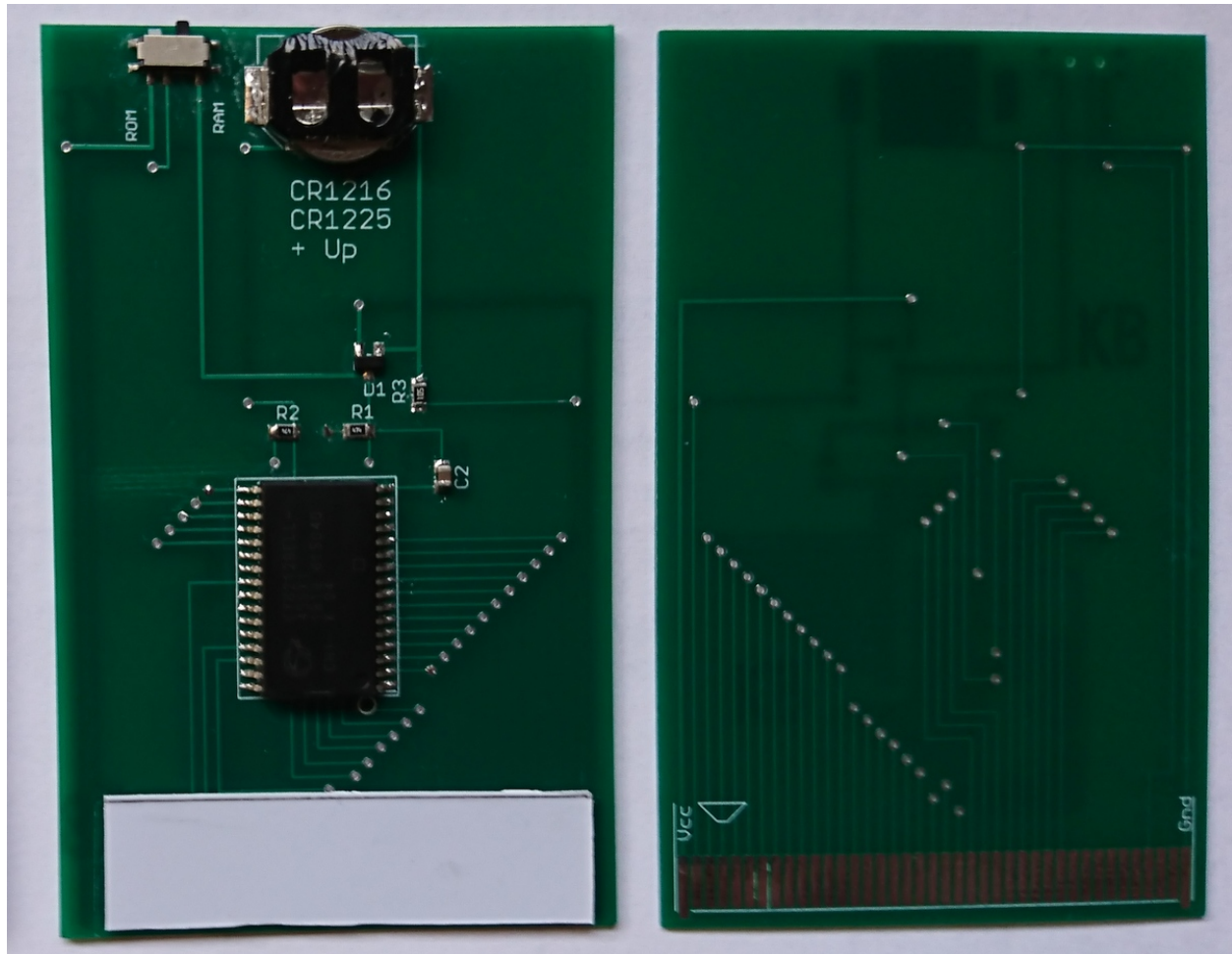# An HP-48SX/GX 128K RAM Card

This repository contains the schematics and Gerber files needed to create a 128K RAM card for the HP-48SX/GX calculators. Data sheets for the parts used are also included. The Bill of Material calls out specific vendor and vendor part numbers for the passive components used, but any equivalent part in the SMD 0805 package can be substituted.

The PCB board dimension is 2.125" wide by 3.375" high. The board thickness is 0.8 mm (1/32") and a 0.8 mm plastic strip must be added so that the card makes a snug fit in the calculator connector. A PCB thickness of 1.6 mm can be used instead if a direct fit is desired, but many PCB houses treat this as a special order size and charge accordingly. If you take this route be sure to notch both sides of the PCB at the connector end for a distance of about 1" and depth 0.1" in order to clear the latch engagement pin.

Battery backup is by use of a 12 mm lithium coin cell, either the CR1216 or the CR1225. The CR1225 has the higher capacity rating of the two at 48 mAh. Although that's only half the capacity of a CR2016, the Cypress MoBL SRAM memory device only requires 1 uA in standby mode when the memory is not selected so battery life should be reasonably long.

Assembly

Before soldering components thoroughly clean both sides of the PCB with isopropyl alcohol to remove any contaminants that may interfere with the soldering process. Be sure to have on hand plenty of flux to insure good solder wetting and flow.

