Interfacing To The HP20b

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Introduction

The HP20b has two designed-in ways to electrically interface to the hardware. Thank you Cyrille! The first is a serial interface to perform Flash programming. The second is a JTAG[1] interface.

The serial interface is of most interest for re-programming.

Technical Details

The photos below show and describe the two circuit board pad areas that provide a means for connecting to the machine. Six circuit board pads provide Flash ROM programming and a Pogo Pin cable is shown in figures one to three below. A cutout in the back cover (not yet made here) could provide easy access to connect the cable without sliding off the back cover. Sixteen circuit board pads provide the JTAG interface.

Fig. 1 – Three items front side of 20b

Fig. 2 – Three items back side of 20b

Fig. 3 – Reset & Erase buttons.

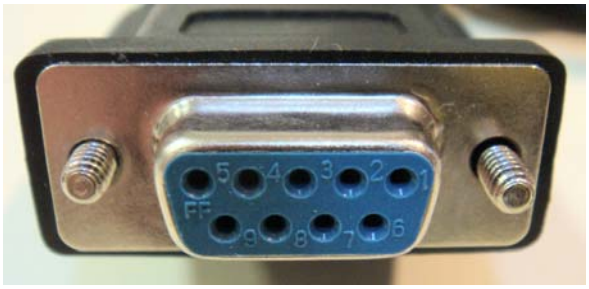

Fig. 4 – Conventional Db9 connector

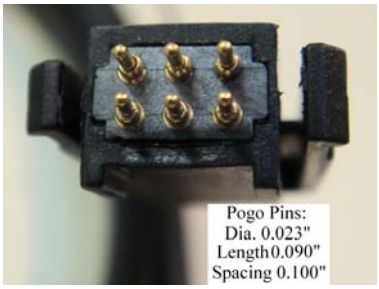

Fig. 5 – 6 pin Pogo Connector

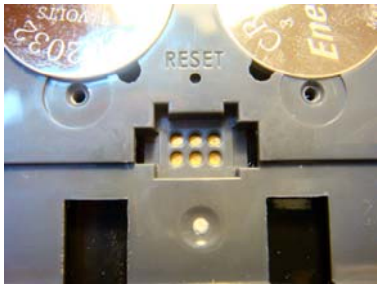

Fig. 6 – Calculator back is off

Fig. 7 – Both electrical interfaces

Fig. 8 – "Ten" pins, cut 2 pairs off.

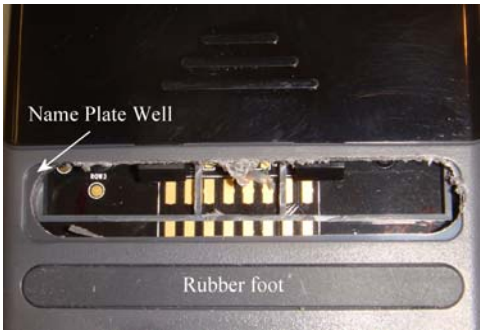

Fig. 9 – Name Plate well cut out.

The lower 16 pads will require a "connector" (see figures eight and ten) to be soldered to the circuit board. This will also require that the area in the center of the name plate well be cut (milled) away to gain access to the pads below. A full width cut is not necessary. See figures 7 – 9 above. A 16 pin, 25 mil post, 100 mil-spacing socket connected to a cable could be used to provide these connections.

Figure 10 shows a close up of the header pin connector[2] that is soldered to the 16 pads shown in figures seven through nine. Two pairs are "snapped" off of one end. An additional suggestion is to leave the extra pins as a means of "polarizing" the connector. Good soldering technique will be required to solder this in place without melting plastic. A socket soldered to a cable to plug into these pins, or one that is purchased, is required for advanced JTAG testing. Most HP20b re-programmers will not need to do this.

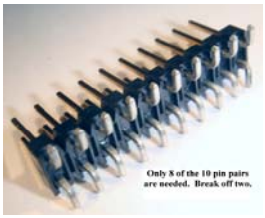

Fig. 10 – JTAG Pins.

Fig. 11 – Cable interface

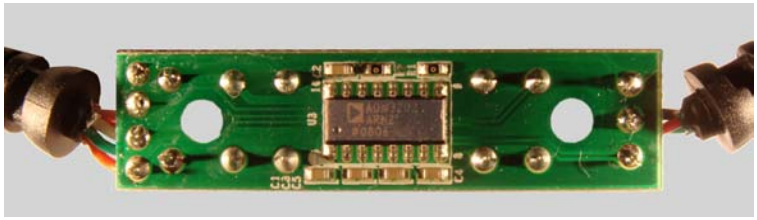

Fig. 12 – Circuit board of interface electronics, close up.

