



An Introduction to Zen TrueX™ Technology

Masters of the Drive™

Marketing Whitepaper

March 25, 1998

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Introduction

The purpose of this document is to provide a general understanding of the high performance optical disc technologies developed by Zen Research. This document provides some background on Zen Research, identifies trends in the optical drive market, and compares Zen TrueX™ technology to current standards.

In order to understand Zen's philosophy it is important to realize certain facts about the optical drive market today, and the opportunities Zen has identified within that market. Zen has based its marketing strategy on the following three premises:

- First, that today's standard disc media is an effective, low cost medium that has been widely accepted in both the consumer electronics and computer industries;
- Second, that although disc media is capable of tremendous capacity (especially with the advent of DVD), it lacks the performance required to successfully run applications directly from the disc without first caching to the hard drive; and
- Third, that the current performance measurement for CD and DVD, the X-rating, confuses the market by depicting variable speed ratings and inflated performance claims.

Based on these three premises, Zen Research has create Zen' s TrueX™ technology, the ONLY technology that delivers extremely fast performance at a constant rate ANYWHERE ON THE DISC.

Drives employing Zen' s TrueX component set

- use industry standard disc media and leverage the capacity and low cost of that medium;
- deliver unparalleled performance that can enable a new class of applications with the ability to run directly off the disc without any hard disk caching; and
- provide consumers with a “true” measurement for performance against which all drives can and should be compared.

About the Company

Zen Research N.V. is a privately held parent company of a multinational group of companies that produce high performance CD-ROM and DVD optical drive components. Zen has an affiliate in Tel Aviv, Israel which boasts a large multi-disciplinary research and development team. Zen's United States affiliate is headquartered in Cupertino, CA

Through technological innovation and revolutionary component design, Zen Research has developed TrueX™ technology which dramatically improves optical disc drive performance. The company has been awarded 10 patents on this core technology, with another 17 pending or in process

Zen Research's mission is to deliver the world's highest performance optical drive components (for CD-ROM and DVD) in the world, through technological innovation and revolutionary product design of components and software.

The Products/Technology

Zen Research develops technology and components that enable optical drive manufacturers to build high-speed CD-ROM and DVD-ROM solutions under the "TrueX™" label. Zen also offers Zen Tools™, optimization software which enables developers to create CD/DVD titles that can take full advantage of Zen TrueX enabled drives, while complying with industry standard recording formats. Zen Tools will be available for free download by commercial software developers who agree to license it, via the Zen Research web site.

Taking the Market by Storm

Zen's strategy is to propagate cost effective, high performance CD and DVD technology. Zen Research changes the way consumers use permanent storage devices like hard disk drives and CD-ROM drives by allowing access to applications and data directly from the CD, reducing installation time and storage costs while managing version control.

Optical Drive Technology/Market

Optical Drive Performance Trends

CD-ROM performance has enjoyed a steady increase from 1X in 1991 to 32X in 1997. Despite DVD's debut in 1997 at 1X speed (equivalent to 8X CD speed), the majority of consumers are still choosing the faster CD-ROM drives over DVD.

DVD has not taken off as quickly as many had predicted last year. In fact most research firms that are following the CD/DVD-ROM market have substantially revised their predictions regarding DVD adoption for 1998 and 1999, to predict a healthy continued growth for DVD.

Another prevailing conception is that the industry as a whole has reached a transfer rate has “capped out” at 32X. The reality is that not only has the ceiling not yet been achieved, but the preponderance of drives in the market today do not live up to their advertised “X ratings”. Conventional CAV (Constant Angular Velocity) drives, which comprise the bulk of models on the market today allow for a maximum speed of 32X or higher, but only on the outermost tracks. Data read from the inner tracks of a disk, where most of today's software is located, is only read at a mere 12-16X. For this reason, there has been significant amount of negative press and analyst reaction.



What the Press is Saying About CD-ROM Drive Performance:

“They...(32X drives) generally obtain the 32X speed only on a disc’s outer tracks– which is why manufacturers rate the drives as, for example, 14/32X. There’s a catch, however: Data rarely fills the outer tracks, so drives rarely read 32X.”

– *PC World, February, 1998*

“PC vendors are shipping ‘16X’ drives not because they’re faster but because they want buyers to think so... More honest (drive makers) label theirs ‘16X Max’. ...Forget a CD-ROM’s X rating. A drive’s advertised speed doesn’t always reflect its true performance.”

– *PC Computing, June 1997*

“For those with the need for speed, an ATAPI 24X speed CD-ROM is the only antidote, right? Wrong! While manufacturers push these potent peripherals like street vendors hustling swag– hyping quality and wielding fancy terminology– these 24X drives don’t deliver.”

– *boot magazine, October 1997*

“If you’re expecting a 24X drive to give you double the performance of a 12X drive, think again. In fact, none of the beta-model drives we tested lived up to expectations.”

