Repairing the HP9866A printer – Part 2

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Dismantling the Printer

1 General Dismantling

To gain access to the internals of the HP9866A for repair, begin by removing the **covers**. The top cover is held on by 2 screws on the rear of the machine, after removing these the cover lifts off leaving the paper access door attached to the mechanism.

The 5 plug-in PCBs are not exposed. These have colour-coded ejector handles which match the card guides and also give the last digit of the PCB part number using the standard resistor colour code. To the left of the print mechanism are :

Data Path : Brown handles

Control : Red handles

Logic PSU : Orange handles

While on the right side of the print mechanism are :

Printhead PSU : Yellow handles

Motor Driver : Green handles – The motor is connected to an edge connector on the top of this PCB

Each set of PCBs is retained by a hold-down bracket retained by 2 screws. Remove these nest; it is easier to remove the countersunk screw holding the bracket to the side pane before the pan head screw holding it to the mechanism. The 2 hold-downs are different, but they are colour-coded to match the PCBs they fit on, so there should be no confusion when the time comes to reassemble the printer. After removing the hold-downs, unplug and remove the 5 PCBs. AS mentioned earlier the motor wiring is connected to the **Motor Driver** PCB, unplug this edge connector before removing the PCB. The **Data Path** PCB contains the MOS character generator ROM and MOS shift registers and should therefore be stored in an anti-static bag.

Next turn the printer upside-down and remove the base cover which is retained by 6 obvious countersunk screws. Loosen the 2 screws at the front of the foot rails that go onto the plastic tabs of the front cover. Turn the printer the right way up again and loosen the 2 screws at the front of the top flanges of the side plates. Pull the front cover forwards, then loosen the 3 screws that hold the switch bracket to it. Slide out the switch bracket and completely remove the front cover.

The **Printhead** is removed next. Remove the 2 pan head screws and large washers from the front edge of the mechanism side plates that hold the head against the platen roller. Then remove the 2 countersunk screws fixing it to the chassis plate. Swing the printhead forward and down and unplug the 4 ribbon cables from the connectors on the **Printhead Driver** PCB. Put the printhead carefully aside.

With the printhead removed, the **Printhead Driver** PCB comes out next. Unplug the 20V power input edge connector from the right hand side of this PCB and then remove the 7 screws holding the PCB to the chassis. Slide the PCB to the right to unplug it for the edge of the **Logic Backplane** and lift the PCB out from the underside of the machine.

Before removing the **Mechanism**, the card guides for the plug-in PCBs must be removed. Although all 20 card guides are identical, the mounting methods for the 4 groups are not. Thy are removed in the following manner :

Front Left : Unscrew the 2 screws on the plate, remove the plate and 3 card guides. Remove the 2 screws holding the fixing bar in place (one to the side plate, one of the mechanism) and remove this bar.

Front Right : Unscrew the 2 screws on the plate, note that the left hand screw is the longer one (it goes through the mounting bar into a tapped bush on the motor mount). Remove the plate and 2 card guides. Remove the mounting bar by unscrewing the countersunk screw holding it to the side plate.

Rear : Each set of rear guides is retained by a bracket fixed by 2 screws. Remove the screws, bracket and guides.

With the printer upside-down, remove the 2 screws holding the paper-out microswitch bracket to the mechanism chassis. Slide the microswitch out and leave it hanging on the wires. Remove the 2 screws on the rear that tap into the right-hand mechanism sideplate followed by the 8 screws on the underside of the chassis. With the printer standing on its rear panel, lift the complete mechanism out.

The **Logic Backplane** is removed by first removing the foot rails. These are retained by the screws that held the front cover in place and 3 further screws. Under each rail is a m,tale chassis rail. The one of the left side is now free and can easily be removed, that on the right side is retained by a further (small) countersunk screw on the front. Then unplug the chassis wiring and input cable edge connectors from the **Logic backplane**, undo its 6 fixing screws, and lift it out.

