

**Dynatek Automation CDE-
CDRW426YD**

**Dynatek Automation
CDM4120TD-G2**

**Hewlett-Packard CD-Writer
Plus 7200i**

Panasonic LF-1196 PD/CD-ROM

Philips PCA362RW Kit: CDD 3610

**Shuttle Technology Datawise
CDRW-PRO**

Sony CDU928E

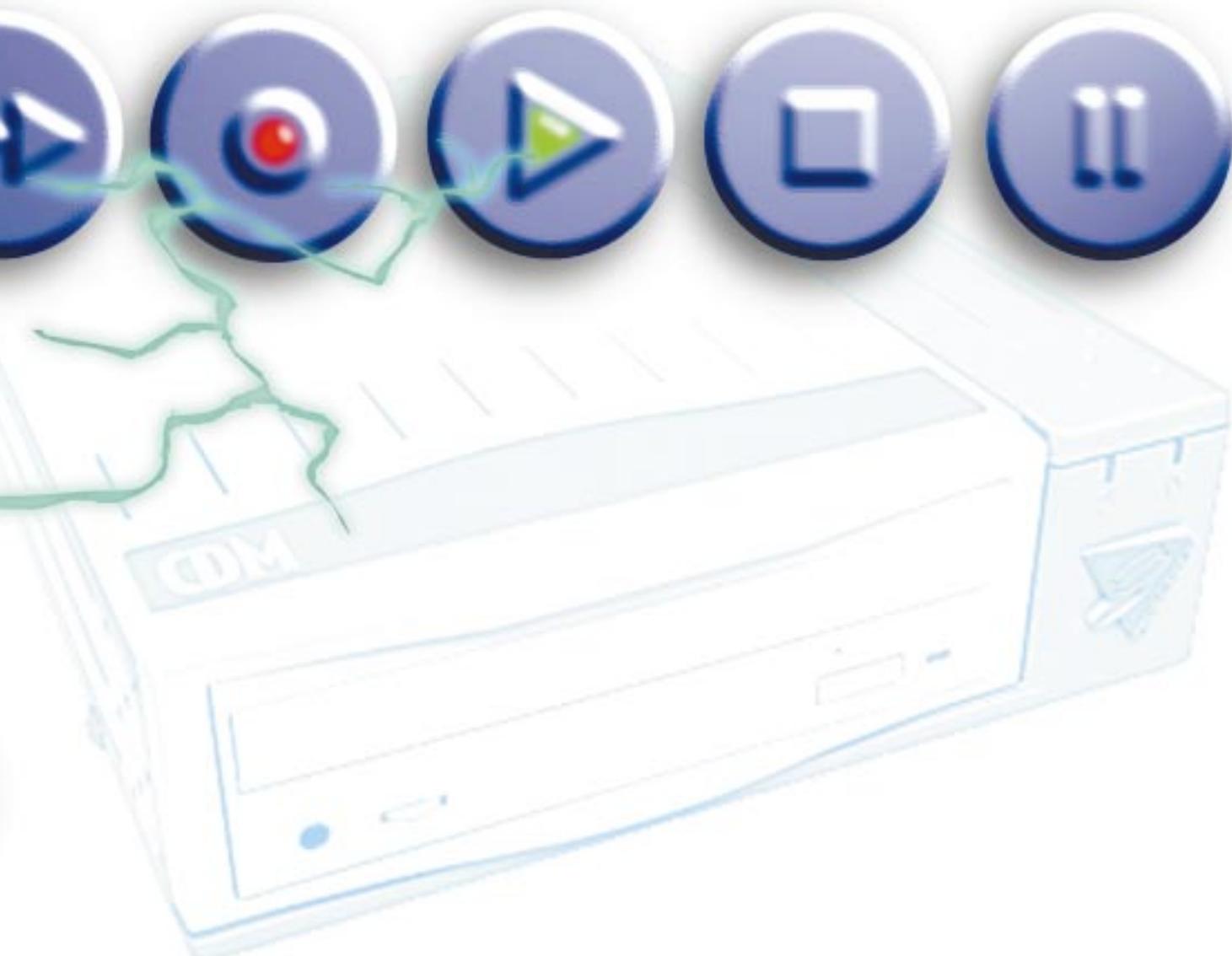
Yamaha CDRW-4260



Now you can make your own CDs – for as little as £250. CD writers are cheaper than ever before and have come within the reach of home users. We look at the latest models and compare the technologies involved



THE WRITE STUFF



Since they were first introduced, it's been easy to get used to having a CD-ROM drive in your PC. With a sound card and speakers you can use your machine to play back audio CDs, and most software now comes on CD-ROM. In fact, it's virtually impossible to find new games on floppy disk and though you can get hold of business software it's so much extra hassle - Microsoft Office takes up 45 disks - that a CD-ROM drive is close to being an essential.