– *Windows Magazine, November 1, 1997*

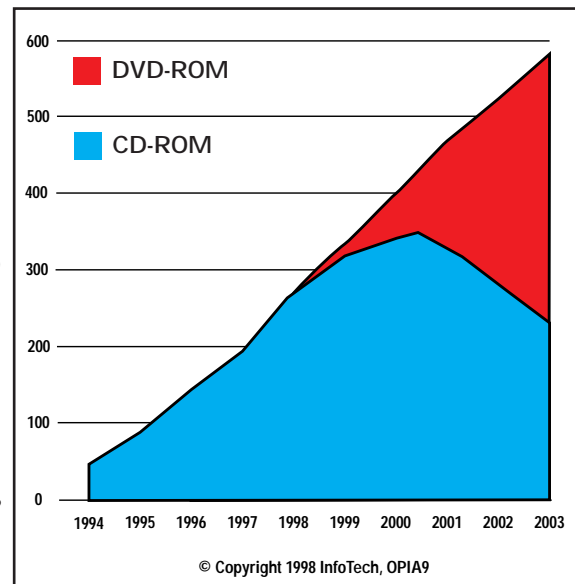
CD-ROM Market

CD-ROM performance and sales have enjoyed significant growth over the past 10 years, with an estimated 195 million plus CD-ROM drives installed worldwide, according to a recent report by InfoTech Research. The installed base of CD-ROM will peak after the year 2000. However, CD will continue to dominate the CD/DVD ROM market until after the year 2002.

DVD-ROM Market

The DVD-ROM market has gained popularity, with most consumer electronics manufacturers promising to support DVD. However, deployment has been slow and will not likely ramp up until more DVD titles are available towards the end of 1998 and beginning of 1999. At year-end 1997, there were a mere 60 DVD ROM titles, as compared to 46,000 CD-ROM titles in print, according to the InfoTech report.

Worldwide CD-ROM / DVD-ROM Drive Installed Base, 1994-2003

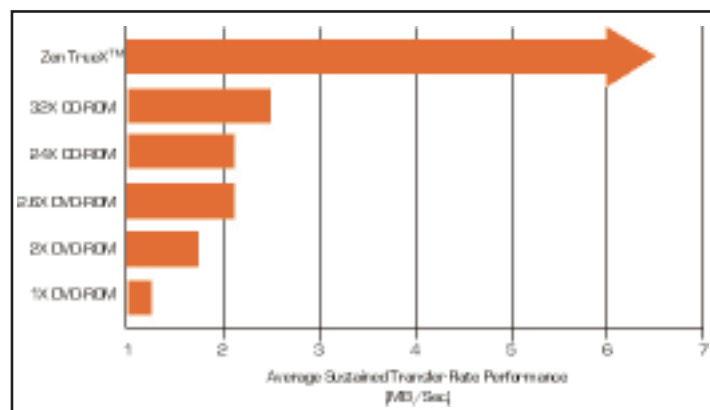


Price/Performance

CD-ROM prices have consistently decreased while performance increased, leveling off at 32X, which is really only 14-17X on average. Zen TrueX enabled CD-ROM drives will significantly boost performance, extending the usefulness of CD-ROM technology for many years. Zen will also apply TrueX technology to increase the performance of DVD products.

Narrowing the Gap Between Storage Devices

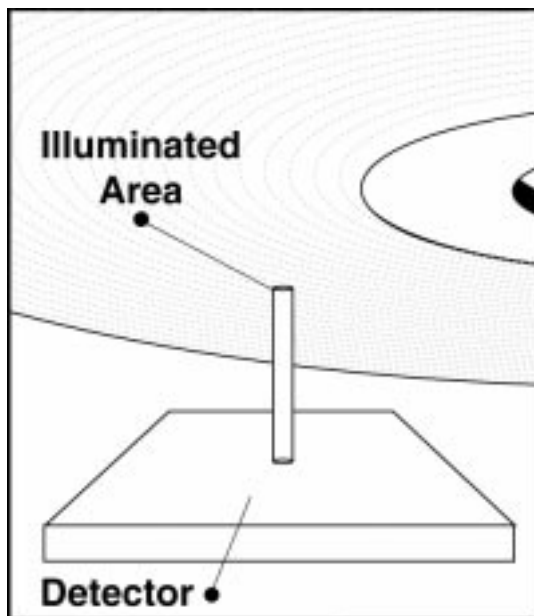
Zen's TrueX technology addresses transfer rate and access times that currently limit CD-ROM on today's PCs. Reading and processing two tracks simultaneously doubles the transfer rate. Reading ten tracks increases the rate tenfold— that's over 6Mbytes/sec at 4x speed, for example.



