Servicing the Philips CD104 CD Player

Mike Leach

The Philips CD104 compact disc player has been around in various guises since the mid-Eighties. Amstrad for example used the basic machine in some midi systems while Mission put it in a smarter looking box. In addition to machines that come into the workshop with specific faults, some can come in because they have been part-exchanged for a more recent model and require certain checks and adjustments to ensure reliable operation before being resold. The purpose of the following notes is to provide guidance on basic servicing and some of the fault conditions likely to be encountered.

Layout

One excellent feature of these machines is the general design and layout. There are various PCBs that are all separate and pluggable. This can help when there's an awkward fault since it's easy to interchange boards with those in a working machine. As I've said on previous occasions, we're all allowed to cheat occasionally. In this connection it's particularly helpful that each board does a specific job, e.g. power supply, decoder, servo, tray control, laser preamplifier etc. In contrast most modern machines have just about everything mounted on a single PCB which has several surface-mounted chips interconnected by very fine print. Thus if you have limited experience of CD players the CD104 is an ideal machine to practice on – provided you gen up on the Philips single-beam laser and tracking system that's used instead of the usual Japanese three-beam laser with sled drive.

Fig. 1 shows a basic block diagram of the CD104. It illustrates the way in which the various functions are split up between the boards. It's worth noting at this point that the focus and radial motors are both incorporated within the laser assembly.

The first thing you see when you remove the top cover is the servo board. It can be hinged up after removal of the two torx ten screws to give easy access to the decoder board beneath. To gain access to the component side of the decoder board and the laser preamplifier board the bottom cover has to be removed. The tray control PCB is mounted alongside the servo board at the top of the machine while the control/display board is on the front panel. Fig. 2 shows the PCB layout.

You can run the machine on its side when fault finding. I don't recommend this however as it's all too easy to press the open/close button by mistake and jam the disc in the carriage mechanism. If it happens to be a Philips test disc you say goodbye to £35 straight away.

Circuitry and Abbreviations

Before delving into particular sections of the machine it's worthwhile familiarising yourself with the terms and abbreviations that Philips use. This helps you to understand what's going on between the various chips, particularly those in the decoder section. These terms may seem to be of little consequence at the moment if you don't have a circuit diagram to hand: if you do have a circuit take a quick look at it and pick out some of the terms listed below.

Basically each chip has a particular function and name. For example the decoder PCB has on it a demodulator (DEMOD) chip, an error-correction (ERCO) chip, an interpolator (concealment, interpolation and muting – CIM) chip, a filter (FIL) chip and two digital-to-analogue converter (DAC) chips. Each chip has to "speak" to others, and in most cases each data line has its own abbreviation. Thus the data line from the demodulator to the error correction chip is called the DADE signal line – it stands for Data from Demodulator to Error correction chip. Some of the main data lines relevant to routine fault finding are listed below. You may find this list of help when you take a look at the circuit diagram for the first time. Since it's difficult to print inversion bars, where relevant we'll precede the abbreviation with a slash (/).

/CLDE = clock from DEMOD to ERCO chip.
/CLEC = clock from ERCO to CIM chip.
CLOX = clock output from the CIM chip (system clock).
DADE = data from the DEMOD to the ERCO chip.
/DEEMPH = de-emphasis.
DLCF = data (left) from the CIM to the FIL chip.
DRCF = data (right) from the CIM to the FIL chip.
FSDE = frame sync from the DEMOD to the ERCO chip.
FSEC = frame sync from the ERCO to the CIM chip.
HF = h.f. input to the DEMOD chip (eye pattern).
HFD = h.f. detector for demodulator.
MCES = motor control from the ERCO to the SERVO chip (turntable motor).
/MUTE = mute signal.
UNEC = unreliable data flag from the ERCO to the CIM chip.

These lines are generally easy to find on the various panels – in most cases you can go to one pin of a particular chip.

