Repairing HP9800 Desktop Calculators – Part 8

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Repairing the HP9810/HP9820 Card Reader

1 Overhauling the card reader mechanism

Most of the faults in the card reader are mechanical. The card reader drive roller will certainly need replacement unless this has been done recently, and the drive belt may be defective

The card reader mechanism consists of 2 side plates joined by pillars. Plastic card guides are riveted to these side plates and these also hold the lampholders and photodetectors for the card sensors. A motor with integral gearbox is fixed to the left side plate, this drives the card roller spindle via a drive belt on the outside of the reader. The magnetic head is fixed in a metal block bolted to the inside of the right hand side plate. A pressure roller assembly runs in bushes moulded into the card guides and holds the card against the drive roller. A further 'centre' card guide is carried on the lower front pillar.

1.1 Dismantling

With the card reader mechanism removed from the machine, begin by removing the drive belt by simply stretching it over the pulleys. Then remove the 2 screws holding the head mounting block in place and remove the hard assembly. Put this carefully aside. It is, of course, a good idea to clean the head face with propan-2-ol while it is out of the reader.

Remove the 2 lampholders from the card guide on the left side plate by simply pulling them out of their mountings. Remove the screw on the right hand end of the lower front pillar, and the screws from the remaining 4 pillars on the left side. Start to separate the plates. Slide the small PCBs carrying the photodetectors out of their slots on the left card guide, taking great care not to break the guide. Separate the plates and remove the pressure roller assembly. Remove the screw on the lower front pillar on the left side plate and remove this pillar with the centre card guide.

To fully separate the plates it is necessary to disconnect the wires from the drive motor. Loosen the 2 small screws that retain the rear end cap on the motor and ease it off Make a note of how the wires are connected and then remove the terminal screws. Put the right hand side plate with the wiring harness aside.

You may want to remove the brushes and clean the commutator at this stage. The brushes are retained by one further screw each, the plastic cover that acts as a support for the brushgear is held on by the 2 screws that retained the rear end cap and one further screw. Removing these parts should not pose any problems. Clean the motor parts, the pressure roller, etc in the normal way.

1.2 Replacing the roller

It is now necessary to remove the old roller hub from the spindle. Clean off the remains of the 'tyre' and attempt to remove the roller from the spindle using the puller tool described earlier. Fit the base plate of the puller between the roller hubs and the left side plate with the puller bolt pressing on the right hand end of the spindle. Tighten the bolt and the roller should be drawn off. Remove the old roller hubs and slide the spindle and its earthing bracket out of the left side plate. Clean the dismantled parts of the reader.

It is now necessary to make a replacement roller hub. and I am afraid to say that this requires a small lathe. Start with a length of nominal 7/8" brass rod about 1" long and measure its diameter accurately.. Put it in the 3-jaw chuck and face off the end. Using a centre drill followed by a twist drill in the tailstock chuck, drill a 3.2mm hole along the axis of this rod. Check that tithe roller spindle will slide into this hole.

You now need to machine 2 grooves into the brass to take O-rings so that the diameter at the base of the groove is 3/4". Calculate the depth from the diameter you measured earlier. Put the centre of one of the grooves 0.1" from the end of the rod, and the other a further 0.15" along. I have found that the brazed-tip round-nose tool available from many model engineering suppliers[1] makes an ideal form tool to cut these grooves. Fit a BS210 O-ring[2] into each groove in turn and check that the outside diameter of the fitted O-ring is 1".

Part off a total of 0.35" of the rod. This will result in a symmetrical component with a groove 0.1" from each end. Drill a radial hole, 2.1mm in diameter at the base of one of the grooves and tap it to take an M2.5 set screw. As a practical tip at this point, it is easier to use hex socket ('Allen') setscrews since they can be held on the end of the hex driver ('Allen key') tool and fitted into position.

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[1] For example GLR Distributors order code 131160

[2] That's 1" outside diameter, 3/4" inside diameter, 1/8" thick

Temporarily refit the spindle to the left side plate of the reader and fit the new hub onto it. Fit the right hand side plate, position the hub and mark its position on the spindle. Dismantle the reader again and mill or file a flat on the spindle to take the end of the set screw.

In a few cases the roller is firmly bonded to the spindle and the puller bends the latter before the roller comes free. In this case it is necessary to make a new spindle as well as the roller hub. Remove the belt pulley from the end of the old spindle, for example by supporting the side plate on a bench vice and driving the spindle out with a hammer and pin punch.

