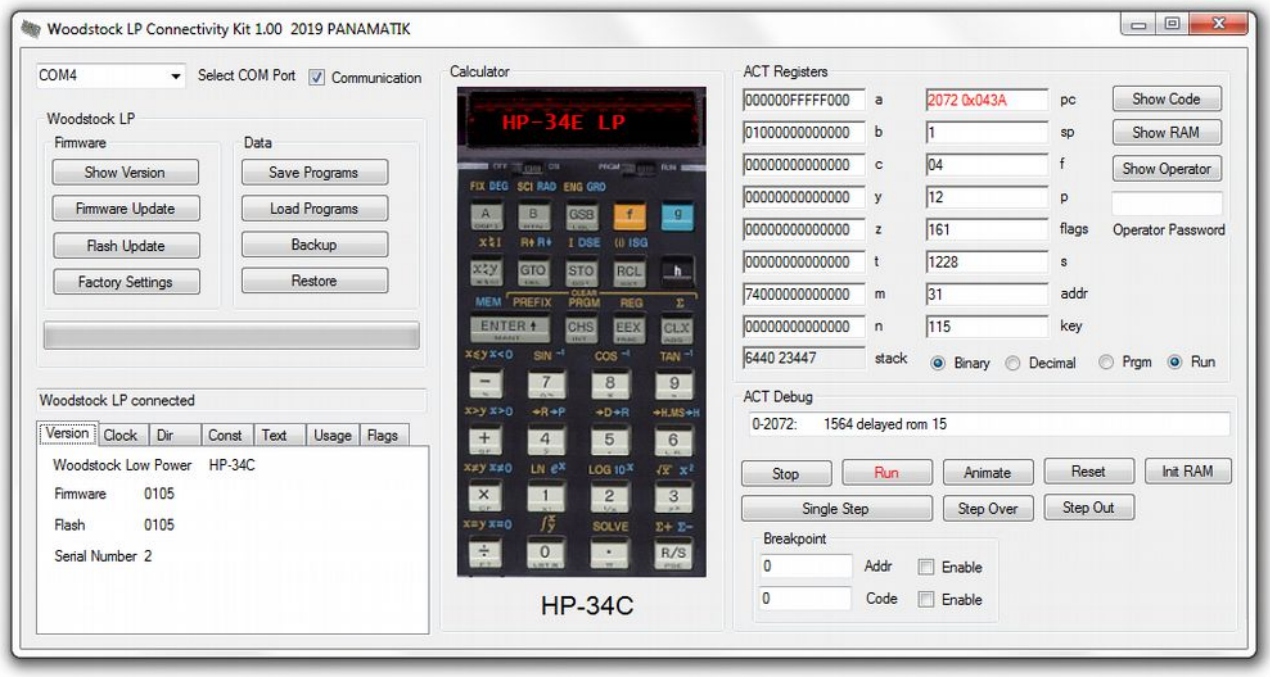
7.) Execution Speed

The execution speed of the the Low Power circuit is significantly faster than the original calculator. This is not always apparently visible, because the PAUSE function doesn't 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 funtion or run a program, then you can see the new speed. The main reason for a speed increase, even compared to the „new ACT“, is that the SLP 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 „SPICE Low Power“ is the big 512 kByte flash memory, which contains the firmware of all SPICE calculators. It is an external serially addressed flash memory. During execution of the HP firmware, each instruction 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 theoretically up to 50000 instructions per second, compared to 3000 of the original calculator. You will not suffer from a slow calculation speed.

PC Application

There is a PC application HPLP.exe, which can communicate with your SLP calculator. It cannot be covered in this manual (see the “LP Connectivity Kit manual” for more details).



1.) Upload/Download Data

The PC application 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 and much more.

2.) 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 (see the “LP Connectivity Kit manual” for a complete description).

3.) Debugger

There is a debugger which allows you to analyze the original ROM code of the SPICE calculators comfortably.

Switching between calculators

1.) Selecting the model

You don't need to reprogram your SLP circuit to switch to another calculator. The existence of all SPICE calculators in the „Low Power“ flash memory allows you to run all of them just by selecting a new calculator. This key sequence, which shows the actual calculator, can be followed by  or  keys to select another calculator. If you leave the menu by  the new calculator will be started. For some seconds the display shows:

With  you leave the menu without switching.