The Laser Unit

The laser unit used in these players is pretty reliable. Some years back when I was at Serviscope we had to replace some of them but on the whole not many. In recent times they've proved to be very good, unlike the later type used in the CD150/160 series machines. Tolerances may change with age however, and the laser supply should be checked in every machine that comes into the workshop. It's possibly a good idea to adjust the laser supply only when you are sure that it's wrong or been got at by a broddler. If the machine is not spinning the disc for example or has some other fault, try to explore all other possibilities first or you could end up with two faults instead of one. I usually check the laser supply once the machine is basically working.

The official, accurate way of checking/adjusting the laser supply, laid down in the Philips service manual, is as follows: Insert the Philips test disc no. 5, part no. 4822 397 30096 (the disc without defects). Connect a d.c. voltmeter across R3308 on the servo PCB or between the emitter of transistor 6239 and the earth line. Play track one and adjust R3180 for a voltage reading of 575mV ±75mV.

That's fine if you have a Philips test disc. But many workshops don't. So we need to find a reasonably accurate

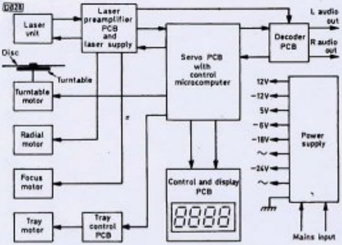

Fig. 1: Basic block diagram of the Philips CD104.

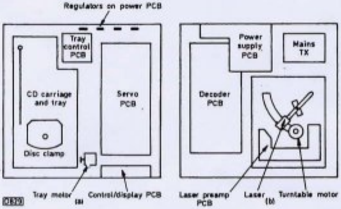

Fig. 2: Top layout (a), bottom layout (b).

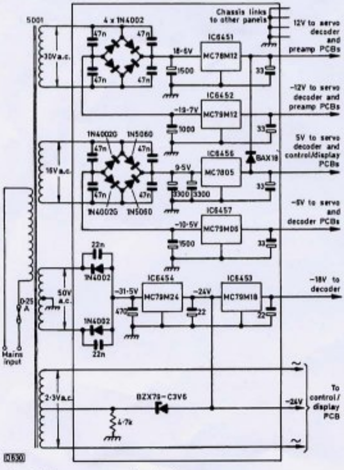

Fig. 3: The power supply circuit.

way of setting the laser supply in the absence of this disc. When a machine has been set up and is in good working order the r.f. eye pattern at pin 7 of the SAA7010 demodulator chip on the decoder board is, with the test disc, at approximately 1·4V peak-to-peak. On most other discs you'll find that this waveform is at approximately 1·2V p-p. So with most domestic discs it's a good idea to set the r.f. waveform to 1·2V p-p. I stress that this is only a rule of thumb, but I've found it to be reasonably accurate.

One thing that can have a significant effect on the laser supply is the cleanliness of the lens. Quite often you can check the supply and find that it's in the region of some 300mV. Clean the lens and you're quite likely to find that it has risen to 400mV. Try this with the next machine that comes into the workshop. So remember, always clean the laser before adjusting its supply.

Power Supply

Fig. 3 shows the power supply circuit used in the CD104. As with most CD players, there are no frills. Basically just straightforward 78 and 79 series regulators and a couple of bridge rectifiers. The power supply does however give rise to a few problems, mainly because of dry-joints rather than component failure. The bridge rectifiers seem to be adequately rated and seldom give trouble. There are no switched supplies, so voltage checks can be made without a disc in the tray. It's best at this point to work with the machine on its side and the bottom cover removed and no disc in the tray. Before you try to locate the cause of a power supply fault note that when the player is switched on and no disc is inserted a normal working machine will show only two dots in the left-hand side of the display window.

The following is a list of some of the power supply faults you could encounter:

(1) Display lights normally (two dots in the window) but the tray moves extremely slowly and when it's fully loaded the disc doesn't spin. Check the MC78M12 12V regulator 6451 which could be faulty or dry-jointed. If the voltage on the 12V line is low check for a fault on the servo panel. The 12V supply feeds the servo, decoder and laser preamplifier panels.