2 Removing the Rear Panel

To completely separate the rear panel from the printer chassis is a fairly major job. All the above parts must be removed, and then continue as follows :

Remove the cable clips from the switch bracket to free the wiring and unscrew the 2 screws holding the mains on/off switch to the bracket. Unclip all the grey plastic cable clips under the chassis and feed the mains switch cable through the chassis to the underside. Next desolder all the transformer secondary winding leads. On the underside of the chassis, there are 2 orange and 2 blue wires on the logic backplane edge connector and 2 yellow and a brown wire on the **Motor Driver** PCB connector. Above the chassis there are 2 grey wires to the input of the printhead supply bridge rectifier and 2 green wires to the input of the +5V supply bridge rectifier. When reassembly, note that the polarity of identically-coloured wires is unimportant. Feed the transformer wires through the chassis to the top side.

Next remove the plastic bumper strips from the sides of the rear panel . They are retained by 3 screws each. Often these strips have decayed with time and become brittle, it is then probably best not to refit them but to simply refit the screws into their tapped holes. With the bumpers removed,, remove the 4 countersunk screws that retain the rear panel to the side panels and remove the rear panel, freeing the switch cable grommet from the chassis plate..

This gives complete access to all parts mounted on the rear panel. However, it is often only necessary to work on the cooling fan or the connector panel. In this case it is not necessary to desolder the transformer secondary wires. Instead, first remove all the parts described in the previous section (up to and including the **Logic Backplane**. Remove the bumper strips and the 4 countersunk screws under them. Then stand the printer on the rear panel and lift the side panels / chassis up to separate them. Free the switch grommet and turn the chassis assembly about a vertical axis to allow access to the fan and connector panel.

The connector panel is retained by 4 nuts on studs on the bezel and can easily be removed. The fan can be overhauled in the same was as the fans in the HP9800 calculators; this procedure was described in that series of articles.

3 Dismantling the Printhead

The printhead pressure springs (2 per printhead hybrid circuit) can be removed by unscrewing their housings with a 5/16" nutdriver. The hybrid circuits can then be removed by loosening the 2 setscrews that clamp each one to its heatsink, but note that they must be carefully aligned when refitting them – the procedure is in the service manual. Hewlett-Packard specifically warn against dismantling the printhead carrier/heatsink unit, my experience is that it can be dismantled and reassembled but that aligning it is very difficult and it is best not to dismantle this unless necessary

4 Dismantling the Mechanism

With the printer mechanism removed for the printer, dismantle it in the following way: First remove the coupling bolt that links the motor shaft to the platen roller using a 5/16" nutdriver. If the mechanism is not seized, it is easy to rotate the roller to allow access to the bolt head. If the mechanism is seized, remove the 4 motor fixing screws and rotate the motor body to get the bolt to a suitable position for removal.

Next, if the motor screws have not been removed, remove them. Then pull the motor off the side of the mechanism. Undo the 3 screws thus exposed and remove the motor mount. When the motor is refitted, fit the coupling bolt loosely, then screw the motor to the motor mount and finally tighten the coupling bolt.

Continue dismantling by removing the screws from the ends of the paper feed roller shafts on the left side of the unit. These retain the belt sprockets which should then be drawn off together with the toothed coupling belt. Unscrew the pivot nuts for the paper feed bearing plates (using a 1/4" nutdriver) and remove their screws from inside the printer mechanism frame. Take off the bearing plates.

On the left side, remove the 6 screws (4 pan head, 2 countersunk). Remove the left hand side plate, the thin spacer plate on the inside of it and the 3 rollers. The platen roller is the plain one with a bearing in the left hand side plate, the front feed roller is divided into 3 sections while the rear feed roller has 4 sections. When refittng the feed rollers, the send with the flats and the axial tapped hole goes to the left side of the machine.

If necessary, remove the similar 6 screws on the right hand side plate and separate the mechanism chassis parts.

The various ball races can be removed from the spindles or chassis parts using conventional methods (a 3-legged puller or suitable drifts in a bench vice) if it is necessary to replace them.

