Addressing Schemes for Optical Discs

- Subcode
- Sectors
- Sector Address
- Recordable Media
- Re-Writable
- Wobble
- Pre-Groove
- ATIP
- Archimedes Spiral
- Land Pre-Pits
- Sector Address Headers

All optical discs containing digital data have some sort of mechanism to allow a player to determine where the data is located. This is what is meant by the term 'addressing scheme'.

The very first digital optical discs, CD Audio, use an addressing scheme known as subcode.

Subcode

Subcode is the term given to the addressing scheme for the Compact Disc family including CD-Audio, CD-I, CD-ROM etc. Alongside the main digital data is a separate stream of data containing a timecode. In simple terms this timecode represents the play time of the disc which, based on a CD-Audio starts at 00:00:00 and increases as the disc plays. The subcode addressing scheme counts in units of minutes, seconds and frames where there are 75 frames in every second.

When CD-ROM was devised as a means of storing data other than digitised audio on CDs, an additional addressing scheme was devised which was more appropriate to data storage. Data on CD-ROM (and variants such as Video-CD, CD-I etc) is grouped in blocks called sectors and each sector has a unique number called the sector address. Similar sectors are employed by the DVD family.

Sectors

The term sector generally refers to a block of data in a data media such as CD-ROM or DVD-ROM. CD-ROM and DVD-ROM sectors comprise typically 2048 bytes although a variety of other sizes are possible. A player will access data on a sector-by-sector basis and each sector has an associated sector address.

Sector Address

The term sector address refers to the unique numeric label which is identifies data sectors in data-based optical disc formats.

The basic addressing schemes of using subcode and sector addresses to identify data on optical discs is only partly applicable to recordable media or re-writable media such as CD-R or DVD-RAM. These media also require some sort of low-level addressing scheme in order that players can access un-recorded discs.

Recordable media

The term recordable media usually refers to optical discs on which data can be recorded once but not reased. Recordable media do not generally need to have data recorded at a single time; rather data can be added at any time but never erased. Examples include CD-R and DVD-R.

Re-Writable media

The term re-writable media usually refers to optical discs on which data can be both recorded and erased. There is generally a limit to the number of re-write cycles (e.g. typically 1000 times for CD-RW). Examples include CD-RW, DVD-RW, DVD-RAM, DVD+RW, MiniDisc and other Magneto Optic formats.

The low-level addressing schemes used on CD-R and CD-RW are identical and involve applying time code data to the un-recorded disc. The time code is in basically the same format as the subcode used to address all CD formats (i.e. minutes, seconds and frames). This time code is applied by modulating the wobble signal in the pre-groove using a scheme termed ATIP (Absolute Time In Pre-Groove).

Wobble

The term wobble refers to the usually sinusoidal deviation of the pre-groove track on formats such as CD-R, CD-RW, DVD-R, MiniDisc etc. The pre-groove is not a perfect Archimedes Spiral, rather it is 'wobbled' in a sinusoidal fashion. The player detects this wobble from the un-recorded disc and uses it to lock precisely onto the pre-groove track. The amplitude of the wobble is generally very small compared to the track pitch (e.g. about 30 nanometres) and can be a fixed frequency (e.g. for DVD-R) or modulated (e.g. for CD-R).

Pre-groove

Many pre-recorded and re-writable formats employ a pre-mastered continuous spiral groove which the player uses to lock on to the track. The recorded pits are then written either in or below this groove.

ATIP

ATIP is Absolute Time In Pre-groove, the addressing scheme for CD-R, CD-RW and Mini Disc. These formats employ a wobbled pre-groove where the wobble is digitally modulated with time code data and other disc information. The time code data is in the minutes:seconds:frames format. The wobble signal is Frequency Shift Keyed with a carrier frequency of 22.05Khz and a deviation of 1KHz.

Archimedes Spiral

The sprial of optical discs is known in mathematical terms as an Archimedes Spiral. That is a spiral that increases in diameter linearly with increasing radius. The interval between turns of the spiral is called the track pitch and this is nominally constant for most optical disc formats (e.g. for DVD it is fixed at 0.74 microns). The length of such a spiral is given by the following relation: For an Archimedes Spiral starting at radius R1, ending at radius R2 with turns separated by the track pitch TP, the length L is:

L = (pi / TP) * (R2*R2 - R1*R1)

The DVD-R and DVD-RW formats employ a low-level addressing scheme known as land pre-pits in addition to a constant frequency (unmodulated) wobbled pre-groove. These formats can only be

mastered with a dual-beam recorder where one beam is used to master the wobbled pre-groove abd the other beam the land pre-pits.

Land Pre-Pits

Land pre-pits are pre-recorded pits written on the land area between the continuous (wobbled) pre-groove of DVD-R and DVD-RW. In these formats the pre-pits are precisely phase-aligned with the positive peak of the wobble groove detected by the player and their relative positions is modulated according to the data recorded. In DVD-R and DVD-RW, the land-pre pits are modulated with disc information and sector address information.

The DVD-RAM format uses yet another low-level addressing scheme. DVD-RAM is designed for high speed random access in computer data applications and employs pre-mastered zoned sectoring somewhat akin to hard disks with addressing performed through the use of sector address headers.

Sector Address Headers

Sector address headers is the term used to describe the low-level addressing scheme employed in DVD-RAM. DVD-RAM uses land-groove recording with wobbled pre-grooves and pre-mastered EFM+ data pits offset by +/- 1/2 a track pitch. These pits contain the sector address data and are preceeded by a preamble of continuous pit/land modulation which is intended to help the phase-lock loop in the player lock onto the EFM+ data.