(2) Display lights normally. Very loud hum is present and the disc doesn't spin. Check the −12V line. The MC79M12 regulator 6452 could be defective or dry-jointed.

(3) No functions and no display. Check the 5V regulator 6456 (MC7805).

(4) Display o.k. but no laser light and the disc doesn't spin. Check the −6V regulator 6457 (MC79M06).

(5) Display lit dimly. All functions o.k. but no sound. Possibly a low noise in the background. Check the −24V regulator 6454 (MC79M24).

(6) All functions o.k. but no sound. Check the −18V regulator 6453 (MC79M18). (See also decoder faults.)

If there's a power supply fault you'll usually find yourself with one of the conditions listed above. I've never had to change any of the smoothing capacitors so I can't comment on faults that could be caused by the electrolytics.

The Decoder

Most incorrect sound symptoms are due to a fault on the decoder board. Fig. 4 shows a simple block diagram of the decoder and the basic data lines. The decoder is obviously far more complex than this, but it does show that when the fault is confined to one channel you can start at the SAA7000 CIM chip and follow through to the relevant audio output stage.

The h.f. signal (eye pattern) from the laser preamplifier board enters the SAA7010 demodulator chip at pin 7. This chip performs various functions. It supplies demodulated data and timing signals to the SAA7020 error correction chip and subcode information to the subcode processor chip on the servo panel. The EFM (eight-to-fourteen modulation) decoder is also in the demodulator chip. The data output (DADE signal) is taken from pin 27 from which it goes to pin 5 of the error correction chip.

The SAA7020 error correction chip is responsible for deinterleaving and unscrambling the off-disc data signal. It detects and corrects small data errors. It also generates the MCES (turntable motor control) signal which stabilises the input data rate via the turntable motor servo system, thus eliminating wow and flutter. The UNEC signal that appears at pin 36 is known as the unreliable data flag: this signal warns the CIM chip that unreliable data is on the way

The SAA7000 CIM chip unscrambles the data and separates it into the left and right channels. By means of interpolation it replaces small errors with good audio data – when it comes to unreliable data it replaces this with good data taken from adjacent information. The interpolation system enables the CIM chip to conceal error bursts of up to 12,304 bits. The left and right channel outputs appear at pins 13 and 15 respectively.

Next comes the SAA7030 digital filter chip. Left and right data enters this chip at pins 20 and 17. The chip contains two identical filters which have a sampling rate that's four times the digital audio sampling frequency, i.e. 44·1kHz times 4 = 176·4kHz. This helps to filter out any unwanted frequencies that don't form part of the original audio signal. The outputs at pins 3 and 10 are fed to the two digital-to-analogue converter chips.

The TDA1540 is a 14-bit mono DAC: it has a 14-bit input shift register with output latches. Input is at pin 1 and output at pin 22. Following the DACs the signals are once again in analogue form. From here they go to the player's audio stages.

Decoder Fault Finding

By now it's common knowledge that the decoder suffers badly from dry-joints. The fault symptoms can be varied, the most common one being no TOC readout. On occasions I've had to repair a machine that has obviously been soldered up before. So a good job is required. It can take some time to do properly.

If the machine powers up and spins the disc but doesn't read the TOC the most likely cause is dry-joints on the earth-through connections on the decoder and servo panels. The most efficient cure is as follows. Note the small solder blobs on the decoder and remove the solder from both sides of the panel until a small hole can be seen through the board. Insert a thin piece of tinned copper wire through the hole. Solder well on both sides of the panel. If the solder bubbles up, it's likely that not all the original solder was removed. Although this is time consuming I've found that this is the most effective method of repairing these earth-through connections. The same job must be done on the servo board.

It's good policy to carry out this soldering even when the machine works all right – it's a good base from which to start. These drys can cause many fault symptoms. If you still have say a no TOC fault after soldering up you can forget about drys and get down to the nitty gritty as it were.