I have never hand to rebuild the rollers in an HP9866A so I can't describe how to do it. Suffice it to say for the moment that it does not look to be straightforward, owing to the fact that the feed rollers are divided into sections.

The **Motor** can be dismantled for repair (after removing it form the mechanism) by removing the 4 slot-headed through-bolts from the front face. The remove the front cover. Often the rotor comes away with this cover, separate them by tapping the ed of the spindle on a wooden bench top. Recover the crinkle washer and the shims from the rear bearing housing and then remove the rear cover of the motor by carefully tapping it free.

5 Initial reassembly

Reassemble the printer mechanism by reversing the dismantling procedure. Refit the rear panel and reconnect the transformer leads if they were desoldered. Refit the logic backplane and reconnect the 2 edge connectors to it. It is best to leave the mechanism out of the chassis until the initial electrical tests have been performed.

Troubleshooting and Repairs

It is difficult to say how far a non-working HP9866A printer needs to be dismantled before attempting to troubleshoot it . For a newly-acquired machine,. the covers, plug-in PCBs, printhead and printhead driver should all be removed, it is probably worth also removing the mechanism and logic backplane and separating the rear panel to clean and oil the cooling fan. For a unit which has been in use and which has recently developed a fault, it may be repair it after dismantling rather less of the machine, but a warning is necessary here :

The printhead power supply can supply enough current at a fairly high voltage (20V) to do extensive damage to the rest of the printer's electronics. The input to this power supply, of over 50V is possibly also dangerous to the repairer. And if, due to a fault ,the printhead enable signals – the **BankN** lines on the printhead connectors – are held asserted, then the printheads will burn out. Replacement printheads are very difficult to obtain.

For this reason, I strongly recommend removing the **Printhead PSU** PCB and the printhead when repairing any part of the control logic. After the repairs are completed and the unit seems to work, refit the **Printhead PSU** and check that none of the **BankN** signals are held on. On then refit the printhead and test the printer fully. There was a 'Test Fixture' which connected to the test connector on the **Printhead PSU** PCB and which allowed the output voltage of this PSU to be reduced, thus protecting the printhead if there was any fault in the logic. Although this fixture is mentioned in the official service manual no internal details are given and thus although it was *probably* a (variable) resistor network that connected to the input potential divider on U2, I cannot be certain, ad my repair procedures will not make use of such a device.

1 Power Supply Troubleshooting

With all the plug-in PCBs, the printhead and the **Printhead Driver** PCB removed, set the rear-panel voltage selector switches appropriately and check there is a good fuse of the correct rating in the mains fuseholder.

If the rear panel or **Logic Backplane** have been removed, then refit them. Reconnect the 2 edge connectors to the logic backplane.

As in the case of the HP9800 calculators, it is difficult to safely operate the mains-on/off switch when the switch bracket is removed from the front cover and mains is applied, so turn on this switch first and used a switched mains socket (if you have them on your workbench) or a switched cable to control the power.

As in the case of the HP9800 calculators, electrical breakdown on the mains input side is very uncommon. However, it is worth checking taut there earth pin of the mains input connector is connected to the metal chassis of the unit. And if you have a high-voltage insulation tester ('Megger') then check the insulation resistance between the live and neutral pins (strapped together) and the case with the mains switch on the unit turned on.

With the printer standing on one side, connect the mains and switch on. If the cooling fan runs then firstly it is working correctly and secondly (and more importantly) the mains fuse has not blown. In this case check the AC voltages from the transformer secondary windings at the logic backplane edge connector and the DC voltages across each of the 2 large capacitors on the chassis. If either of the latter are missing then suspect the associated bridge rectifier.

If the fan does not start, check any one of the AC voltages. If it is present, then the most likely problem is a fault in the cooling fan itself.

If the mains fuse blows, the n the most likely problem is that one of the bridge rectifiers or smoothing capacitors has shorted. Remove the mechanism (if you have not already done so) for access to these parts. If these all test good, and indeed if the mains fuse continues to blow with the transformer secondary winding leads disconnected from the bridge rectifiers, then unfortunately the mains transformer is suspect.