The serial interface electronics cable housing as shown in figure three shows two blue button switches. The housing is opened as shown in figure 11. It is interesting to note that the housing designer had two choices. Make the housing symmetrical (he choose this approach) or off set one switch so that the cover could not be accidentally put on incorrectly and reversing the nomenclature of reset and erase. The text added to figures three and 19 will help the user who didn't notice which end was which before taking the housing apart.

Figure 12 shows a close up of the single sided circuit board with the cables connected. An Analog Devices ADM3202[3] High-Speed, 2-Channel RS232/V.28 Interface is used to provide the electrical interface between the 3V calculator and the typical RS-232 serial interface. Table 1 lists the features of this integrated circuit.

Table 1 – Analog Devices Serial Interface Integrated Circuit features

- 460 kbps Data Rate
- Specified at 3.3 V
- Meets EIA-232E Specifications
- 0.1 µF Charge Pump Capacitors
- Upgrade for MAX3222/32 and LTC1385
- Low Power Shutdown (ADM3222E and ADM1385)
- DIP, SO, SOIC, SSOP and TSSOP Package Options
- ESD Protection to IEC1000-4-2 (801.2) on RS-232 Pins (ADM3202 Only)
  ±8 kV: Contact Discharge
  ±15 kV: Air-Gap Discharge

Two SMT[5] (surface mount technology) resistors (R1 & R2) and five capacitors (C1-C5) may be seen in figures 12 and 18. The data sheet[3] shows a typical application circuit and this is reproduced in figure 13.

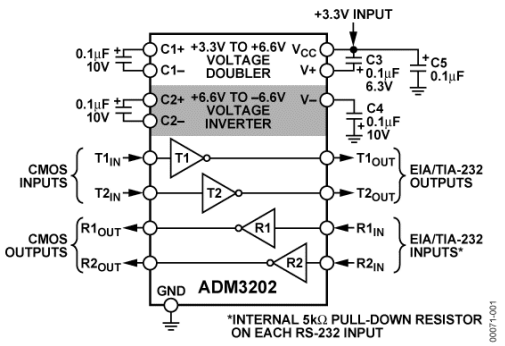

Fig. 13 – Typical application circuit.

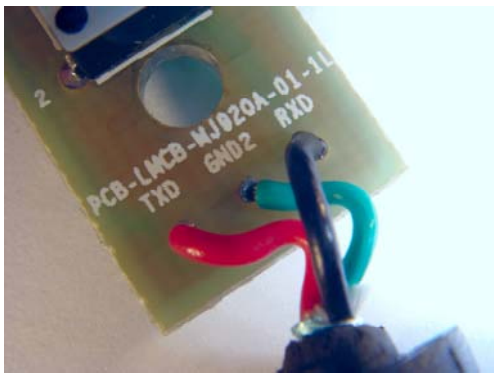

Fig. 14 – Serial connector wiring.

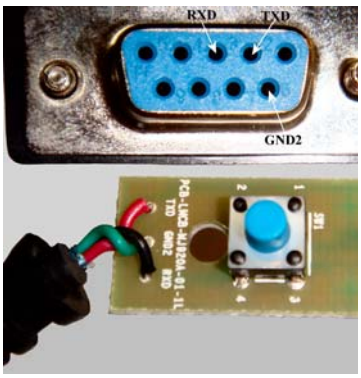

Fig. 15 – Wire connections.

Figures 14 through 17 show the cable connections to the circuit board and their respective connectors – Serial Db9 and Pogo pin 6.

Figure 18 shows the component side of the circuit board with the various connections identified. R1 & R2 are zero ohm resistors[4]. The reset and erase buttons may be see in figure 19.

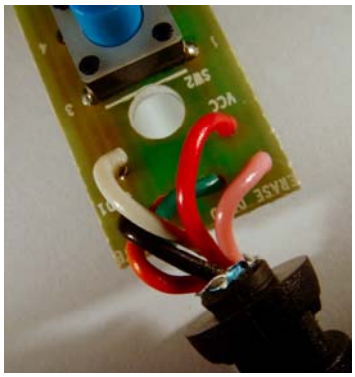

Fig. 16 – Pogo pin wiring.

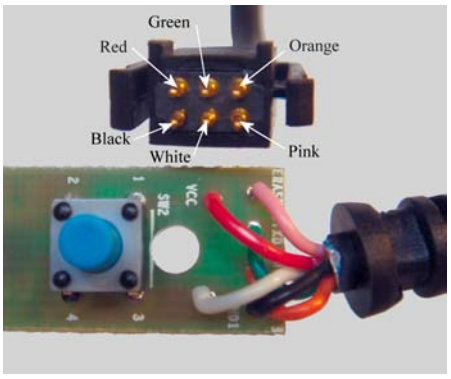

Fig. 17 – Calculator Pogo pins.