The replacement spindle is made from 1/8" stainless steel rod. One end has to be fitted to the pulley. The end of this rod should be turned down in the lathe to be a sliding fit in the bore of the pulley.

A metal pulley can be drilled and tapped radially for an M2.5 setscrews and a flat milled or filed at the end of the rod for this to locate on. If your M2.5 tape is not long enough to tap this hole to the full depth, tap it as deep as you can and put a small metal rod under the setscrew to press against the flat.

If the pulley is plastic, it is easier to drill and tap the new spindle axially for an M2 screw. Fit the spindle onto the end of the new spindle (it won't go on too far as the end was turned to fit in the pulley bore) and anchor the pulley with an M2 pan head screw and shakeproof washer.

Temporarily reassemble the reader side plates and insert the new spindle in its bearing holes. Mark the required length just beyond the right hand side plate, remove the spindle, cut it to length and face off the end.

Once the new spindle has been made, fit it to the side plate and the new hub as described above, mark the position of the roller and mill or file a slot for the setscrew.

1.3 Reassembly and electrical tests

Fit the spindle through the earthing strip and left side plate and fit the new hub, locking it in place with the setscrew. Fit a pair of BS210 O-rings to the grooves in the new hub.

Reassemble the motor brush gear carrier and the brushes. Before connecting the wiring or fitting the rear end cap, connect a 24V power supply between the brushes. The motor should run, if not, check that the brushes are located correctly.

Reconnect the wiring, fit the motor end cap and reassemble the card guides, pressure roller and side plates. You will notice that the motor wires are connected to a tag strip on the inside of the right hand side plate which carries the anti-back-emf protection diode. Connect the 24V power supply to these tags, taking care to ensure that the cathode (banded end) of the diode is connected to the positive side of the supply. Again the motor should run.

Fit the drive belt by stretching it over the pulleys and try again. The drive roller should rotate. Feed in a card. If it doesn't pass correctly through the reader, check to see what is slipping. Most of the time the problem is the drive belt on the left side of the reader.

There are 2 ways to determine the length of this drive belt. A calculator enthusiast would measure the diameter of the 2 pulleys and the distance between their centres with callipers and enter the data into the Belt Length program of the HP67 M.E. Pac 1 (Program ME1-17A) or a similar program for the HP41. A practical person would run a length of string round the pulleys, mark it, remove it and measure the length between the marks. Of course, once the length is known, it is as easy as (dividing by) π to find the diameter of the O-ring that would make a suitable belt.

Being both a calculator enthusiast and a practical person, I did both. And they agreed to well within the accuracy of the measurements. This suggested that a BS231 O-ring[3] would be an ideal drive belt for this reader, and tests showed this was correct.

With the drive system working, it is worth checking the 4 card sensor lamps by measuring the resistance from the lampholder body to the end contact. If any are open-circuit, pull them out of the card guide and dismantle the lampholder by unscrewing the 5/16" nut on the front end. This will also unscrew the central tube and release the bulb. The latter is a T1 midget flange bulb rated at 6V, 50mA, and is still available[4].

It is worth checking the head windings for continuity at this point by measuring the resistance between the centre pin and each of the 4 corner pins of the connector 'plug' (actually a small PCB with 5 pins soldered to it). Use an ohmmeter which only supplies a small test current (use it on a high resistance range if in doubt), and if possible demagnetise the head with a 'defluxer' afterwards. I suspect that replacement heads are impossible to obtain for these machines, though.

Finally refit the magnetic head and refit the card reader mechanism and the **Card Reader Interface** to the machine.

[3] Outside diameter = 2+7/8", inside diameter = 2+5/8", thickness = 1/8"

[4] For example RS Components 360-7531.

2 Troubleshooting the card reader electronics

Most of the (rare)failures that occur on the **Card Reader Interface** PCB are in the motor driver circuit.

2.1 Motor driver

With the card reader system connected to the rest of the machine, perform any load or store operation. If the card reader motor does not start, first check that U5a on the **Card Reader Interface** PCB is being set. If not, check the **CROut** signal from the **I/O Interface** PCB and the outputs of the I/O register. Then check the 2-transistor circuit connected to the output of this flip-flop. The most common problem is for the PNP transistor that actually feeds the motor to fail.