I generally begin with the small SMD parts. Don't solder R1 in place as it is not needed. The remaining components R2, R3, C1, and D1 can be held in place with tweezers while soldering. Pick up a bit of solder on your iron tip and bring the tip straight into the end of the component near board level and note the flow of solder under and around the component end. Add plenty of flux beforehand. Spin the board around and solder the other end of the component while applying downward pressure with the tweezers. When all SMD components are soldered you can touch up each solder joint by applying heat and a little more solder from top and sides of the joint.

Solder the memory IC next. The circle mark identifying pin 1 should be downward towards the connector edge of the card. Holding the IC in place, apply plenty of flux and then solder tack the pins at each end of the IC side nearest you. This will hold the IC in place as you solder the pins on the other side of the IC. Turn the card 180, apply flux and then solder each pin on the opposite side. Turn 180 again and solder each pin on the remaining side after applying more flux. If any flux evaporates while you are soldering, stop and apply more to keep your work wet as you go.

Visually inspect each pin for good solder coverage and insure there is no solder bridge between pins. I like to "ring out" the connections afterwards with a multimeter set to the continuity test position. To check for shorts, walk your meter probe pins across successive pairs of via holes surrounding the IC. You can check further by placing one probe on top of an IC pin and the other on its corresponding via. This check doesn't take long and can save you quite a bit of headscratching if the card fails or acts strangely when you plug it in.

Solder the four corner pads of switch first, holding it in place with tweezers. The switch will align itself to the PCB with two pins on the bottom registering into two holes in the PCB. Be sure to have plenty of solder (and flux) on these corners as the switch will experience a fair amount of force when it is toggled from one position to the other. It is also the place to grab and pull when removing the card from a calculator. Finish with the three switch contact pins themselves and ring out the connections.

The flexible contacts punched from the top of the battery holder are bent downwards far enough to touch the PCB. Left as-is they will make it more difficult to insert and remove the battery. The spring force can even be enough to cause the solder bond between holder tab and PCB to fail resulting in the battery popping out of the holder. Press the two spring tabs upwards so that they are closer to the top of the holder.

The top of the battery holder is at the potential of the positive side of the battery. The holder top presents a possibility of a short, so I would advise covering it with a strong adhesive tape or contact sheet. Better yet, remove the chrome coating from the top with rough sandpaper prior to soldering the holder to the board, then coat with paint or nail polish after the soldering operation.

The battery holder is held by solder to the PCB. Be sure to apply enough to cover the contacts well because the holder will likely be subject to a pulling force by those who grasp it to remove the card from the calculator.

To insure the card contacts are pressed firmly against the card connector contacts in a calculator, attach a strip of 0.8mm (1/32") thick plastic behind the contacts on the component side of the PCB (photo above). The strip should meet the lower edge of the PCB and extend upwards about 1/2", but should not extend the full width of the PCB. Keep the strip about 1/4" from the left and right sides so that it doesn't cause the card to be blocked by guide tabs in the card connector block inside the calculator. Double-sided tape works well to hold the strip.

Usage

The card may require a bit of wiggling to clear guide tabs molded into the card connector assembly. These tabs help guide a commercial card and open a spring-loaded cover protecting the card contacts. Insertion and removal is fairly easy in either card slot of an HP48SX. It may help to turn the calculator on its face and then apply some downward pressure to the back of the card as the card is pressed down on the top edge.

Insertion in slot 1 of an HP48GX is slightly "stickier" but is easily done by turning the calculator over. Slot 2 is a different story as the bottom edge of the PCB catches on a ledge above the connector slot. A plastic ruler can be use to press the back of the card near the bottom until it clears the ledge. An alternative is to move the plastic strip from the front to the back of the PCB just above the row of contacts. The downside is that now the card will no longer fit in slot 1.

When inserting the card for the first time the calculator will display an Invalid Card Data warning message. For an HP-48GX use the PINIT command to initialize the RAM. Be sure the memory protect switch is in the "RAM" position. For an HP-48SX a card in initialized by storing a variable to the card and then purging it. The calculator will take several seconds to perform the purge as it initializes the card.

You can periodically check the voltage of the battery by touching multimeter probes to the top of the battery and a via located below and to the left of the battery holder near the RAM label.

Bill of Materials

The passive components listed here can readily be substituted from another vendor as long as the value and voltage rating is preserved. The dual diode is also multi-sourced from other vendors. The parts are all available from Mouser as of this date (2019).

Symbol	Device	Part #	Notes
IC1	Cypress 128Kx8 SRAM	CY62128ELL45SXI	SOIC-28
D1	Dual Schottky Diode	ON Semi BAT54CLT1G	SOT23
R2	470K, 5% Resistor	Panasonic ERJ-P06J474V	SMD 0805
R3	1M, 5% Resistor	Yageo RC0805JR-071ML	SMD 0805
C1	470nF, 16VDC Capacitor	Taiyo Yuden EMK212B7474MG-T	SMD 0805
U1	Battery Holder	Linx BAT-HLD-012-SMT	Use CR1216 or CR1225
U2	SPDT Switch	Apem MA12R	