

CD or Not CD?

With all due apologies to W. Shakespeare, CD or not CD is no longer the question at most radio stations. The only question at this time is, "How many?"

Do you remember the first time you heard a compact disc being played? The sound was probably crystal clear and noise free. No clicks, thumps, bumps, rumbles, or other sounds that didn't belong. Just music, beautiful music. Right?

At least that's the way it was the first time I heard one. My only complaints were that there was so little material available on compact disc, and it was very expensive. Of course, the player was well over a thousand dollars.

Along with the beautiful sound was all the media hype about this fantastic new invention. We no longer had to worry about the record sticking, the stylus jumping the groove and skipping, dirt and fingerprints on the surface of the disc, and all the picky rules about handling and cleaning of records. All you would have to do is insert the disc in the player and enjoy the music. These wonderful shiny discs would even have track numbers, index numbers (optional) for less important points in the music, and accurate timing encoded on the disc. Some of the players would even show you the time remaining until the end of the track and the end of the entire disc. Even more amazing, they could hold more music than two sides of a standard LP! This was the answer to all the music listeners' problems.

Then reality set in. It was about a year later. The second time I saw a CD player in person we were evaluating it for use on the air. Software (the discs themselves) were still hard to find, but the promise was there of a bountiful supply as soon as the new pressing plants were in full swing. The manufacturer of the player provided us with a sample disc. We connected the player

to a console so we could listen to it. After fighting with a few grounding problems (this was a piece of hi-fi equipment after all) we got everything nice and quiet. In went the disc, the door was closed, and we waited. And we waited. And we waited. All we heard was silence. I looked at the machine, and the disc was not even spinning. After some further investigation, we came to the conclusion that the machine was defective.

A few days later another machine of the same type arrived from the manufacturer. We hooked this one up, inserted the disc, closed the door, and waited. HUM. That's right, HUM! This noise-free medium was full of hum. Stop the disc, and the hum goes away. Go to another track on the disc and there is no hum. Only track #1 hums. We listened to the LP version of the same recording. Sure enough, there is hum on the LP, too, but it is partially masked by the surface noise of the LP. So much for perfect reproduction.

We finally got some CD players on the air, and the sound was great. Then one day, in the middle of a piece of music, we hear this strange pinging sound. On closer inspection, we discover that the CD player is stuck, repeating the same bits over and over. Wait a minute! That's not supposed to happen, either. Another jolt of reality.

Perhaps your experiences with compact discs have not been as interesting, but I'll bet they were just as shocking. By now, most people realize that the compact disc is not a perfect medium, but one that is better than LP's in certain respects. Yes, the noise is lower, they may sound better (this is still being debated in some circles) and they sure are convenient. But they have their own set of problems that can be just as annoying, if not more so, than LP's. If you're not using CD's yet, check them out. In many places you can buy a player (maybe not a good one, but usable) for about \$100.

With a little shopping you can find discs as cheap or cheaper than LP's, and the sound is little more than amazing on a well-produced recording. More important, whatever your taste in music, it is being released and re-released on CD. Old classical, rock, jazz, and other recordings are being reissued on CD. If you missed them first time around, or were just too young to buy them, you can have another chance. There are even some newly released CD's that contain historic, but never before available material. But that's not on our subject.

Most radio stations are using CD's for at least some of their programming. A few are exclusively CD. If you are in charge of maintaining the equipment, and have any CD's in your system, you have undoubtedly encountered the "What's wrong with this equipment? They aren't supposed to do this!" complaint from your PD or GM. If your players have misbehaved, you have probably looked at them in wonderment, thinking to yourself, "why don't they give you anything to adjust on these things?" Let's look at some of the things that might happen and maybe we can figure out what to do with them.

The basic concept behind the compact disc is simple. Data is recorded on the shiny metallized layer of the disc as a series of pits. A laser shines a beam of light (possibly infrared) onto the disc and reads the variations in the light reflected to a sensor. These variations are then translated into a digital bitstream, which is in turn converted to stereophonic audio. Sounds simple enough, doesn't it? The problems come in when you notice that there is nothing to guide the light beam except the reflected light. Unlike an LP, there are no grooves. Not only that, but this digital stuff wants a steady bit rate, much more stable than you can do with a simple turntable. All of this requires some sophisticated electronics and mechanics to make it happen.