There is also a shortcut, which works all the time from whatever state. Just press the  key for more than 3 seconds in calculator mode and miracoulusly the above menu will appear. Because the  key will be processed, I recommend to press the  key before, this avoids stack lift and overwrites only the X register.

Follwing Calculators can be selected: HP-31E/HP-32E/HP-33C/HP-34C/HP37E/HP38C

2.) Continuous Memory

Every time you switch to another calculator, its “Continuous Memory”, consisting of the actual registers and the actual program, and depending on the calculator sometimes also the display mode and some other data, are loaded from flash memory. And the memory of the now suspended calculator is saved for the next time. Thus you will always get the calculators memory restored to the state, when you last used it. Also your program library and the register sets are saved to individual memory for each calculator. Perhaps you might not have been aware of it until you now have read these lines, the SLP circuit gives you 110 programs for HP-33C and HP-34C, the programmable calculators, a total of 220 programs, some of them use up to 210 program steps. Wow!

3.) Context switch

But even more, the complete processor context will be switched. The ACT registers are saved and restored when switching to another calculator. You will get back the calculator in the same state as you left it. For example if you have selected an HP-33E, then switch to HP-34E, then return to the HP-33 calculator, the stack will be the same as you left it. And if you switched in PRGM mode, the same program step is shown as before.

But lets go one step further. If you have started a program, which is now running and you switch to another calculator model, make some calculations, and return to the same calculator, the program will still be running. Or you can even start a program in HP-33E mode and HP-34E mode at the same time and whenever you switch back, the programs will continue. However a program cannot be running in the background, it was halted when the calculator was suspended, but kept in its exact state and when switched back, it is now proceeding as nothing would have happened.

Charging Batteries

Are you allowed to charge your batteries, when the calculator is switched ON?

I hoped this most discussed question for many years had come to a simple answer with the SLP circuit, but it is still not completely solved.

Yes, you are allowed to charge the batteries with the original HP charger when the calculator is switched ON. Especially because the SLP circuit cannot be switched OFF any more, because it is always connected to the batteries.

But there is still a problem:

When the battery pack is not inserted, running the calculator from the original charger could harm the SLP circuit, even if the ON/OFF switch is in OFF position!

Charging the calculator with batteries inserted is a necessary achievement. It wouldn't make sense to charge the batteries externally, because you will lose the time and date and the actual state of the calculator, when you remove the battery pack, which was not in the range of ideas of the developer.

The solution:

Before plugging in the charger, to be sure, that the batteries are connected properly, just switch ON the calculator to see if the display lights up. This assures you that the batteries are not deep discharged and charging will not harm the electronics.

Bugs

I hope there are no serious bugs left in the SPICE LP firmware version 1.08, but due to the complexity and so many calculators I don't know. What I know is that I had to make some compromise. The PIC16F1519 processor provided not enough RAM space for all functions.

Sometimes it was rather complicated to add features like recall a constant or hexadecimal conversion or clearing the prefix button after an extended function to all calculators. The HP-33C for example needs to press XY button twice after recalling a constant to show it in the display. The HP-37E has no „clear prefix“ function and executes the „Amortization“ function after invoking extended functions.

Some calculators like HP-33E need a SST after having loaded a program to refresh the display for showing the actual program step. These are minor bugs in my optinion

The HP-38C has a complicated internal memory structure, therefore it was not possible to store its programs to the program library. You only have a single program for use.

In conclusion I may be allowed to say „Nothing is perfect“. And if a software finally has become bug free, it is outdated.

Rules for Key Sequences

Some of the additional functions of the SLP calculator should be available from whatever calculator is selected. When using many calculators with only one keyboard, it is sometimes difficult to remember, which key sequence to use. Therefore I will outline some general rules for the most important sequences.

Single prefix versus double prefix

If a single prefix sequence exists for this calculator, then the double prefix sequence will invoke the same function. Single prefix is of course one keystroke shorter.

Time Menu

As an example, the HP-34 Time Menu is called by  , the HP-32 needs the double prefix sequence  , because the single sequence is already occupied. For compatibility also the HP-34 can use the double prefix. Generally all calculators will try to use the same sequence for invoking the same menu.