But commercial CD-ROMs suffer one major disadvantage. They may hold a tremendous amount of data - some 650Mb per disc - but you can't change them or make your own. Nonetheless, it's now relatively easy to create your own CDs. It's not even too expensive, although you will need a bit of effort and some extra hardware.

What is a CD-R?

Mass-produced CDs, whether they're audio discs or the latest game, store data using tiny pits in the surface - for more details see the 'How do they work?' box on page 101. To create these

pits, they're manufactured in high-precision pressing plants, which mould discs by the thousand. Obviously, this is impracticable for small-scale use - a CD factory won't fit under your desk.

It was obvious that many people - musicians who want to create demo discs, or software developers who want to distribute a small number of beta copies, for instance - would find making their own CDs useful. So, in 1988, the CD manufacturers got together and wrote a standard known as the Orange Book. This set down a common specification which would enable CDs to be created using a different process more suited to small runs and desktop machines, yet still be read by normal CD players.

Rather than use pits, information is stored as areas of differently coloured dye. This gives CD-R (CD-Recordable) discs their traditional green underside, making it easy to distinguish them from the silver of commercial discs. You can write to CD-R discs using a laser rather than needing a press, and it can be done in a drive no bigger than a normal CD-ROM.

What's the difference between a CD-R and a CD-RW?

CD-Rs have the big advantage over CD-ROMs that you can write your own data to them. This makes them ideal for archiving data or keeping historical records, or for storing large files such as images. However, CD-R discs are a WORM medium. WORM stands for Write Once, Read Many, and means that once you have stored data you can't change it although you can sometimes add more.

While this is fine for archiving or for music purposes, it's no use at all if you'd envisaged using a CD writer as an extension of your hard disk. If you want to store little-used files on CD, but still be able to edit them as needed, you need a CD-RW. This stands for CD-ReWritable, and is yet another standard, though most up-to-date CD writers will also write CD-RWs.

This time, it's silver discs. Rather than pits or dye, these discs use a crystalline layer to store data. Once you've written to it, the laser in your CD writer can erase and overwrite your original files. Again, more details are in our box on page 101 but it's worth bearing in mind that



although they can read CD-Rs, not all CD-ROM drives can read CD-RW discs. A MultiRead badge on a CD-ROM (or DVD-ROM) drive is your guarantee of compatibility.

What is PD?

PD optical discs share many features with CD-RW, and a PD drive can read CD-ROMs. They use the same phase-change technology to record data, but the discs themselves are designed to include more precise positioning and formatting information. They come in cartridges rather than as loose discs, so can't be read in anything other than PD drives. Although they're inflexible in this respect, if you're after a disc for long-term use they may be a better choice than either CD-R or CD-RW.

CD-R discs are vulnerable to heat and deteriorate naturally. Though studies have shown that even the lowest quality discs are likely to last at least five years (and topnotch ones should still be readable after more than half a century), this may not be long enough for some purposes. CD-RWs are rated for up to 1,000 write-erase cycles, while PD discs can be rewritten 500,000 times.

What discs can I use?

No matter which type of drive you choose, you'll need to buy discs for it. CD-R has the advantage of using the cheapest discs. They're available from most of the same manufacturers as audio tapes, and they're cheap enough to be practically disposable. If you shop around you can find them for around a pound

each. Most discs will hold up to 680Mb or 74 minutes of audio, but more expensive ones with slightly higher capacities are available.

If you are using CD-RWs, you can choose to format the disc in several different ways. Depending on which you opt for, its capacity can range from just under 500Mb to the 680Mb of a CD-R. For this, you'll pay about £15. PD discs are available in capacities up to 650Mb, and are a bit more expensive again. Still, at around £20 they're still affordable.

Speed – is faster always better?