The HP20b shown in these photographs has had milled case cut outs to allow access to the internals. These "windows" show the internal clearances for the electronics.

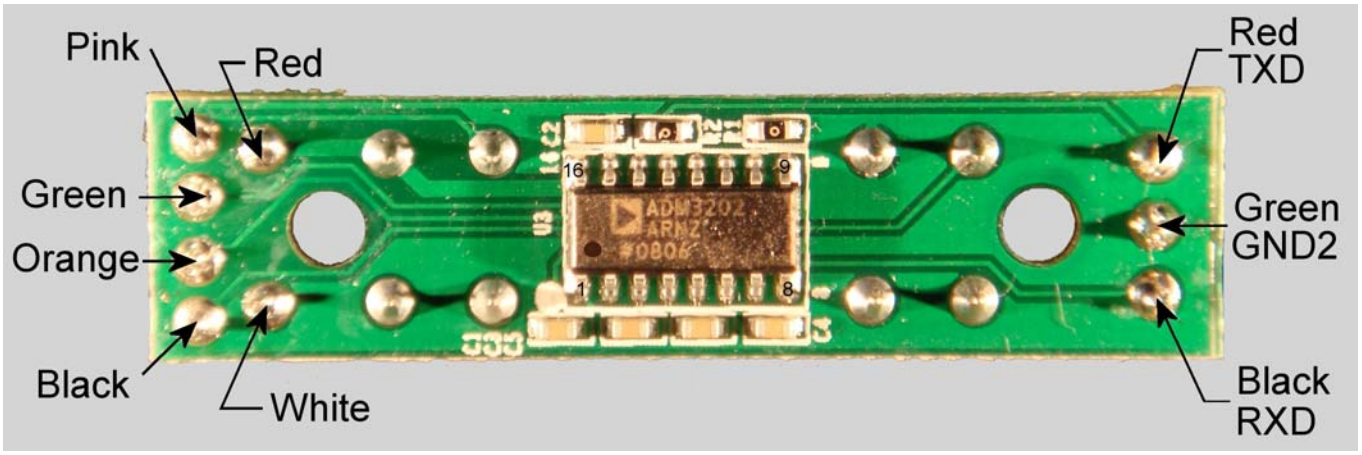

Fig. 18 – Etch side of interface electronics circuit board with cable lead wires and connections identified.

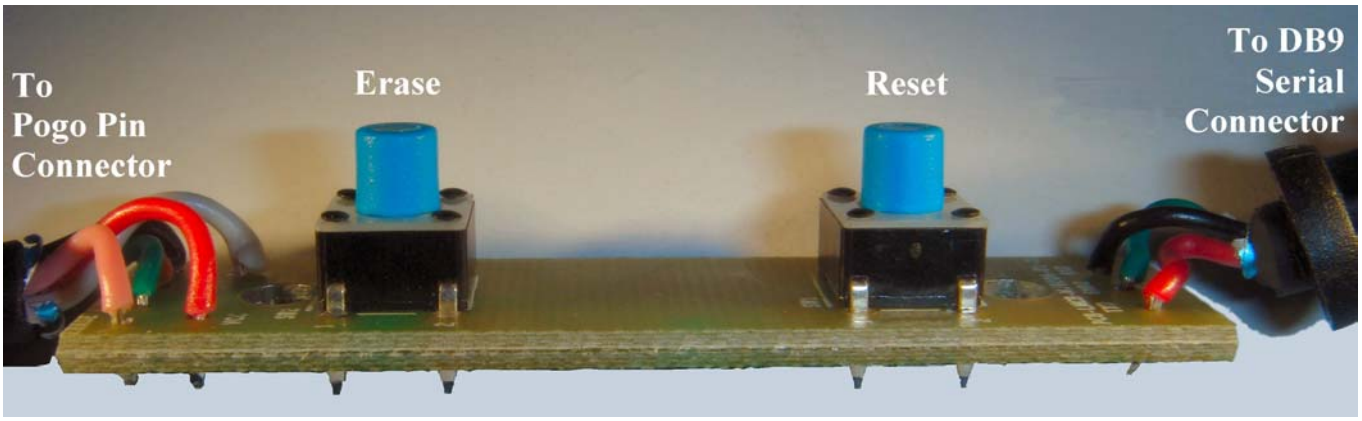

Fig. 19 – Side view of the single sided interface electronics circuit board showing cable lead wires.