Real Time Clock and Special Functions

Generally the “RTC functions” are invoked by  followed by an arithmetic key   and the “Special Functions” by  and arithmetic key. Normally all programmable calculators have the compare functions placed on these arithmetic keys, which are free for use in RUN mode. If the prefixed arithmetic keys are occupied however, a double prefix  or  is necessary.

The calculators HP-31 and HP-37, which only have one prefix button, use a double prefix  for the special functions and single prefix  with numbers   to invoke the RTC functions. These buttons are located at the right of the arithmetic keys.

Appendix A Key Sequences

1.) Function menu

Function	Description
g g . 1	Enter Function Menu
.	Show firmware revision and serial number
0	Toggle flags 1-20
1 FRAC	Show calculator / Select calculator
2	Show free memory
3 ABS	Show/Enter program name, Load Store selected program
4	Show program number and checksum
5	Show memory usage programs and registers
6	Show operating time
7	Show Flash write cycles
8	LED Test
9	Enter Ticker Text

[1] key sequence might differ for some calculators

2.) Repeat keys

Key	Description
R↓	Show stack
x≷y	Show XY registers
SST	Show program steps forward in PRGM mode
BST	Show program steps backward in PRGM mode
×	constant growth
+	constant sum

3.) Special keys[1]

Key	Description
f (−)	Show ticker text
f (+)	Show battery voltage
f (×)	Show temperature
f (÷)	Goto Sleep, Wakeup from Sleep with (÷)

4.) Real Time Clock keys[1]

Key	Description
g (−)	Show date. CHS toggles date format
g (+)	Show time. CHS toggles time format
g (×)	Show alarm time. activate with ENTER
g (÷)	Show weekday. Set with 0 - 6

1 some calculators need double prefix

5.) Stopwatch keys

Key	Description
g g R/S	Enter and leave stopwatch mode
R/S	Start and stop stopwatch
CHS	Start and stop countdown
CL x	Reset stopwatch or countdown
ENTER	Enter countdown or stopwatch time
STO 0 - 7	Store Lap Times 0 - 7
RCL 0 - 7	Recall Lap Times 0 - 7

6.) Print keys

Key	Mode	Description
	**RUN**	**Paper Advance**
	**RUN**	**Print X**
	**PRGM**	**Print Program**
	**RUN/PRGM**	**Toggle Print Mode enable**
	**RUN/PRGM**	**Toggle “Print Norm” flag**
	**RUN/PRGM**	**Toggle “Print Trace” flag**

1.) Key sequence summary *HP-31 SLP*

Key sequence	Description
f f %	**Enter stopwatch mode**
f ENTER	**Show mantissa/Print X**
f f ENTER	**Paper Advance**
f f RCL	**Show registers 0 to 3**
f f . 0 - 9	**Enter function menu**
f f 7	**Show date, CHS toggles date format**
f f 4	**Show time, CHS toggles time format**
f f 1	**Show alarm time, activate by ENTER**
f f 0	**Show weekday, Set with 0 - 6**
f f −	**Show ticker text**
f f +	**Show battery voltage**
f f ×	**Show temperature**
f f ÷	**Goto Sleep, Wakeup with ÷**
f f CLx	**Beep**

2.) Key sequence summary *HP-32 SLP*

Key sequence	Description
g g %	**Enter stopwatch mode**
f f %	**Enter Hexadecimal entry**
f ENTER	**Print X**
g ENTER	**Paper Advance**
g g RCL	**Show registers 0 to 9**
g g . 0 - 9	**Enter function menu , or** g g y^x
g g −	**Show date,** CHS **toggles date format**
g g +	**Show time,** CHS **toggles time format**
g g ×	**Show alarm time, activate by** ENTER
g g ÷	**Show weekday, Set with** 0 - 6
f f −	**Show ticker text**
f f +	**Show battery voltage**
f f ×	**Show temperature**
f f ÷	**Goto Sleep, Wakeup with** ÷
g g Σ+	**Beep**