2.2 Card sensors

Next check the card sensors. With the motor running (and thus **SenseEn** at +12V), check that the appropriate **DI(n)** signal changes state as each light beam is interrupted. Of course the most common problem here is the failure of the filament lamp in the card reader mechanism, but you should have already checked these. In any case, a quick look at the reader mechanism when the machine is switched on will detect this fault.

2.3 Writing

The next test it to type in a short test program and attempt to save it on a blank card. Using your logic probe, check that U8a's output on the **Card Reader Interface** PCB is low throughout writing, and that there is activity on the outputs of the 4 flip-flops driving the write drives. If you have an oscilloscope, check for activity on the collectors of the driver transistors and the head connections. You may have to write the program several times to be able to check all the signals.

Faults are normally limited to one channel, and are thus fairly easy to find. If the 'S' timing channel is malfunctioning, also check the **CRSout** signal from the **I/O Interface** PCB.

2.4 Reading

Now try to re-load the program you just saved. If it loads without errors, there is nothing more to be done, if not, then start by checking that U8a on the **Card Reader Interface** PCB is set (to disable writing) throughout the read operation. Also check that the outputs of U9e, U9f, U7f and U7e are low.

Next check that **ClRd/**. for example on the reset input of U10b, is high when the card is actually passing through the reader. Look for pulses on **CRRdClk**, if this signal seems dead, trace the signal from the head through the 'S' channel read amplifier with an oscilloscope. Then look for activity on the outputs of the read flip-flops, U10b, U10a and U11b. If any are static, investigate that channel's read amplifier.

It is, of course, possible that the reader is working correctly, but that **I/OFlg/** is never being asserted so that the processor ignores the incoming data. Check the SR flip-flop U4c and U4d and the data selector U9 on the **I/O Interface** PCB.

Repairing the HP9810/HP9820 Printer

1 Overhauling the printer mechanism

As a mechanical device, the internal printer of the HP9810 and HP9820 machines benefits from being dismantled and cleaned. The platen roller may also have decayed with time and turned into a black, sticky, goo and this clearly needs to be cleaned off and the roller replaced.

1.1 Dismantling the printer mechanism

Being by removing the 3 screws holding the **Printer Interface** PCB to the right-hand side of the printer chassis. Hold the **Printer Driver** PCB in place on the underside of the printer and ease the **Printer Interface** PCB off, separating the edge connector from the card edge of the **Printer Driver** PCB. Inspect the **Printer Interface** PCB for burnt r damaged components and set it aside.

At the front of the printer, there is a metal beam running across the chassis in front of the printhead. In the middle of this beam is a hexagonal domed housing that contains the printhead pressure spring. Unscrew this with a 5/16" nutdriver – carefully so the spring doesn't escape – and remove it and the spring. Undo the 2 screws that hold the beam to the bearing plates (noting the position of the ‘P’ clip for the microswitch wires) and pull the beam out. If you want, remove the microswitch screws to completely free the beam from the printer.

The printhead is carried on a pair of arms with adjusting cams at the lower ends. Remove the self-locking nuts from the fixing screws and remove the springs, cams and screws from the printer. At the rear edge of the **Printer Driver** PCB, unplug the edge connector that carries the motor and switch wiring and then remove the PCB and printhead from the chassis.

To separate the printhead from the **Printer Driver** PCB, remove the setscrews in the clamp. Slide the printhead, the flexible PCB tail and the clamp bar out of the block. Handle the printhead with great care, it has a brittle ceramic substrate and the only source of replacements is another HP9810 or HP9820 printer.

Back on the chassis, remove the circlip on the platen (upper) spindle at the front left side and slide off the gear. Loosen the 4 motor mounting screws and slide the motor forwards to relieve the belt tension. Remove the sprocket from the loading belt (lower) shaft at the front left, it is supposed to turn freely on this shaft, and remove the drive belt. On the right hand side, remove the circlips and gears from both shafts, the larger gear fits on the loading belt (lower) shaft.

On the underside of the printer, you will see the 2 loading belts that feed the paper towards the platen. Remove the circlip from one end of the rear belt shaft and slide this out, recovering the plastic rollers. Moving towards the front of the chassis, remove the (smaller) circlip from one end of the next shaft and slide that out too, again recovering the rollers. This shaft also carries the paper-out contacts, which can be left hanging on the wires.