At this stage it is worth checking the 2 power transistors and the diode mounted on the main chassis. With the PCBs removed these can be tested at the terminals of the associated edge connectors. Again, if replacement is necessary, the mechanism has to come out.

It is worth pointing out that many of the plug-in PCBs have test connectors on their top edges which carry many of the useful signals needed for the following tests. Consult the schematic diagrams for the connection details

Now refit the mechanism and card guides if they were removed. Refit the **Logic PSU** PSU and apply power again. Check the 3 voltage outputs form this board on the backplane pins. Again, should the mains fuse fail at switch-on, check the input rectifiers and smoothing capacitors for shorts. The ±12V power supply circuits are very easy to sort out, if there is voltage across the smoothing capacitor then the only likely fault is a defective e 3-terminal regulator. The 5V power supply is a little more complex, Check the 7A fuse on the PCB. If this has failed, then most likely the pass transistor has shorted (or maybe Q1 on the PCB has shorted)(, causing the output to rise too high and tripping the crowbar circuit. If the pass transistor and fuse are OK and there is still no output, check the input voltages to U3. If **+5VRef** is missing then either U3 has failed or Q4 is turned on, possibly because the AC-present detection circuit is malfunctioning. Of course it;'s possible for a fault in U4 or its associated components to shut the power supply down by indicating an over-current situation where none, in fact, exists. Finally on this PCB check that the **Init/** signal is logic high If not, check the 5V Vcc supply to U5, U5 itself and the associated components.

If the +5V power supply is present, the power-on indicator on the switch bracket should be glowing. If not, then the bulb has most probably burnt out. Replace it. Check the paper-out (Load) indicator by grounding the White/Blue wire on the logic backplane edge connector. Again, the most likely fault here is a burnt-out bulb.

Switch off the mains,insert the **Printhead PSU**, and switch on again. Check the output voltage from this board, either at the edge connector that would connect to the **Printhead Driver** PCB or across either of the 2 largest electrolytic capacitors (C1, C2) on the PCB. As this is a switch-mode PSU, it is herder to debug then the linear supplies previously dealt with, but not impossible. Begin by checking he voltage on the emitter of the chopper transistor Q2, mounted on the main chassis. If this is missing,, it is likely that the 10A fuse on the PCB has failed. This, in turn, may be due to problems with the chopper transistor, the inductor on the PCB or the output capacitors C1 and C2, also on the PCB.

If the chopper is getting power, but there is no output from this part of th PSU, check the **osc** (oscillator) signal on the test connector with an oscilloscope., A non-linear ramp should be present here. Now check TP1 on the PCB with a logic probe. This point should be toggling, if not, then check the inputs to U6a, Either the comparator U5 is not driving the rest of the circuit (in which case check U5 and U2), or one of the other circuits is shutting the power supply down, possibly due to a lack of one of the other voltages. This should not be difficult to trace.

If TP1 is toggling and there is still not output, check the transistors Q2, Q4, Q5 and Q6 that drive the chopper. After getting this power supply working, disconnect the mains input and remove the **Printhead PSU** PCB again and set it aside until the printer logic is essentially working.

2 Getting the Motor to Run

Next (with the **Logic PSU** still fitted), refit the **Data Path**, **Control** and **Motor Driver] PCBs. Connect the motor edge connector to the top of the last PCB. As an aside, the only reason for having the Data Path fitted is to make RotEn a logic 0, thus enabling the manual paper feed logic**

Apply power again and carefully (so as not to touch the mains connections on the on/off switch) press the feed button. The motor should turn. If not then start by checking the output of U15a on the Control PCB. It should be toggling while the feed button is pressed. If not, then check that Autofeed is not being held low due to a fault in the state machine or the decoder U13. Check that the motor oscillator is running (that the output of U23d is toggling) and the inputs to U22a.

Once MotorClk is correct, check the 4 motor drive signals, ϕA, ϕA/, ϕB and **ϕB/** at the backplane connector. Lack of activity here suggests a problem in the motor counter *U21a and U21b) or the associated open-collector inverters.