The purpose of this photo essay is to provide enough technical information and details for the serious programmer to decide if he or she should pursue the tremendous opportunity that the HP20b offers as a platform for custom development to convert/upgrade the HP20b into a low cost platform of choice. The Flash RAM is easily re-programmed and low to moderate numbers of machines may be easily "customized" as desired.

The header pins shown in figures eight and ten may be ordered from Mouser Electronics[2] and other major electronics supply houses. See figure 20 for a Mouser screen that provides technical details and ordering information. Exploring the well designed websites of these suppliers is very educational.

Part Number / Keyword
649-95278-101A16LF Search
Stocked RoHS Compliant

MOUSER ELECTRONICS

Buy Selected

Select	Mouser Part #	Mfr. Part #	Mfr.	Description		Availability	Pricing	Quantity	RoHS	Pitch	Number of Rows	Contact Plating	Mounting Style	Termination Style	Product
☐	649-95278-101A16LF To purchase full reels, order in multiples of 300	95278-101A16LF	FCI	Bergstik Headers 2X8P UNSHRD HDR 30 microinch gold	Page 1,375 Data Sheet	In Stock Click to View	1: $0.75 100: $0.69 Reel of 300: $0.69 500: $0.65 1,000: View	Buy Min.: 1 Mult.: 1 Reel: 300	RoHS Details	2.54 mm	2	Gold	SMD/SMT	Solder Tail	Pin Strip & Breakaway Headers

Buy Selected

Fig. 20 – Mouser web site view to get header pin information. You will also find cables and connectors.

You may solder the header to the printed circuit board without removing the back of the calculator – if you have milled a window similar to what is shown in these photographs. This will require patience and experience and one user (Eric) has reported doing it this way. You may alternately expose the circuit board (which also has the keyboard heat staked to it) by removing the back of the calculator assembly. See figure 21.

Opening the calculator case – after removing the five small screws – is a tricky process and a little experience and patience will help because you are working "blind." You must slip a knife blade into the case and pry in such a way to effectively bend back the tab or hook. See figures 22 and 23 for a typical example. The HP20b has tabs in the center at the top and bottom of the keyboard. The top tab hook has been removed by milling as may be seen by the cutout at the top of the back cover shown in figure 21.

Start at the bottom from the keyboard side inserting the blade between the black and gray parts about ¾ inches from the outside working towards the center and unsnap the tab. I used a Swiss Army Knife with a two inch blade which is appropriate in size – thickness, width and length. Once the tab is released from the hook you should work your way around each side towards the top. You must work carefully to avoid

Fig. 21 – Five small screws are removed & the back unsnapped.

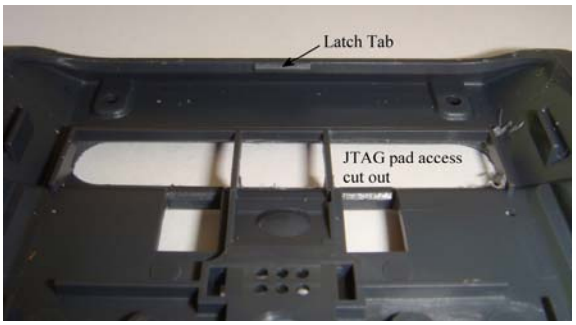

Fig. 22 – Close up of latch tab that snaps the back to the electronics assembly.

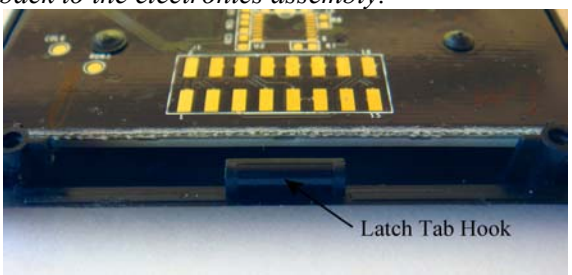

Fig. 23 – Close up of latch tab that snaps over the tab shown in figure 22. See the text on how to unsnap these hooks and tabs.

nicking and scratching the case. Keep your brain engaged and be careful. The first snap-together-case opening is the most difficult. These photos should help.

Fig. 24 – Side view of the calculator shows the case locking tab locations. ***Photo by Eric Rechlin***

There are three tabs on each side. See figure 24. The top and bottom tabs are about one inch in from the top and bottom. The center tab is not in the center, but about one tab length (5/16") above center from the top of the calculator.