There are actually 2 types of paper-out contact. One type has one wire connected to this contact assembly and the other soldered to a metal plate on the front section of the printer chassis. The other has both wires connected to separate contacts on the assembly carried on this spindle, they are connected together by coming into contact with an isolated metal plate on the front section of the chassis when the paper runs out. This makes little difference to the dismantling and repair procedures though.

The platen and loading belt shafts are carried in bearings in plates screwed to the sides of the chassis. Remove this assembly, note the positions of the plastic spacer strips under them. There is a thin idler roller carried in holes in these palates that may fall out at this point, make sure you don’t loose it.

Now, on the right side of this assembly is the red manual paper freed leaver. Turn this through 180° to free it from the left bearing plate (this will take some force if the platen has not decayed) and then separate the various parts.

On the main printer chassis again, remove the 2 rear through-bolts. Push the rear chassis section downwards and unclip the paper guide wire. Remove the 2 front through-bolts, the top one carries the threaded spacer for the **Printer Interface** PCB, and separate the chassis parts. Remove the 4 screws loosed earlier and separate the motor from the left side plate.

Clean all the parts of the printer. If the platen has decayed, it will take a lot of elbow-grease to remove the goo from the various chassis parts,m the **Printer Driver** PCB and the printhead. But clean the latter with care, it is very easy to damage

1.2 Dismantling the motor

Once the motor has been removed from the printer it can be dismantled to inspect and lubricate the bearings or repair winding faults.

Check the windings for continuity between the appropriate pins of the edge connector that plugs into the **Printer Driver** PCB. I have never had to do it, but it should be possible to re-wind the motor once it is dismantled.

Remove the rear end cover by unscrewing the 3 screws on it. These screws tap into pillars which are fitted with plastic sleeves, remove these sleeves next. Loosen (or remove) the 2 setscrews in the motor sprocket and slide this off the spindle followed by the plastic bush under it. Remove the circlip and the shim washers under it and slide the rotor, with more shim washers on the shaft, out of the rear end for the motor. Make sure that no shims have been left adhering to the bearing faces, or they are likely to be lost. Treat the rotor with care, it is fairly brittle and spares are difficult to obtain.

To dismantle the stator, use a suitable bar (such as the shaft of a large screwdriver) between the pillars that take the rear end cap screws to rotate the locking plate and free it from the motor casing. Remove the plate and the large spring washer under it, then lift out the stator pole pieces and the coils, keeping them in order. Ensure you refit the coils the same way up, if one (and only one) is turned over, the motor will run in reverse when it is reassembled. This causes no damage but you will have to take everything apart again to turn a coil over. The metal band around each coil slides off followed by plastic covers. At this stage it is possible to re-wind the motor.

Reassemble the motor is the reverse order to dismantling it and lubricate the needle-roller bearings with high melting point grease.

Next, reassemble the main chassis. If the platen is in good condition, reassemble the platen, bearing plates and belts too. But do not refit the PCBs or print head just yet. If the platen has decayed, the next section will tell you how to repair it.

1.3 Repairing the platen roller

To repair the platen the best material[5] appears to be 3M 8242-8 Cold Shrink(TM) kit[6]. This kit contains a length of the Cold Shrink tubing on a plastic support, 2 sleeves, and a packet of silicone grease. Ignore the grease, you do not want the platen to slip once assembled.

Push the 2 sleeves onto the ends of the original platen spindle (after cleaning the latter, of course), so that they meet near the middle of the spindle. It will take considerable force to do this. Make sure they go on evenly and touch, but don't force them on so far that there is a bulge at the joint between them

Slide the Cold Shrink over this and start to pull out the helically-wound support. When about half the support is removed, cut round the Cold Shrink itself and reposition it over the layer already fitted. Remove the remainder of the support.

Thus the spindle is covered with the sleeves and 2 layers of Cold Shrink tubing. The next job it to cut it to length. Rest the roller on the partially-open jaws of a bench vice and use a sharp knife to trim off the ends. Make the platen too long at both ends at this stage.

Clamp the spindle in the 3-jaw chuck of a small lathe and support the other end on a tailstock centre (HP kindly provides centring holes at each end of the spindle). Hold the knife against the toolpost and position the carriage so that the knife will cut that end of the platen at the correct place. Then while *turning the lathe by hand* (Don't even thin of running the lathe under power unless you want to make a trip to hospital – or worse – when the knife ends up in you), cut the sleeving to length. Reverse the platen in the lathe and cut the other end.