3.) Key sequence summary *HP-33 SLP*

Key sequence	Mode	Description
g g R/S	RUN/PR	Enter stopwatch mode
f R/S	RUN	Enter Hexadecimal entry
f ENTER↑	RUN	Print X
g ENTER↑	RUN	Paper Advance
g g RCL	RUN	Show registers 0 to 9
g g . 0 - 9	RUN/PR	Enter function menu, or g g GTO
f g	PRGM	Switch to RUN mode
g f	RUN	Switch to PRGM mode
f f STO 0 - 9	RUN	Store register set in Storage 0 to 9
f f RCL 0 - 9	RUN	Recall register set from Storage 0 to 9
f f RCL . 9 9	RUN	Recall constant 0-99 from Constant Collection
f f STO . 9 9	RUN	Store constant 20-99 to Constant Collection
f f RCL . 0 0	PRGM	Load program 00 to 99 from Library
f f STO . 0 0	PRGM	Store program 00 to 99 to Library
g −	RUN	Show date, CHS toggles date format
g +	RUN	Show time, CHS toggles time format
g ×	RUN	Show alarm time, activate by ENTER↑
g ÷	RUN	Show weekday, Set with 0 - 6

	**RUN**	**Show ticker text**
	**RUN**	**Show battery voltage**
	**RUN**	**Show temperature**
	**RUN**	**Goto Sleep, Wakeup with** 
	**RUN**	**Beep**

4.) Key sequence summary *HP-34 SLP*

Key sequence	Mode	Description
g g R/S	RN/ PR	Enter stopwatch mode
f f R/S	RUN	Enter Hexadecimal entry mode
f ENTER	RUN	Print X
g ENTER	RUN	Paper Advance
f ENTER	PRGM	Show Program number and checksum
g EEX	RUN	Show registers 0 to 9
g g RCL	PRGM	Show program steps (h h RCL)
g g RCL	RUN	Single Step Debug
f g	PRGM	Switch to RUN mode
g f	RUN	Switch to PRGM mode
f f RCL 0 - 9	RN/ PR	Load register set / Load program
f f STO 0 - 9	RN/ PR	Store register set / Store program
f f RCL . 0 0	PRGM	Load program 00 - 99
f f STO . 0 0	PRGM	Store program 00 - 99
f f f RCL .	PRGM	Load application 00-99
f f RCL . 0 0	RUN	Load constant 00-99
f f STO . 2 0	RUN	Store constant 20-99
g . 0 - 9	RN/PR	Enter function menu (g g GSB)

g M−	RUN	Show date, CHS DEG toggles date format
g M+	RUN	Show time, CHS DEG toggles time format
g M×	RUN	Show alarm time, activate by ENTER
g M÷	RUN	Show weekday, Set with 0 - 6
f M−	RUN	Show ticker text
f M+	RUN	Show battery voltage
f M×	RUN	Show temperature
f M÷	RUN	Goto Sleep, Wakeup with ÷ x=0
g CLx GRD	RUN	Beep

Repeat keys *HP-34 SLP*

Key	Mode	Description
x≷y %	RUN	Show XY registers
h RCL	PRGM	Show program steps forward in PRGM mode
h STO	PRGM	Show program steps backward in PRGM mode
× M×	RUN	Constant Growth
+ M+	RUN	Constant Sum

5.) Key sequence summary *HP-37 SLP*

Key sequence	Description
f f Σ+	**Enter stopwatch mode**
f f • 0 - 9	**Enter function menu**
f f 7	**Show date, CHS toggles date format**
f f 4	**Show time, CHS toggles time format**
f f 1	**Show alarm time, activate by ENTER**
f f 0	**Show weekday, Set with 0 - 6**
f f −	**Show ticker text**
f f +	**Show battery voltage**
f f ×	**Show temperature**
f f ÷	**Goto Sleep, Wakeup with ÷**
f f CLx	**Beep**

6.) Key sequence summary *HP-38 SLP*

Key sequence	Description
g g R/S	**Enter stopwatch mode**
f ENTER	**Print X**
g g ENTER	**Paper Advance**
g g . 0 - 9	**Enter function menu**
g g −	**Show date, CHS toggles date format**
g g +	**Show time, CHS toggles time format**
g g ×	**Show alarm time, activate by ENTER**
g g ÷	**Show weekday, Set with 0 - 6**
f f −	**Show ticker text**
f f +	**Show battery voltage**
f f ×	**Show temperature**
f f ÷	**Goto Sleep, Wakeup with ÷**
g CLx	**Beep**