None of the drives we've looked at are fast compared to a hard disk. CD-ROM manufacturers don't help by quoting speeds like '4x' – the fastest write speed

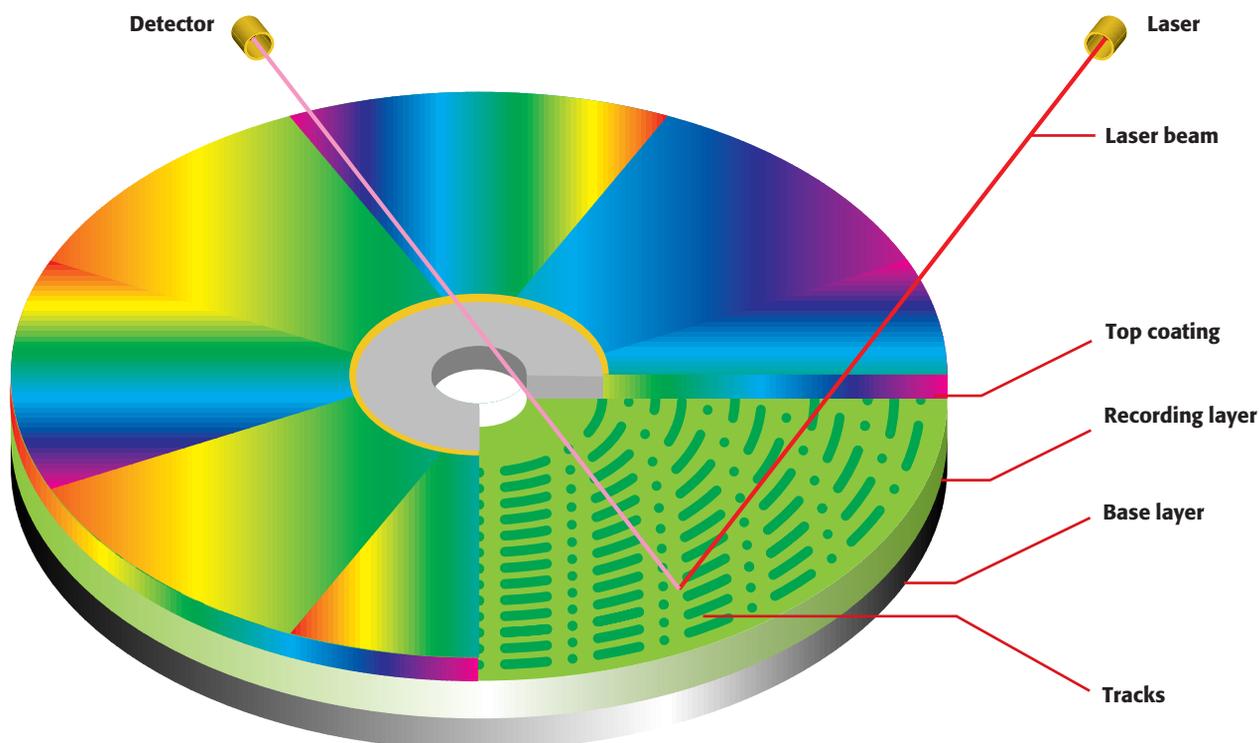
How do they work?

All computer data is digital, so it's stored as a series of ones and zeroes that, when read in combination, make up your information. A CD-ROM – or indeed an audio CD – stores the ones and zeroes as pits and lands (the flat surface of the CD) which are pressed into its surface.

Inside the CD player, a laser beam is shone at the disc – this is much more precise in a CD-ROM drive than in an audio CD player – and reflected back to a sensor. Depending on the intensity of the light reflected – a pit behaves differently to a land – the detector reports this as a one or a zero. As the sequence of bits in a track is read by the PC, it can start to process the data.

Rather than pits and lands, blank CD-Rs contain a layer of organic dye, as shown in the diagram below. When you 'burn' a CD, the drive shines a higher-powered writing laser at the disc. In the areas affected by this, the dye changes colour, and therefore reflectivity. It can now be read in the same way as a conventional CD-ROM.

CD-RWs use yet another means of recording the information. This time, instead of a dye, they contain a layer of material that crystallises when heated. As with a CD-R, the writing laser selectively heats particular areas. When crystallised, they reflect more light than the unaffected parts of the disc, but can be returned to their original state, erasing the information, by reheating.



What does the future hold? – DVD-RAM and its rivals

Good as it is for storing data, CD-R is already looking dated. Last month, we reviewed Panasonic's first DVD-RAM drive. As its name suggests, this uses rewritable DVD discs which have a much higher capacity than CD-Rs.

Like CD-RW and PD discs, DVD-RAM stores information on a phase-change layer that changes state when heated. As with PD, the discs are stored in a protective cartridge and have header information embedded in them. However, the capacity of DVD-RAM is much greater – 2.6Gb on a single-sided disc and 5.2Gb on a double-sided one.