You should now have a repaired platen of the correct size. Reassemble the platen, belts and bearings and refit this assembly to the front of the printer chassis. Reassemble the gearing.

1.4 Checking and refitting the print head

the printhead has 88 connections in a row along the bottom edge which connect to corresponding pads on the flexible PCB that's integral with the **Printer**

[5]Suggested by David Smith and Katie Wasserman on the Museum of HP Calculators Forum
[6]Available from RS Components, 251-7566 or Farnell 126-6864

Driver PCB. These pads, starting at the left side of the printhead follow the pattern of 10 individual resistor connections followed by the common for those 10 resistors, followed by another 10 individual connections, their common and so on for a total of 8 groups.

Begin by testing the printhead. Check the resistance from each individual connection to the corresponding common one. A new printhead would have resistors measuring between 120Ω and 260Ω. The resistance may increase with wear, but it should still be less than 300Ω. If any resistors are totally open-circuit, then I am afraid the printhead needs replacement. The only source is another machine.

If the printhead is good, fit the clamp bar to the clamp block and position the head and flexiprint so that the contacts are aligned. Carefully tighten the setscrews. Do not overtighten them, there is a very real risk of cracking (and ruining) the printhead.

Now check that the printhead is connected properly by measuring the resistance between the collector (or metal case) of the transistor Q4 on the **Printer Driver** PCB and the cathodes (banded end) of each of the diodes in the row alongside it. Then check from the collector of Q3 to the cathodes of the next row of diodes, the collector of Q2 to the next row and finally the collector of Q1 to the cathodes of the front row of diodes. In each case you should see the resistance of a printhead resistor.

If some or all are open-circuit, release the clamp, reposition the head and flexiprint and try again. I am sure there was a jig at the factory for this, but it's not that difficult to do by hand.

When this is correct, refit the remaining mechanical parts and the PCBs to the printer chassis. Then fit the printer into the machine (it is not necessary to fit the fixing screws, just plug the **Printer Interface** PCB into the backplane) ready for electronic troubleshooting.

2 Printer electronic troubleshooting

With the printer fitted and the machine turned on. press the manual paper feed lever at the right hand side of the printer. The printer motor should turn.

If it doesn't, begin by checking **MotorClk**, for example at the output of U96 on the **Printer Interface** PCB. If it is not pulsing, check that the manual feed clock astable is running (there should be a square wave at the collector of Q21) and that **Feed/** at the collector of Q24 is being asserted. Then work through the few logic gates involved.

When **MotorClk** is behaving correctly, check that **MotorEn/** at the output of U5b is being asserted (low). Next, on the **Printer Driver** PCB check that the motor state counter is running. If so, then check the motor driver stages.

Once the printer will feed paper correctly, insert a roll of the correct thermal paper and try to print something. There are a number of possibilities:

The printer prints correctly : Not a lot more to be said, all you have to do is screw the printer down and it's done.

The paper feeds but nothing appears on it : First check the paper is in the right way round with the thermally-sensitive surface against the printhead. The method I use for this is to hold the end of the paper over a hot soldering iron. It will soon be apparent which side changes colour. Then try adjusting the printhead height using the adjustment cams so that the row of heater elements is against the paper. It may be necessary to remove the head and reposition it in the clamp. Check that **PrtHdEn/** is being asserted and that U4 on the **Printer Driver** PCB is enabling the printhead selection transistors,. It is possible, albeit unlikely that all the drivers have failed at once, it may be worth checking this if not other fault can be found

It prints, but some dots are missing : If only a few odd dot-columns are blank, then it is likely the fault is either a defective printhead or the appropriate diodes on the **Printer Driver** PCB. If an entire electrical row or column of the printhead matrix is missing, then investigate the driver for that line.

Nothing happens at all : First check that the printer doesn't think it's out of paper. The collector of Q23 on the **Printer Interface** PCB should be high. Then check if **PrtEn** is being asserted. If not, check the logic around the SR flip–flop U4b and U12a on the **I/O Interface** PCB. If **PrtEn** is being asserted, check that it is asserting **PrtHdEn**via U7a on the **Printer Interface** PCB, and check the motor signals as above.

Once the printer is correctly working, refit the 4 screws that anchor it to the main chassis.

Repairing the HP9830 Cassette Drive

1 Overhauling the tape drive mechanism

The HP9830 tape driver suffers many fewer mechanical problems than the card reader or printer of the HP9810 and HP9820 machines,and that that do occur are generally easy to repair. It is necessary to remove the mounting bracket and front panel for almost all repairs, the head plate and drive spindles can then be dismantled as necessary.