When these signals are correct, move on to the **Motor Driver** PCB.First check the (unregulated) power supply voltages on C1 and C2. Then, using an oscilloscope, look at the **MA** and **MB** signals on the motor connector. Problems here are generally caused by defective transistors on this PCB. Or course the problem could be an open-circuit winding in the motor itself, This is easy to detect (using an ohmmeter across the terminals of the motor edge connector when it is unplugged from the **Motor Driver** PCB), but much harder to correct.

Of course with no paper in the printer, the Load lamp should be on. Operate the paper detection microswitch with a suitable tool and check that the lamp goes out when it is depressed. If not, check the debounce flip-flop U28a and U28b on the **Control** PCB and the driver transistor Q1.

3 Repairing the Control Logic

When working on the control system, the **Printhead PSU** PCB and the printhead should be removed, but all other parts should be fitted.

First check **SMCLk** and **OutEn/** on the **Control** PCB test connector. There should be a clock signal of about 850-900kHz on each one. If not, check the master clock circuit (expect about 3.5MHz on the output of U8c) and the clock divider circuit. Without the correct clocks, the state machine can't possibly work properly

The easiest way to locate faults in the control logic is to use a logic analyser to trace the operation of the state machine. The *Inverted* form of the 5 state bits – **SMA(0)/...SMA(4)/** are available on the test connector on the **Control** PCB. Since the state changes on the rising edge of **SMClk**, the analyser should be clocked on the falling edge of this signal so that it samples stable signals.

Two further comments are necessary. Firstly, if any of the state flip-flops, U2a, U6b, U6a, U18b and U2b are faulty, the inverted signals on the test connector may not reflect the actual signal being sent to the state machine ROM. And secondly, remember that every state transition is conditional, the **CC** signal cannot be inhibited. Unconditional transitions are simply the result of having the 2 possible next states actually being the same. But if the input gates to the state flip-flops are malfunctioning, the actual next state may (incorrectly) depend on the **CC** signal. If the state machine seems to go in an impossible sequence, then investigate this area.

3.1 Character Input

Connect the printer to a suitable machine, such as an HP9830, which can send individual characters. Use a suitable rod to operate the paper-out microswitch so that it appears that paper is loaded (if necessary remove the microswitch from the mechanism). It us helpful to have the printer standing on one side panel so that the test connectors on top of the PCBs and the **Logic Backplane** pins are both accessible.

It is useful to have a way to reset the printer electronics. A momentary SPST switch (e.g. a 'push to make' button) connected between **InitIn/** and ground on the **Logic PSU** test connector is a good way to do this.

Monitor **IFFlg/** on the **Logic Backplane** or interface connector and send a printable character (other than a linefeed). If **IFFlg/** pulses low then the character input section of the state machine is basically working.

If not, then if logic analyser is available, connect this to the **SMA(n)** signals on the **Control** PCB test connector. Reset the printer and if possible set the logic analyser to trigger if the state is no longer 00. If the logic analyser does not support that sort of trigger, then trigger when **SMA(1)/** goes to 0.

Send a character as before and see what states the state machine goes through. If the sequence is totally crazy, then suspect a problem with the state machine flip-flops, the input gates or the state machine ROM itself.

If no logic analyser is available, then monitor **SMA(1)** with the logic probe. While this will not indicate anything like as much, it will at least indicate that he state machine is doing something as the machine leaves state 00.

If nothing happens at all when a character is send, then look at **Stb/** at the output of U22b on the **Control** PCB. If that is not changing state, then check to be sure that both **PaperOut/** and **Feed/** are high. Debug the debounce SR flip-flops if necessary. Then check **CC** and **CC/** (input and output of U1d) to make sure they're behaving correctly. And then, check the state machine flip-flops, gates and ROM.