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When playing a disc, any dirt on the surface of the disc or defect within the disc may cause the light beam to be reflected somewhere other than the sensor. If the error is large enough, causing a long enough interruption in the data, the machine will get lost and not know exactly where it is. To alleviate this problem, the manufacturers have devised all kinds of clever schemes to correct and conceal the errors. However, if the dirt is large enough, nothing will be able to correct it. Since different manufacturers use different schemes for error correction and concealment, and the same manufacturer may even use different schemes in different models, different machines may respond differently to the same dirt or defect. If you have more than one brand of machine you have probably noticed this phenomenon. Supposedly the newer machines will be more tolerant of defects than the older ones, but there are no guarantees. Only a comparison with a number of defective discs will show which are better in this regard.

While dirt is the most common cause of mistracking, scratches on the disc can have the same effect. A radial scratch (one going from the center directly to the edge of the disc) may not cause any audible problem, since it will only interrupt for a few bits of data on each revolution. On the other hand, a scratch going around the disc, like the groove on an LP, is almost guaranteed to cause trouble, since it will interrupt a longer portion of the data and exceed the capabilities of the error correction circuitry. You can usually see any scratches in the surface of a compact disc by holding it up to a light so that you see a rainbow effect on the non-label side of the disc. Any ripples in this rainbow indicate a flaw in the surface of the disc and scratches will stick out like a sore thumb.

It is also possible for the disc itself to warp, much like an LP, if it is not stored correctly. Compact discs should be stored in the plastic jewel boxes in which they come. Some discs only

come in cardboard sleeves, and these should be replaced with a jewel box. If you need more boxes, they can be obtained from some of the broadcast equipment suppliers or from your local Radio Shack or record store. The discs in their boxes should be stored vertically on shelves, just like books or LP's. Do not pack them in so tight that you can't remove one, but make sure they are not leaning, either. Depending on your player, a warped CD may or may not play properly. Some players have very little clearance below the surface of the disc, and these will give you problems. Also, if the disc is very warped, the laser may not be able to track the variations in distance from the disc to the sensor.

Dust can also be a problem with the player itself. The lens of the laser and sensor (many times the same unit) should be kept free of dust. This can be cleaned with a lens tissue or a slight burst of air from a squeeze bulb such as are used on camera lenses. **CAUTION:** When cleaning the lens or working around the laser, be sure that power is off and the plug removed. These units are equipped with interlocks to prevent operation of the laser when open, but they may fail. Looking into an operating laser may cause permanent eye damage. You may have to remove the cover of the player or other parts to clean the lens. Consult your service manual, if you have one, as to the proper way to get to the lens.

Another area where dirt can be a problem with a CD player is in the mechanism. The laser tracks the disc from the center out, just the opposite of an LP. As the disc spins, a servo circuit maintains the speed of the disc at a constant linear velocity. This means that the rotational speed of the disc (RPM) will change as the relative position of the laser to the disc changes. The closer the laser is to the center of the disc, the slower the disc will rotate. The speed of the disc varies from about 500 to 800 RPM. Another servo circuit controls the position of the laser relative to the disc. This may be accom-

plished either by moving the disc or the laser assembly. Any dirt in any of these mechanisms may cause binding, which will result in skipping or hanging up of the disc as it is being played.

Some player manufacturers have an unfortunate habit of using some sort of grease on the gears of their mechanisms. With time, the grease becomes gummy and may cause the gears to bind. To reduce the amount of slop or backlash in the mechanism many players use split gears. If you look closely at these gears, you will find that they actually are made of two pieces with a small spring causing the teeth to mesh more fully than they would in a normal gear. I have found that the two sections of these gears will gum up and bind, causing the player to skip and mistrack. When you encounter binding in the mechanism, the only cure is to carefully clean all the old lubricant from the system and re-lubricate all the gears.