I've had to replace the SAA7010 demodulator chip on a couple of occasions. In each case the disc spun very fast and of course couldn't read the TOC. A quick scope check on the eye pattern at pin 7 of the chip can tell you quite a lot. For instance is the waveform clean? Is it approximately 1·2-1·4V peak-to-peak? If the waveform appears to expand and contract, the turntable servo could be at fault. Fig. 5 shows the turntable spindle waveform at pin 4 of the error correction chip. You may find that this waveform contracts slightly with each revolution of the disc. Two transistors, 6233 (BC635) and 6234 (BC636), on the servo board drive the turntable motor. They rarely fail. It's always worth a solder up here as part of routine servicing. More on the turntable servo when we get to the servo board – and more on TOC problems.

The cause of a one channel dead fault is usually on the decoder board. The first check to make ought to be on the reed switches in the audio output stages. The TDA1540 DAC chips rarely fail, but always check the −18V supply to these chips at pin 11. If the −18V regulator chip IC6453 on the power supply panel fails the supply can go high or low. I've had this supply rise to about −23V and affect one channel only, making the relevant DAC suspect. Thus if one channel is missing or distorted, always check this supply.

The one channel missing fault can also be caused by the CIM and filter chips. Follow through the data lines with a scope as described earlier (Fig. 4). I've had both these chips fail and can't say which is the more common fault.

The surface-mounted resistors and capacitors on the decoder panel don't seem to give any trouble. Failure of any of these is unlikely though there's always a first time.

I've never known the SAA7020 error corrector chip or the associated RAM chip IC6512 fail and would put them at the bottom of the list of suspects in the event of an unusual fault.

If the player appears to work only when pressure is applied to the decoder or servo board and all relevant dry-joints have been resoldered there's a good chance that the cause of the problem may be to do with the crimped leads at the edge of the relevant board. The boards themselves rarely suffer from cracked print but the various plugs can be suspect. Be careful of these.

The Servo Board

One of the most common faults is no TOC readout. Rarely do CD104s skip and jump like most modern players. A fault on the servo panel can also be responsible for the no TOC symptom. All three servos – turntable, focus and radial – are on the board, under the control of a microcomputer chip. This chip, IC6201, can vary from player to player though you will usually find that it's an MAB8440-D041 (or -D061). Some players were fitted with the -D034 version which gives the no sound symptom in service mode B – more on this later. Fig. 6 shows a simple block diagram of the servo systems on the board.

Service Modes

A fault in any of the three servos will give the no TOC symptom. Use of the service mode enables the servo systems and the display PCB to be checked. Service loop A provides a check on the focus and turntable servos plus the display section of the machine. Service mode B switches on

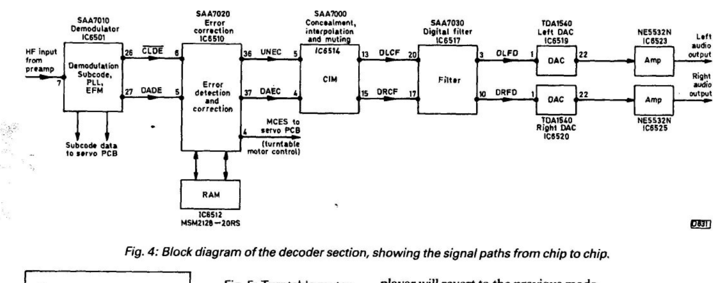

Fig. 4: Block diagram of the decoder section, showing the signal paths from chip to chip.

Fig. 5: Turntable motor spindle waveform (MCES). Scope settings 50μsec, 0·1V per graticule division.

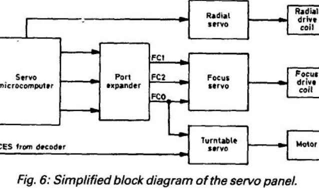

Fig. 6: Simplified block diagram of the servo panel.

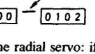

Fig. 7: The display in service loop A: the play bar can be seen between the two sections of the display.

the radial servo: if the player is left in this condition for a minute or so music can be heard. Although not essential, it's a good idea to scope pin 7 of the SAA7010 demodulator chip on the decoder board when you try the service mode. You can then look at the eye pattern and see the waveform differences at each level of the service mode: as the servo systems are turned on in the service mode the eye pattern changes.