Appendix B Connectors

1.) SPICE Low Power Pinout Processor 40-pin DIP

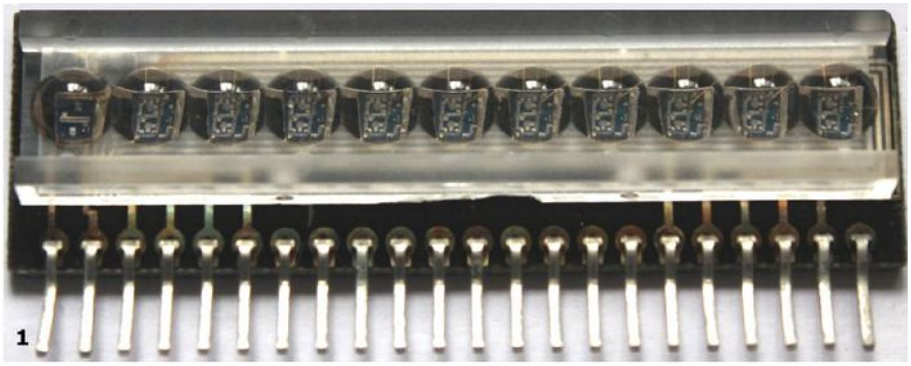
Pin	Name	Description
1	f N2/19	Display Segment f
2	a N2/20	Display Segment a
3	b N2/21	Display Segment b
4	g N2/18	Display Segment g
5	d N2/17	Display Segment d
6		
7		
8		
9		
10		
11		
12	VCC	Battery Power
13	GND	Ground
14		
15		
16		
17		
18		
19		
20	PRGM/RUN	Input High=RUN open=PRGM
21	digit 1 row 7 N2/16	digit 1 KB row 7 (/ 0 . R/S)
22	col 2	KB column 4 (/ x + - ...)
23	digit 2 row 6 N2/15	digit 2 KB Row 6 (x 1 2 3)

24	col 3	KB column 3 (0 1 4 7...)
25	col 4	KB column 2 (. 2 5 8 ...)
26	digit 3 row 5 N2/14	digit 3 KB Row 5 (+ 4 5 6)
27	col 5	KB Column 1 (R/S 3 6 9 ...)
28	digit 4 row 4 N2/13	digit 4 KB Row 4 (- 7 8 9)
29	digit 5 row 3 N2/12	digit 5 KB Row 3 (Enter CHS EEX CLX)
30	digit 6 row 2 N2/11	digit 6 KB Row 2 (XY Roll STO RCL ...)
31	col 1	KB Column 5 (SST XY)
32	digit 7 row 1 N2/10	digit 7 + KB row 1 (n i PV PMT FV)
33	digit 8 N2/9	digit 8
34	digit 9 N2/8	digit 9
35	digit 10 N2 7	digit 10
36	e N2/6	Display Segment e
37	s+ N2/2	sign digit anode
38	d.p. N2/3	Display decimal point
49	c N2/4	Display Segment c
40	cm N2/5	Display semicolon

2.) N1 Power Supply Connector

Pin	Name	Description
1	charge	not connected
2	ON	ON/OFF switch upper right
3	BATT+	ON/OFF switch lower right, Battery +
4	VBatt	ON/OFF switch left side
5	Test LK1	Jumper for Test RAM ROM
6	GND BATT-	Ground, Battery -
7	VRAM	Continuous RAM Power supply
8	VCC	Power
9	n.c.	not connected
10	?	LK2 Jum per
11	display current	I disp
12	n.c.	not connected