Like a DVD-ROM, the tracks on a DVD-RAM disc are packed more closely together and the drive uses a red laser, with a shorter wavelength, to let it achieve these capacities. Single-sided (2.6Gb) discs can be removed from their cartridge to be read in conventional DVD-ROM drives. Differences in the error-correction protocol used mean you can't do this at the moment, but the changes needed are minor. The next generation of DVD-ROM drives should cope easily.

The Panasonic drive has the widest compatibility we have so far seen. It can read almost any format of disc, as well as writing to both DVD-RAM and PD. It's little more expensive than a CD-R and with such large-capacity discs we reckon that it's a winning formula.



However, it may soon be challenged by ASMO, DVD+RW and MMVF drives. DVD+ReWritable and Multimedia Video Format discs will offer around 3Gb of storage, while Advanced Storage Magneto-Optical promises up to 6Gb on each side of a disc. At this stage though, none of these drives seem to have made it off the drawing board – we look forward to seeing them.

you'll see in a CD-R drive. This refers back to the original CD-ROM specification, which called for a data transfer rate of 150kbits/sec. Accordingly, 4x is 600kbits/sec, which translates into the ability to transfer the entire contents of a CD-ROM in just under 20 minutes.

Logically enough, this is twice as fast as a 2x drive, but this extra speed can be at the expense of reliability. A CD-R written to the original standard, ISO9660, must be written all at once and so depends on getting its data in a constant stream, and the faster the drive the more rapidly it needs data. If the stream is interrupted you will waste a disc.

Fortunately, all drives come with a memory buffer to help guard against breaks in the data stream. It's only if the interruption is long enough to empty this buffer – known as a buffer underrun – that your write will fail, so you should look for a 2Mb buffer like that on the Yamaha drives. If you still have problems, perhaps because you have a slower PC, then you can always record at double or even single speed on a faster drive.

Interfaces – SCSI, IDE, parallel

The speed of a CD-R drive is partly dependent on how it is connected to your PC. SCSI drives are fastest, and are available as internal or external versions. However, you'll need to buy a SCSI interface card as well as the drive itself. SCSI has the advantage of taking some of the load of writing the disc off your PC's

processor, which reduces the risk of a buffer underrun.

IDE drives are more common now, and use the same interface as your existing CD-ROM drive and hard disk. They are very easy to install, but are only available for internal fittings. External parallel devices are the slowest because of the parallel port's own limitations. We'd be reluctant to buy one, but at least you don't need to mess around inside your PC at all.

Software

Although reading a CD-R is just like reading a normal CD-ROM, writing to it isn't as simple as dragging and dropping files to a hard drive or Zip disk. Windows doesn't support CD-Rs directly, so you need to use extra software. Fortunately, this isn't a hard decision to make. Nearly all the drives we tested came with Adaptec Easy CD Creator, which makes writing a CD little harder than dragging and dropping files in Windows Explorer.

If you like, there's a Wizard to walk you through the whole process, while upgrading to the Deluxe version gives you CD Spin Doctor as well. This helps you record from old records and tapes to CD while eliminating the crackles, and actually works quite well. There's also a test process. This 'writes' a CD virtually and checks whether you're likely to suffer a buffer underrun.

Even easier is a technique called

packet writing, which allows you to add files to a CD-R piecemeal. It needs still more software, with the leading packages being Direct CD from Adaptec and CeQuadrat's PacketCD. These allow you to drag and drop files to your CD-R just like any other drive. However, packet writing uses a different disc format to ISO9660 called UDF. UDF-formatted discs lose some capacity – they can hold just under 600Mb – and you need to install a special utility to read them. Fortunately, one can be downloaded free from Adaptec's Web site.

Copyright

Recording your own CDs, of course, opens up a whole new can of worms in terms of copyright. If all you want to do is make up your own discs of pictures you have taken or music you have written, or to back up your data, it's not an issue you need worry about. You own the copyright in your own files, and can make as many copies as you wish.

It's a different matter if you want to make copies of discs or music created by someone else. The Copyright, Designs and Patents Act 1988 protects the authors of computer software just as it would any other author, say of a book. Tempting though it might be to just run off a copy of Office for a friend, it's illegal. You may be permitted to copy software as a backup in case your original disc develops a fault, but this will depend on the terms of your licence agreement.