If the state machine appears to be running but **IFFlg** never goes low, then check **InClk/** on the **Logic Backplane**. Reset the printer and send a character. if **InClk/** never toggles then check the state machine output decoder U13 on the **Control** PCB. If **InClk** does toggle, then check U22a on the **Data Path** PCB. If **IFFlg** goes low and never returns high, then reset and send another character while monitoring **ClrFlg/** on the **Logic Backplane**. If this signal is toggling, then check U21a, U21d and U22a on the **Data Path** PCB. Again, if not, check the decoder U13 on the **Control** PCB. Of course if the interface flag flip-flop U22a (on the **Data Path** PCB) seems to be working correctly but **IFFlg/** is not, then suspect the open-collector buffer U20c.

Once the printer is working well enough to accept characters, there are a few other signals that are worth checking. Of course it is now no longer necessary to reset the printer before sending each character. First check that **SClk** is pulsing low for each character entered. If not, the fault is likely to be U20d or U13 on the **Control** PCB. then check that the character counter is correctly incrementing after each character – its outputs are available on the test connector on the **Control** PCB. If not, then it is possible that the characters are not being treated as printable, check the input latch and the character testing gates U10, U16d, U16c and U16b on the **Data Path** PCB.

3.2 Paper Feed

Reset the printer to clear all the counters and then send a single linefeed character. If you are monitoring the state machine with the logic analyser, check that it does the transition form state 1B to state 15.

In any case, the stepper motor should turn the rollers to advance the paper by one character line (if there was paper present). There are 3 possible problems here :

If the motor doesn't run at all (and, incidentally, **IFFlg/** remains low) then it is likely that **AutoFeed/** is never going low. Check the state machine and its output decoder.

If the motor advances one step and **IFFlg/** remains low, then it is likely the state machine is stuck in state 09, waiting for the motor timing monostable to time out. You can check this my monitoring the **SMA(n)/** signals with a logic probe. if this is the case, then check U22b the associate gates and the flip-flop U18a on the **Control PCB**.

The last possibility is that the motor starts running and never stops. The general cause of this is that the condition at state 1F is always true, so the state machine stays in the paper feed loop. Again, a logic analyser will prove the point. This generally means that the row counter or **RotEn** on the **Data Path** PCB is the problem. The counter outputs can be checked on the test connector of this PCB, **RotEn** is the output of U19a. If the motor is running, then the counter should be incrementing on each step, this is

3.3 Print Cycle

Now send a reasonably long line of printable characters (but fewer than 80) and a linefeed. The correct behaviour is for the rollers to move by one character line but rather slower than before (as the printer is processing each dot row). As before there are several easily-spotted failure modes.

If the printer 'hangs up' with **IFFlg/** l;low having not moved the paper at all, it is likely that it is stuck in the buffer-fill loop, states 17,04,08. The easiest way to check this is with a logic analyser, if one is not available, continual **SClk** and **PHClk** pulses (at a third of the state machine clock frequency) are a symptom of this problem. Check that the character counter is incrementing and find out if **Start/** is ever going low. Finally suspect the state machine condition multiplexer U14.

If the paper advances one dot row and the printer hangs then the state machine has entered the print cycle loop but for some reason it is not completing it. Again a logic analyser is the best way of finding out what the state machine is doing, the most likely problems are :

It is stuck in the 'shift by 4' loop at 07,1C, waiting for **LnFlg/**. This can be detected with a logic probe by a continual stream of pulses on **ForceSpace/** and nothing on **SClk** (The latter distinguishes it for the buffer-fill loop). In this case, check if the output of U20a on the **Control** PCB is toggling. If not, check this gate, if it is, investigate the 4-state counter U17a and U71b.

It is stuck in the transfer characters loop from 18 to 03. Generally this means that **NewBank/** is never being asserted. Check the character counter and the gates that produce this signal.

It is stuck in the complete dot-line loop because **Firstbank/** is never being asserted so the condition at state 0C never passes. Check U15c on the **Control** PCB.

It is hanging in state 0A waiting for the timing monostable U26a (on the **Control** PCB) to time out. Again, this is easy to detect wit ha logic probe as the state machine flip-flops will be static in that state. Check the monostable and associated gates.