3.) N2 Display Connector



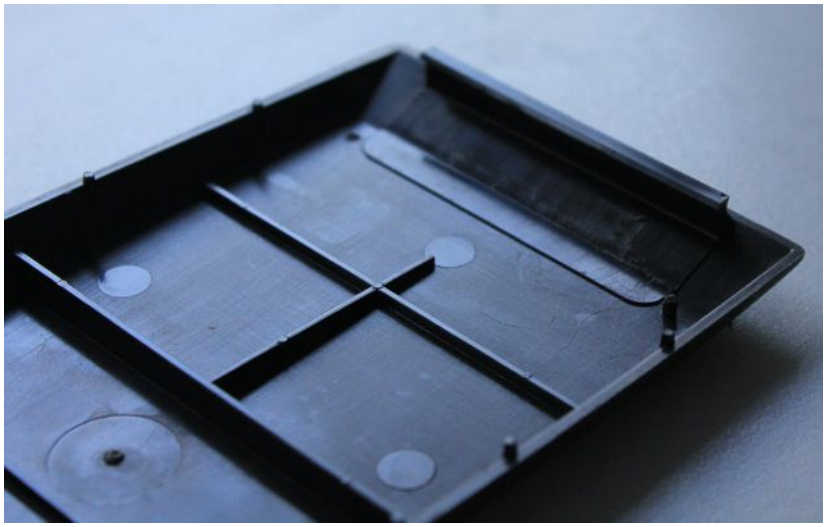
Pin	Name	Description
1	GND	Ground
2	s+	VBATT sign digit anode
3	dp	decimal point anode
4	c	segment anode
5	cm	comma anode
6	e	segment anode
7	10	digit leftmost
8	9	digit
9	8	digit
10	7	digit
11	6	digit
12	5	digit
13	4	digit
14	3	digit
15	2	digit
16	1	digit rightmost
17	d	segment anode
18	g	segment anode
19	f	segment anode
20	a	segment anode
21	b	segment anode
22	s-	sign cathode

4.) J1 PC Connector

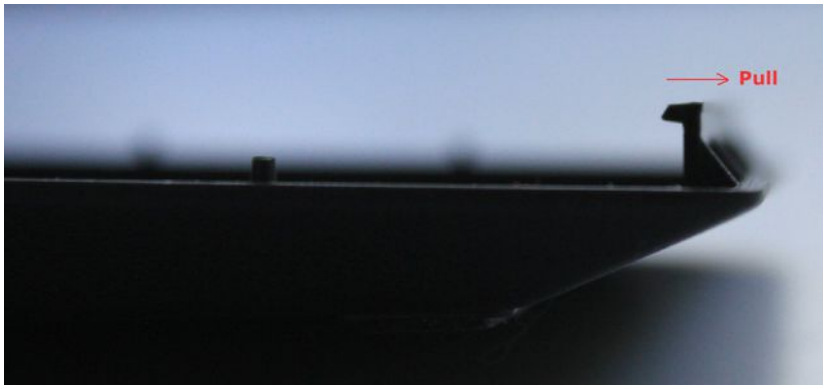
Pin	Name	Description	USB/Serial converter
1	MCLR	Master Clear Reset	not used
2	RX	Receive Data Signal	connect to TX
3	TX	Transmit Data	connect to RX
4	VCC	Supply Voltage Bat+	not used
5	GND	Ground	connect to GND

Appendix C How to open the calculator

Believe it or not, the most difficult part of the SPICE LP installation is to open the calculator. First remove the two screws in the battery compartment. To separate the two halves of the case a special procedure and an excess of power is needed. The reason is a ridge in the front of the lower case.



It functions as a hook, which is connected to the keyboard PCB when closed. It has to be bend outwards before it can be opened.



There are some different methods described. Here are some examples.

https://www.hpmuseum.org/cgi-sys/cgiwrap/hpmuseum/archv019.cgi?read=151125

http://voidware.com/calcs/spicerepair.htm

https://www.keesvandersanden.nl/calculators/hp32e_repair_1.php#links

The approach as described by voidware.com:

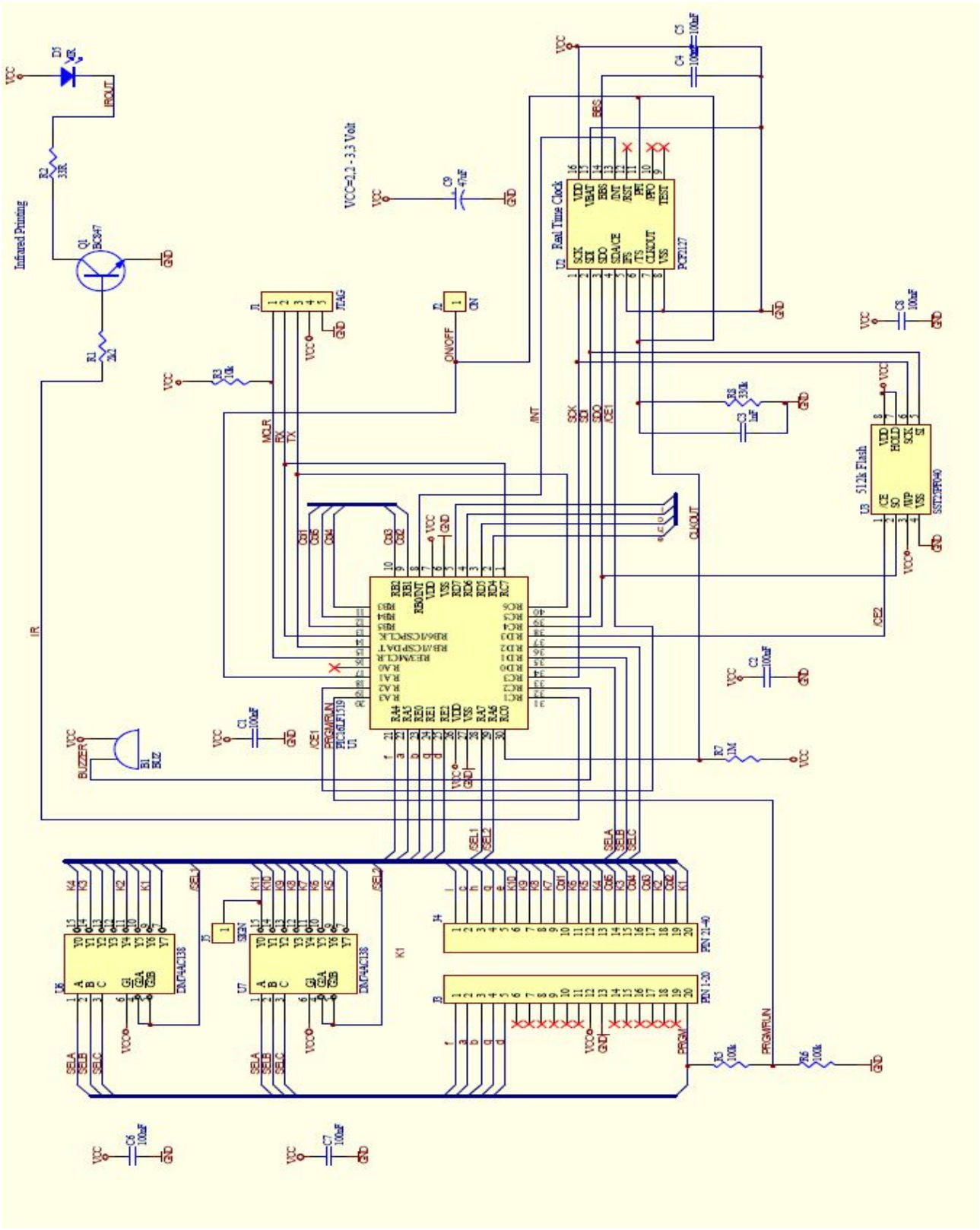
Take off the battery cover and remove the battery pack. Undo the two small screws at the top.
The unit wont open because there is a catch inside the case at the base. Adopt the special grip shown

here and push up with the thumbs and pull back with the hands so as to pull the case twowards you.

Another method described by Karl Schneider:

Tie a loop of waxed dental floss. After removing the two screws in the battery compartment, place the calc face down and spread the halves apart at the top no more than an inch (watch the battery terminals). Insert the floss between the halves and slide it past all six tabs (three each side) and around the corners at the bottom so that the floss exits through the case seam at two places on the bottom edge. Internally, the floss should wrap around the long hooked bridge attached to the bottom case half. Hold the main (top) case half in place on the table face down (use a rubber glove if you like) and gently pull the loop of floss away from the calc in order to detach the smaller back case half

Appendix D SPICE Low Power Schematic



Appendix E 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 SLP 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.