1.1 Initial dismantling

Begin by removing the rear mounting bracket which is fixed by 4 screws. Unplug the 4 ‘plugs’ (actually PCBs with pins soldered to them) from the **Tape Drive Connector** PCB.

These plugs connect to the following parts of the drive :

S – Solenoid (9 pins) : The 2 solenoids that rock the motor beam and the ‘write protect’ and ‘cassette in’ microswitches

M –Motor (5 pins) : The 2 drive motors

P - Photo (5 pins) : The optical EOT sensor

H- Head (9 pins) : The **Tape Head** PCB

The **Tape Drive Connector** PCB is held to the bracket by 3 screws, loosen these a few turns at a time to separate the PCB from the bracket. Normally the screws and spacers stay with the bracket, the threaded ends of the spacers unscrew from the tapped bushes on the PCB.

Next remove the tape drive front panel. It is retained by a long through-bolt. With the tape drive front-upwards. remove the nut, washers and spacer from the end of this and then pull out the bolt with a further spacer and washers. You may want to store these parts on the bolt and refit the nut by a few turns. Lift up the front panel and slide out the window. Remove the nut and bolt holding the earth wire to the front panel and remove the panel entirely.

The motors are removed next. Take out the screw on the motor beam pivot post and the 4 screws holding the rear bracket to the sides of the drive. Take off this bracket and slide the motor assembly off the pivot.

1.2 Dismantling the head plate

The tape head is connected to the **Tape Head** PCB by 4 wired fitted with push-on contacts that go onto the pins of the head. Remove these, noting their positions then remove the 2 screws and spacers holding the PCB to the head plate assembly. Put the PCB aside.

Remove the 3 screws holding the left-hand cassette guide to the head plate Ease off the guide and unhook the cassette holding leaf spring from inside the frame. Remove the 2 bushes form their pins on the chassis (these often fall off if you are not careful). Free the right hand guide from the similar bushes on the right side of the drive chassis and remove the complete head plate. Again remove the bushes before they fall off and get lost.

The optical EOT sensor PCB is retained by 2 further screws. Remove the guide from the front of the sensor and remove the PCB complete with the LDR and light bulb. This bulb is one of the common failures of the tape drive, it is a 5V 60mA T1 wire-ended bulb[7] You can easily check this for continuity and solder in a replacement at this stage.

It is not advisable to remove the head, it would have to be realigned when it is refitted. I have never done this, but maybe one day…

1.3 Dismantling the drive spindles

On the main tape drive chassis, remove the motor beam pivot post which is retained by 1 screws.

It is possible to remove the drive spindles without removing their leaf springs first, but it is a little tricky. It is a simpler to remove the single screw from the rear face of the drive wheel and lift off the leaf spring. Then remove the circlip and plastic washer from the front end of the spindle. slide the spindle out rearwards, and recover the second plastic washer.

The 'tyre' on the drive wheel is the other main failure point of this drive. It is a size BS219 O-ring[8] and can easily be replaced at this point by stretching it over the drive wheel.

The brake plate is retained by 2 screws. Remove these, free the return spring and remove the plate and its spacers. The latter are asymmetrical and must be refitted the correct way up.

1.4 Initial electrical tests

Clean all the parts of the tape drive, paying particular attention to the head face.

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[7] For example Farnell 113-9296

[8] This O-ring is 1+9/16" outside diameter, 1+5/16" inside diameter and 1/8" thick

Some of the electrical parts of the tape drive should be tested at this point. The resistance of each drive solenoid (measured between the pins on the connector 'plug' PCB should be around 22Ω. The drive motors, again checked at the pins on the 'plug' should be around 10Ω. Also check the filament lamp in the EOT sensor if you have not already done so. The head windings can be checked for continuity, but as in the case of the card reader use a low-current tester and demagnetise the head afterwards.

Then reassemble the tape drive and fit it, and the 4 PCBs in the tape control section, to the machine.

2 Repairing the tape drive electronics

Although the tape drive controller is much more complicated than, say, the card reader system of the HP9810 or HP9820, it is quite straightforward to repair. One reason is that HP intended it to be repaired to component level in the field, and provided some very useful testpoints on the PCBs. The HP service manual for the HP9830 includes some information on troubleshooting this section, but it suggests you find the faulty board by boardswapping, which is something that I will never recommend.