Figure 25 shows the two interface pad layouts along with the pad numbers as shown in the HP20b schematic diagram[7]. The JTAG pad connections are shown in figure 26. Note the, to me, unconventional pad numbering scheme. Normally you number down the long dimension of the pad/pin layout. Both I/O pad patterns are numbered alternately across the short dimension of the pad pattern. This is very clearly shown in figure 26. Is this a more common practice in Asia? The company that made the drawings is Chinese[8].

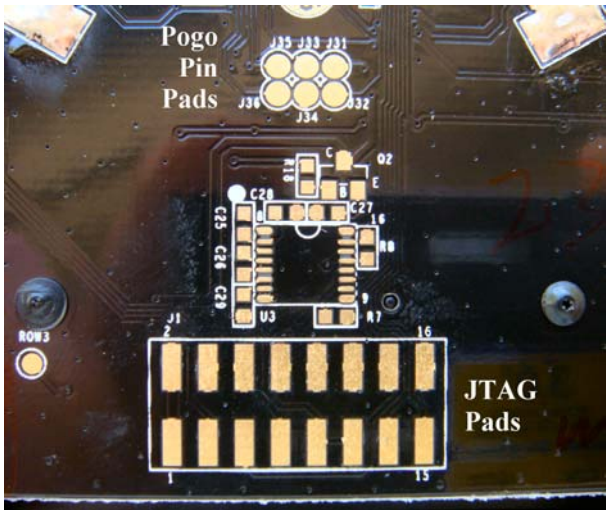

Fig. 25 – Circuit board pad numbering.

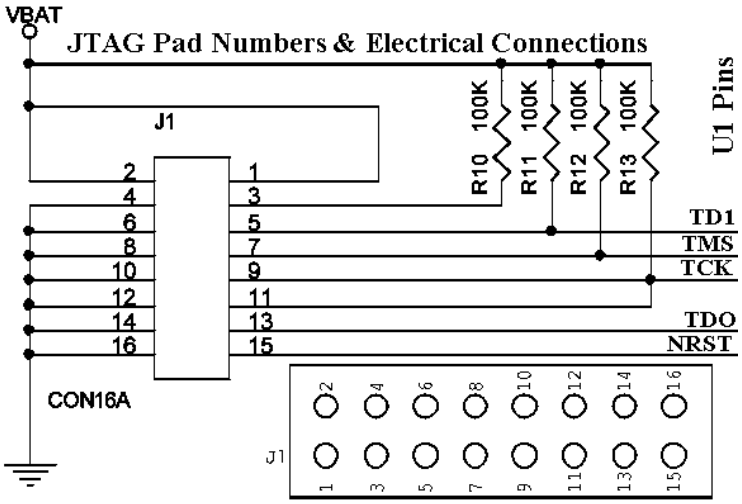

Fig. 26 – JTAG Pad numbering and electrical connections.

Conclusion

Interfacing to the HP20b for the purposes of reprogramming the Flash RAM has been made an option by Cyrille to open the possibilities of third party development by using a $40 Atmel ARM7 Development Platform - also known as the HP20b business calculator. This collection of photographs and notes will provide an idea of what this means for the technically curious about the electrical interface.

Acknowledgement

I wish to acknowledge and thank Eric Rechlin of hpcalc.org[8] for an ongoing email discussion on the re-programming of the HP20b. He reviewed this article and provided the photo used in figure 24. He will go beyond this introduction to the topic by getting into the re-programming itself. I am sure he will share his progress, conclusions, and results in the future.

Notes and additional References

1. See additional JTAG (Joint Test Action Group) information at: http://en.wikipedia.org/wiki/JTAG
2. Header pins may be ordered from Mouser electronics at:

http://www.mouser.com/Search/Refine.aspx?Ntt=*64995278101A16LF*&N=1323038&Ntx=mode%2bmatchall&Ns=P_SField&OriginalKeyword=649-95278-101A16LF&Ntk=Mouser_Wildcards

3. See additional details at: http://www.analog.com/en/interface/rs-232/adm3202/products/product.html#
4. Zero ohms? These resistors could be used to change the circuit if needed by simply unsoldering – an easy process. Another purpose could be to provide a trace "jumper" to avoid using a more costly multilayer printed circuit board.
5. See SMT description at: http://en.wikipedia.org/wiki/Surface-mount_technology
6. If the development project qualifies the HP20b single source serial cable may be obtained from Cyrille at: de Brebisson, Cyrille (Calculator Division) <cyrille@hp.com>
7. See HP20b Schematic diagram at : http://commerce.hpcalc.org/HP20b_Development_kit.zip
8. Inventec website; http://www.inventec.com/english/group/group_content_a02.htm
9. See the best source for technical information on HP's high end machines at: http://www.hpcalc.org/

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Comments and suggestions are welcome. email me at rjnelsoncf@cox.net