CD-Rs compared

Manufacturer	Dynatek Automation	Dynatek Automation	Hewlett-Packard	Panasonic	Philips	Shuttle Technology	Sony	Yamaha
Model	CDE-CDRW426YD	CDM4 120TD-G2	CD-Writer Plus 7200i	LF-1196 PD/CD-ROM	PCA362RW Kit : CDD 3610	Datawise CDRW-PRO	CDU9 28E	CDRW-4260
Price	£351.33	£351.33	£351.33	£233.83	£351.33	£413.60	£252.63	£399
Contact	01256 331111	01256 331111	0990 474747	0800 444220	0181 665 6350	0118 977 1588	0990 424424	01908 369259
Web site	www.dynatek.co.uk	www.dynatek.co.uk	www.hp.com	www.panasonic.co.uk	www.eu-philips.com	www.shuttletech.com	www.ita.sel.sony.com	www.yamaha.com
Interface	SCSI	SCSI	IDE	IDE	IDE	Parallel	IDE	SCSI
Int/Ext	Ext	Ext	Int	Int	Int	Ext	Int	Ext
Buffer size	2Mb	1Mb	1Mb		1Mb	1Mb	512Kb	2Mb
Write speed (claimed/tested)	4x/N/A	4x/3.6x	2x	2x/1.8x	2x/2x	2x/1.8x	2x	4x/1.9x
Read speed (claimed/tested)	6x/5.5x	12x/10.6x	6x	6x/5.4x(PD), 5.8x(CD)	6x/5.6x	6x2.3x	8x/7x	6x/5x
Rewrite speed (claimed/tested)	2x/N/A	N/A	2x	N/A	2x	2x	N/A	2x/1.9x
Media compatibility (write)	CD, CD-R, CD-RW	CD, CD-R	CD, CD-R, CD-RW	CD, CD-R, CD-RW, PD	CD, CD-R, CD-RW	CD, CD-R, CD-RW	CD, CD-R	CD, CD-R, CD-RW
Media compatibility (read)	CD-R, CD-RW	CD-R	CD-R, CD-RW	PD	CD-R, CD-RW	CD-R, CD-RW	CD-R	CD-R, CD-RW
Software supplied	Adaptec Easy CD Creator	Adaptec Easy CD Creator	Adaptec, Direct CD, Adaptec Easy CD Creator, Adobe Photo Deluxe, Corel PrintHouse, Norton AV	Drivers	Adaptec Easy CD Creator	Adaptec Easy CD Creator	CeQuadrat WinOnCD	Adaptec Direct CD, Adaptec Easy CD Creator, Adaptec Toast
Ease of use	N/A	★★★★	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
Performance	N/A	★★★★★	★★★★	★★★	★★★	★★	★★★★	★★★★
Value for money	N/A	★★★	★★★★	★★★★★	★★★	★★	★★★★	★★★★
Overall	N/A	★★★	★★★★	★★★★	★★★	★★★	★★★★	★★★★
Notes	Uses Yamaha CRW4260 mechanism	Uses TEAC CD-R55S mechanism				Uses Philips CDD 3610 mechanism		
Verdict	Would not write to CD.	An easy-to-use drive as long as you don't want to use CD-RW. The fastest read speed here.	A good-value software bundle – just a shame it is all installed whether you want it or not. The drive is fine.	Ideal for robust backups as long as you don't need to write CDs.	The same price as most drives here, the Philips is adequate but does not stand out.	The parallel interface may be convenient but makes this drive very slow.	Uses a slightly awkward caddy loading system. The data buffer is too small for confident use.	A good choice if you want the extra speed and flexibility of SCSI. We were impressed by the large buffer.

★ = Poor ★★ = Below average ★★★ = Average ★★★★ = Good ★★★★★ = Excellent N/A = not applicable

Copying music for personal use is another matter again. Clearly, copying CDs and taking them to your nearest car boot sale is illegal, but what about making a second copy of a disc you already own or transferring an old LP onto CD, perhaps so you can play it in the car? This is a grey area where copying is probably technically illegal, but may be covered by 'fair use' provisions in the Act. At *What PC?*, we'd have no moral problems with copying LPs or making up or own compilation CDs, provided that we already owned the discs.



Our favourite of all the CD-Rs that we tested for this report is the Yamaha CDRW-4260. It boasts a fair read speed, good 4x write speed and can write to CD-RWs as well.

A large 2Mb buffer means you are unlikely to waste CDs due to buffer underruns, and its SCSI interface will not put you off if you are serious about creating your own CDs. Just remember to budget for an interface card as well as the drive.



Hewlett-Packard's 7200i is a respectable choice if you want the simplicity of an IDE drive. It has an excellent software bundle and good documentation, though we could not pick and choose which packages to install. For a long-term backup solution we'd also suggest Panasonic's LF-1196. Because so few other people will be able to read its PD discs it falls short of an award, but it is a fine choice for extra durability.

John Sabine