Begin by pressing the rewind key on the keyboard. This will set U4a on the **Tape Controller** PCB (even if the reset input of this flip-flop is low, the Q output will be high while the rewind key is pressed). This will cause all 3 control signals to the **Motor Control** PCB to go low, The appropriate solenoid and motor should operate turning the supply side spindle. If not, then check that TP5, TP7 and TP8 on the **Tape Controller** PCB are all low. If not, troubleshoot the the motor control logic on the **Tape Controller** PCB. If these signal are all low, check the direction control logic on the **Motor Control** PCB to fund out why the solenoid isn't engaging or the speed control circuit on the same PCB id the solenoid operates but the motor doesn't.

Now take a scratch tape, and using an audio cassette recorder, fast-forward it off the clear leader. Put this in the HP9830 drive and press the rewind key again. The rewind flip-flop should now latch on, the tape should rewind to the leader and stop. Problems here can be caused by the rewind flip-flop, U4 on the **Tape Controller** PCB, the end-of-tape logic on the **Tape Interface** PCB, or the EOT sensor itself. It is also worth checking that **CassSw** is high, If the microswitch in the tape drive is not properly detecting the cassette, U4a's reset input will be kept low.

Next initialise the tape in the usual way. The forward drive should now engage (on the **Tape Controller** PCB, TP5 should be low and TP7 and TP8 high). If these signals are incorrect, check if **TapeSel** (on TP2 on the **Tape Controller** PCB) is pulsing high. If not, check the selection logic on the **Tape Interface** PCB and if necessary the **CEO** signal logic on the **I/O Interface** PCB. If **TapeSel** is pulsing high, check U10, U8 an the **Tape Controller** PCB.

If the motor control signals are correct but the tape motion isn't, again investigate the **Motor Control** PCB as described above.

While the tape is initialising, the write signals should all be active. Check **WrClk** on TP10 of the **Tape Controller** PCB, write data on TP9 and **WrMark** on TP10. If they are all missing, check that the write clock oscillator is running (TP1 is the output of this circuit). Also check that the bit counter and the data shift register are working correctly. Moving to the **Read/Write** PCB, the BMS-encoded data can be checked on TP2 and TP3. Unfortunately the 5V supply to the write buffer on the **Tape Head** PCB is not available on a test point but it may be worth checking that this is present if you have problems with writing.

If you get an error suggesting that the tape is write-protected, the first thing to check is the write protect microswitch on the tape drive itself. Mechanical switches cause a lot more problems than electronics!

If you have a printer, next try listing the tape. This will check the read function. During this you should see transitions on TP6 and TP7 of the **Read/Write** PCB (if either is missing, check the read amplifiers and the head itself) and then check there is **RdClk** on TP10, **RdData** on TP4 and **RdMark** on TP9. If these are correct but the listing operation fails, check the data shift register and associated control logic on the **Tape Controller** PCB and the flag logic on the **Tape Interface** PCB.

If you don't have a printer, try saving a short program to the tape. At the start of the save operation, the system reads the file headers from the tape and thus the read signals can be checked during this time. Then try loading the program back in, if this works, the tape system can be considered to be operational, if not, the fault is probably on the **Tape Controller** PCB around the data shift register or the **Tape Interface** PCB around the data flag logic.

3 Beeper

The beeper is simple to troubleshoot. Perform some operation that causes an error, and which therefore should cause the beeper to sound. If it does not, check the **CROut** signal from the **I/O Interface** PCB is being asserted, if not, check the source of this signal. If it is, check U12 on the **Tape Interface PCB** is changing state.

Then check that the oscillator U15a and U15b is running, and that during the beep a square wave appears on the output of U15d. Finally check the loudspeaker driver transistors and their associated components.

Final Comments

Now all the electronic and mechanical sections of your HP9800 calculator have been repaired, all that remains is to complete the reassembly.

In an HP9830, refit the **Display** PCB fixing screw and check that the tape drive and expansion ROM unit are screwed in place. In an HP9810 or HP9820, check that the card reader and printer are screwed down. Refit the keyboard, hooking the bezel behind the printer paper guide if appropriate, and fit the 4 fixing screws on the underside of the machine, starting with the 2 nearest the back which screw into the metal pillars on the keyboard.

Do one final check of the machine's operation before refitting the PCB hold-down bars in an HP9830 and the top cover.