If the printer starts to feed the paper and never stops, it is likely that **Row7** is never being asserted, and this the condition at state 16 never passes. Check that the row counter is incrementing and then check the output of U19b on the **Data Path** PCB.

Once the print loop is basally functional, send the line of characters and linefeed again, and check **PHEn**. It should be toggling. If not, check U24 on the **Control** PCB.

4 Locating Data Path Problems

In general problems in the data path are easier to find than those in the control system because, if the latter is working, the printer will accept characters and attempt to print them. Many faults can thus be located by examination of the printed output.

Begin by refitting the **Printhead PSU** PCB – the only electronic section now not fitted should be the printhead. Power up, and check that **PH+** is at about 20V and that all of the **BankN** are 'dead'. Now, with the paper out microswitch operated as before, send a line of text followed by a linefeed. After this, again check that all of the **BankN** signals are dead. If not, Find out why not before fitting the printhead. Check the **PHEn/** signal. If it is stuck low, check the timing monostable U24 on the **Control** PCB. If **PHEn/** is high, then check the bank select NOR gates, the drivers and the transistor array U8 on the **Printhead Driver** PCB. Do not fit the printhead before curing such faults, a burnt-out printhead is not pleasant.

Now, power down, refit the printhead power up and load a roll of thermal printer paper[1]. Check that that the 'Load' lamp on the switch bracket has gone out, if not, find out why the paper is not operating the paper out microswitch.

Again print a line of text (ending in a linefeed). This time something should appear on the paper, and there are several possibilities :

The printer prints correctly. There is not much more to do. Just refit the casing parts and enjoy hard copy output on the HP9830.

The entire line is blank. This normally means the printhead is not being driven. Check **PHEn/** and the bank select gates. No data being loaded into the dot shift registers on the **Printhead Driver** PCB can cause this (it can also cause this, so check **PHClk**. Of course the printer might be printing space characters in all positions dues to a problem with the input latch or the data shift registers on the **Data Path** PCB, but this is rare. Also rare, fortunately, is a totally data character generator ROM which can produce either entirely blank or entirely dark characters.

If every fourth character is blank, it suggests that the associated **BankN** signal is never being driven. Check its driver transistor in U8 on the **Printhead Driver** PCB and the associated gates.

[1]Thermal fax paper works perfectly.

If the same dot column of every character is either blank or always dark, then the problem is most likely in the dot data path. Check the appropriate **PHData(n)** signal on the test connector of the **Data Path** PCB. If it is not changing state during the print cycle, then check the inverter that drives it and the character generator ROM. If **PHData(n)** is toggling, then check the inverter that receives that bit on the **Printhead Driver** PCB ,ad the associated dot shift register.

If characters on the right side of the printout are correct, but those on the left side have either missing or dark dot columns then most likely the dot shift register for that bit of **PHData(n)** is defective. Remember that characters are loaded from the right hand end of the line (so that the first character ends up being shifted all the way to the left), so a fault in the shift register that stops the bits flowing any further will cause this fault.

A single missing dot column is most likely due to a problem with that printhead. Assuming a replacement printhead is unavailable, it may be best to move the defective one to the rightmost position and try to only print short lines.

If some or all characters are printed wrongly but are still valid character patters, then the problem is most likely in character code data path. Check the input register flip-flops, the data storage shift registers and their input gates and the character generator ROM.

If the first dot row of the line is correct, but subsequent rows are wrong (particularly if only wrong for some character codes), then suspect the recirculation gates on the shift registers.

If the first line is correct but subsequent lines have their dot patterns rotated to the left (in 4 character increments) then the problem is most likely in the control system,m. Check the **char0** signal and ensure that the state machine correctly skips the rotation loop at the end of each dot line.

Minor defects in the characters such as missing or extra dots are most likely due to the character generator ROM. Since this is an HP custom part (it is a mask programmed ROM of a similar type to the ROMs used in the HP9800 calculators), it may be simplest to live with this problem if it is not too severe.