For service loop A, proceed as follows. Place a disc in the machine: tray closed, mains off. Press stop, next and pause simultaneously and switch on the mains supply. You should see the eye pattern start to appear, but blurred. At this stage the laser and focus control are working and the turntable should be rotating. The laser will stay permanently under the lead-in section of the track. Numbers should be visible in the display: they will start at 00 – 0102 and increase, shifting to the left.

Now press the search reverse key for approximately one second. The error, repeat and pause LEDs will light. The play bar in the display (see Fig. 7) will light. The radial servo is switched off. If search reverse is pressed again the player will revert to the previous mode.

To use service loop B, first obtain service loop A. Then press search forward for approximately one second. The pause and error LEDs light and the play bar will go out but the repeat LED will stay on, indicating that service loop B has been found. The r.f. eye pattern will have become clearer. The radial servo has now been switched on, irrespective of the subcode and P bit. Music will be heard after about a minute. This may vary depending on the length of the run-in section of the track. As the music is played a normal r.f. eye pattern will be seen.

That's it. Quite an easy service mode really. If play is pressed while music is playing in service loop B the player will leave the service mode and revert to normal operation. Two bars will appear in the display's left-hand window. If play is pressed again the machine will play normally.

Note that if the servo microcomputer chip is type MAB8440-D034 music will not be heard in service loop B. To obtain music, the mute line to pin 39 of the ERCO chip must be interrupted and linked to the +2 supply line (5V). Most of the players I've come across have type -D041 or -D061 micros however: both allow music to be heard in the service mode.

This is all very well with a working player. But what we're interested in is a player that doesn't work and for one reason or another the service loops can't be found. What to do?

In the service manual several pages of arduous test procedures are set out to determine which section of the player may be faulty when a service mode can't be reached. We've neither the time nor the space to cover all this, so we'll keep to first-line servicing and possible causes of problems, based on my own experience.

Let's assume that the player won't read the TOC and that the decoder and servo panels have been checked for dry-joints and the supplies are in order. We'll also assume that the machine won't initiate service loop A and worked all right prior to the onset of the fault condition, also that nobody has tampered with the player. Four questions need to be asked:

(1) Is the laser producing light?

(2) Is the laser producing enough light?

(3) Does the laser focus?

(4) Does the turntable rotate?

If the answer to any of these questions is no, the player won't initiate service loop A.

If there's no light, check the laser supply. If this is o.k., it's very likely that the laser is faulty. If light is emitted, check with the laser power meter. I've found that good working players give a reading in the region of 0·1mW. If the reading is significantly lower than this, again suspect the laser – but try cleaning it first!

If the objective lens doesn't move up and down, check the focus drive waveform at pin 2 of plug 23 on the servo board and press play. The d.c. level should rise and fall three or four times. If this is o.k., check the connections on the h.f. preamplifier panel underneath the deck. Also check the flexi PCB connections to the laser assembly. If all is o.k. here, suspect a faulty laser assembly.

If the drive waveform isn't present at pin 2 of plug 23, check the waveform at pin 1 of the MC1458 chip IC6208. Presence of the waveform at this point suggests a fault in the region of the focus drive transistors 6231/2, types BD135 and BD136 respectively. If there's no waveform at pin 1 of IC6208, check the supplies at pins 4 and 8. If these are o.k., check the FC1 and FC2 waveforms at pins 13 and 12 of the HEF4094B chip IC6202. Also check the FCO (focus control on) waveform at pin 14 of IC6202. Absence of this waveform will affect the focusing – the objective lens will rise only very slightly. The absence of this waveform will also stop the turntable rotating, which is part of service loop A. The FCO line should be at 5V in the stop mode and 0V in play or TOC. If there are no waveforms at pins 12, 13 and 14, suspect IC6202 or possibly the servo microcomputer chip IC6201.