Complete cleaning may require partial disassembly of the unit. If so, be sure to do it carefully and in accordance with the service manual's instructions. There are some very delicate wires and parts in this area of most CD players. When lubricating the unit, be sure to use the proper oil or grease as suggested by the manufacturer. If you do not have access to this, a good hobby shop can suggest an appropriate lubricant that will not attack the plastics used in the player. A service person for one player manufacturer even suggested not lubricating the player, since the plastics used were slippery enough. I can't guarantee that this will work forever, but there would certainly be no grease or oil to collect more dirt.

The lasers used in CD players have been known to age and to fail. If you have a consistent problem with errors and cannot find a mechanical reason for it, you should check the laser output. This is usually done by measuring the current on the output of the optical sensor, which should be a good indicator of the light output of the laser. Some machines have adjustments for this,

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and if yours does, it should be adjusted. If you are out of adjustment range, the laser may need to be replaced. This can be an expensive proposition, so try to make certain that is the problem before you order a new one.

As I have already mentioned, there are a number of servo circuits in CD players. Typically there are at least three: one for disc speed control, one for laser position control, and one for laser focus. Some players may have more, but I don't know of any that have fewer. Servicing servo circuits is difficult, since whatever you do affects the entire circuit. It is very difficult to determine what is the cause of the problem and what is the effect. Do not attempt to service the servo circuits in a CD player without a service manual and the necessary instructions and equipment. You will probably need a special test circuit, a precise signal generator, an oscilloscope, and a special test CD to make the necessary adjustments, so be sure you have everything you need before you begin.

The digital bit stream from the optical detector is fed to the inputs of the various servo circuits through appropriate filters and wave-shaping circuits. Adjustments for these circuits include local oscillator frequency, detector sensitivity, gain, and other phase-locked-loop parameters. The error output from the phase-locked-loop is amplified and filtered to drive the motor (or laser positioning circuits) to make the necessary correction. Proper adjustment of these circuits will go a long way toward minimizing audible problems with your discs.

Most compact disc players have some other adjustments that should be checked if there are problems. These may include power supply voltages, laser current, and others. Again, check the service manual for the proper procedures.

Compact discs are pretty amazing. They can hold a lot of information in a small area. Unfortunately, the system is far from perfect. The digital bit stream

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coming from a typical compact disc is amazingly poor, with missing chunks of data and many other problems. The bit replacement, error correction, and error concealment systems in a typical player do such a good job that it sounds nearly perfect. It is a credit to the designers of the compact disc system that it works as well as it does. However, the time will come when it will not work. If so, the first thing you should check is for a defect in the disc or dirt on the disc. I have seen some that look like they were used as pizza plates, and these have lots of trouble working. If you have consistent problems with a number of discs in the same machine, look for dirt in the machine or a sticky mechanism. Then check the laser for proper output, if possible. Usually the last thing to fail is the electronics.

If you have eliminated all the mechanical possibilities, and do not have access to a service manual, you may want to send it out for factory service. If it is not an expensive machine, you may want to consider replacing it. Remember that the machine you can buy now for a given price is probably better than the one you could buy three years ago for the same price. If you don't have expensive machines, replacement may not only solve your operational problem, but it may sound better as well.

Finally, a few comments on the sound of compact discs. The compact disc system was never intended to be a super fidelity medium. The original intent was for it to be a low cost better fidelity medium than the LP. This would help get better sound to more people, and the compact disc has been very successful at this. However, many people will argue that the compact disc sounds harsh, bright, edgy, or any other number of complaints. I even heard one person present a paper at the Audio Engineering Society suggesting that digital sound caused undue stress on the human body. Needless to say, the discussions emptied the meeting hall.

Unfortunately, I was presenting the next paper and had almost no audience. While some of these complaints may be valid, many other claims are not.

There have been any number of "fixes" for compact disc defects suggested. Some of these may have some validity, but many do not and are simply a waste of money. If you understand how the compact disc system works, you will be able to determine which devices are valid and which are simply "snake oil." There are a number of books available which explain how the compact disc system works, and I would suggest that you buy one and study it. The best one I have seen was written by some people from Sony, but someone has walked off with my copy of this book and I do not know the title, author, or where to get it. However, the explanations of the theory, mechanics, and electronics are thorough yet simple, with good diagrams to help you understand the text.

You may not feel bold enough to venture into the world of compact disc player repair, but perhaps this will help you realize that it isn't all black magic.

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