Turntable Servo

Turntable servo faults are rare. If a turntable servo fault is present the cause is likely to be in the driver stage or the motor. The motor can seize up – I've had this one on several occasions. Fortunately it's easy to strip the motor down to service it. To do the job properly you'll need to remove the loading carriage to gain access to the turntable.

To remove the bottom half of the motor, just take out the torx 10 screws that hold the bottom bearing in place. The centre screw is for adjusting the turntable height: provided the locking paint on this screw has not been broken adjustment shouldn't be necessary. A small drop of oil on the long motor spindle and a small blob of grease on the bottom bearing should put a seized or noisy motor to rights. I always go through this procedure when skipping and jumping is the problem with a CD104, especially when the motor has become noisy, although again this is fairly rare.

If after servicing the motor you find that the turntable is still unstable or jumping and skipping are experienced, check the r.f. eye pattern to see if it's stable. The most likely cause of skipping is when the waveform is contracting to the right-hand side – you may find that the condition gets worse as the laser moves across the disc. If the waveform is stable the turntable servo is likely to be o.k. When the waveform is contracting, check by substitution the two 2V zener diodes D6261/2 in the turntable drive stage: also check C2220 (33μF) by substitution. You get very few faults in the turntable motor drive circuit which is generally speaking very reliable. If the waveform still contracts, replace the turntable motor.

Radial Servo

Fortunately the radial servo is also free of common faults: it's a very complicated circuit, and fault finding is difficult. Arriving at the diagnosis that the radial servo is at fault can itself be difficult. The service loop can be of use here. In service loop B the radial servo is switched on: if no music is heard after one minute the radial servo is likely to be at fault and a service manual will definitely be required. Obviously the radial drive transistors T6240/1 are suspects.

If a radial servo fault is present there's a good chance that the TCA240 chip IC6216 is defective. It's readily accessible, but a word of warning is required here – make sure that you obtain the correct chip. Recognising the number, I once dived into a scrap Philips VR2020 VCR which has a TCA240V on one of its subpanels. Beware of this: the V version is different and doesn't work in the CD104. When dealing with sticky faults in the servo system it's also worth trying a replacement servo microcomputer chip (IC6201) if you have one to hand.

The Mechanics

The CD104 has a very robust metal carriage which, unlike modern players, doesn't fall to bits or go out of sync. The tray in/out switches often need cleaning as part of a routine service, and of course the loading belt. The only item that's likely to break is the tray itself. I once had to replace a tray due to a customer's heavy-handed approach to fault finding! This item is easy to fit but not so easy to obtain – CPC eventually managed to get one for me. Presumably all mechanical and electrical parts should be readily available to those with a direct Philips Service account. Some useful part numbers are listed later on.

The disc clamp can also cause niggly problems. I've known one or two to be noisy, and in extreme cases the clamp can produce a skipping effect.

That's about it with the mechanics: no real problems here. Really the only time you may have to work on the carriage is when a player has been dropped or abused.

Summary

When all is said and done the CD104 is an extremely reliable, good-quality player. As a secondhand machine it's a far more viable proposition than one of the Japanese types from the same era. A reliable laser, accessible components, robust design and excellent sound quality combine to provide one of the best home CD players of the Eighties. If you've just taken one in as a part-exchange item and find that it doesn't work, hopefully this article will provide a clue and insight into fixing it.

Most of the major spares suppliers either have in stock or can still obtain any parts likely to be required. Here are some useful part numbers:

Tray	4822 444 40113
Disc clamp	4822 526 10261
Loading belt	4822 358 30335
SK2 in switch (tray in)	4822 276 10863
SK3 out switch (tray out)	4822 276 11277
Turntable motor	4822 361 20484
Play button (CD104/30)	4822 410 23971
Tray front	4822 443 40148
Reed relays (decoder)	4822 280 20115
TCA240 chip	4822 209 80629

Model CD304

Finally note that the Philips CD304 is in many ways similar to the CD104 but has remote control and other features. Many of the panels are not interchangeable with those in the CD104. The control and display board is completely different.