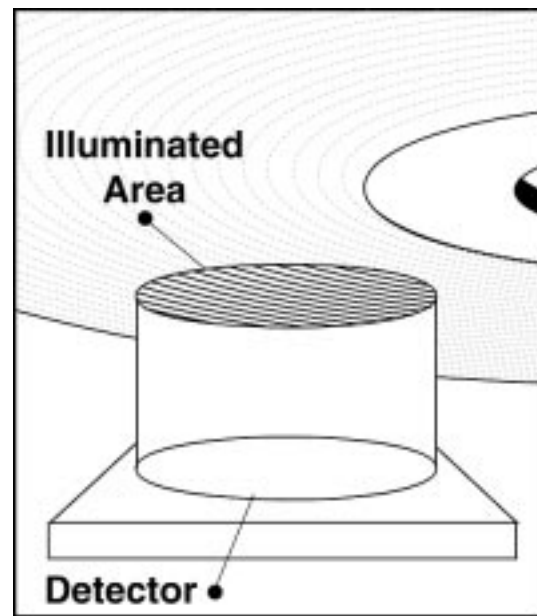
Introduction to Zen TrueX Technology

Today, CD and DVD-ROM drives use a highly concentrated laser beam to read the digital signal that is encoded onto tracks of very small pits that have been stamped onto the disc surface. The laser beam is directed at a single track of information, which forms a continuous spiral on the disc. Variations (data pits) on the disc surface cause variations in the reflected laser beam, which are detected by an optical sensor. The disk drive rotates the tracks under the laser and the result is a stream of serial data that can be transferred to a processor for interpretation.

Conventional CD-ROM



Zen TrueX CD-ROM



Rather than directing a narrow laser beam at a single track of serial data on a CD or DVD-ROM disc, the Zen approach illuminates multiple tracks, detects them simultaneously, and reads them in parallel.

The format of the disc media is unchanged and remains industry CD or DVD standard. The mechanical elements of the disk drive are not changed substantially. Disc rotation and read head motion remain essentially the same. Zen technology can be applied to CLV (Constant Linear Velocity) and CAV (Constant Angular Velocity) disc rotation systems. Zen chooses to apply its technology to CLV rotation systems, in order to deliver constant rates across the whole disc. In either case, higher data rates are achieved at lower, more disc-tolerant rotation speeds.

The Zen TrueX Advantage

Zen's advantage is gained through reading multiple tracks simultaneously, and by processing the data through a custom ASIC. To understand how this works, it is important to understand the following three areas of Zen TrueX technology:

- **Multiple Beam Illumination**

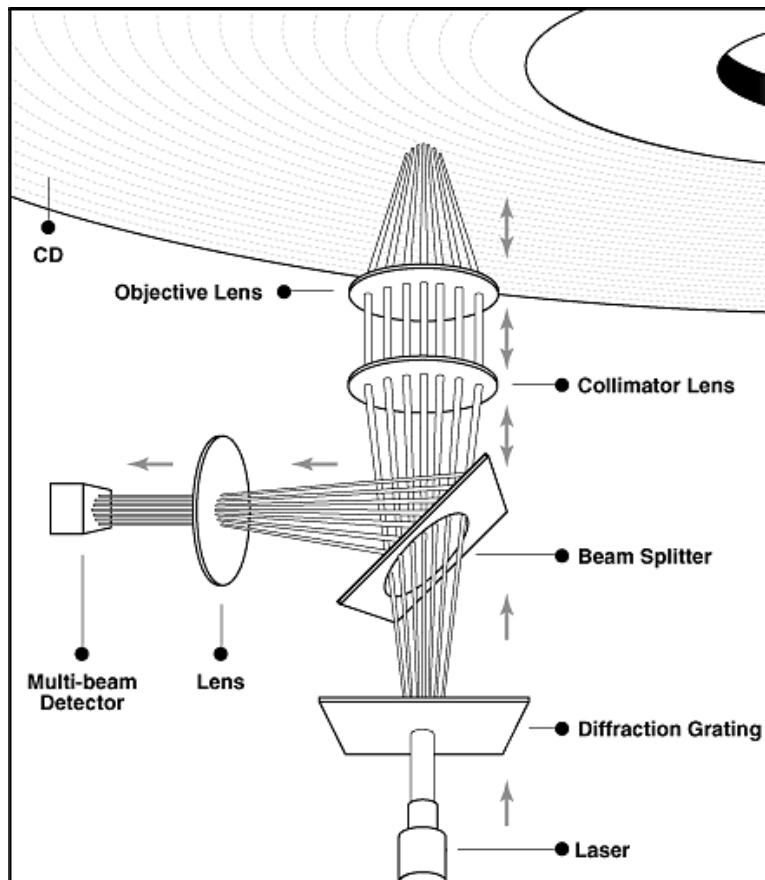
Reads multiple tracks on media concurrently

- **Broad Beam Illumination**

Reads a wider area on media concurrently

- **Parallel Processing ASIC**

Multiple Beam Illumination



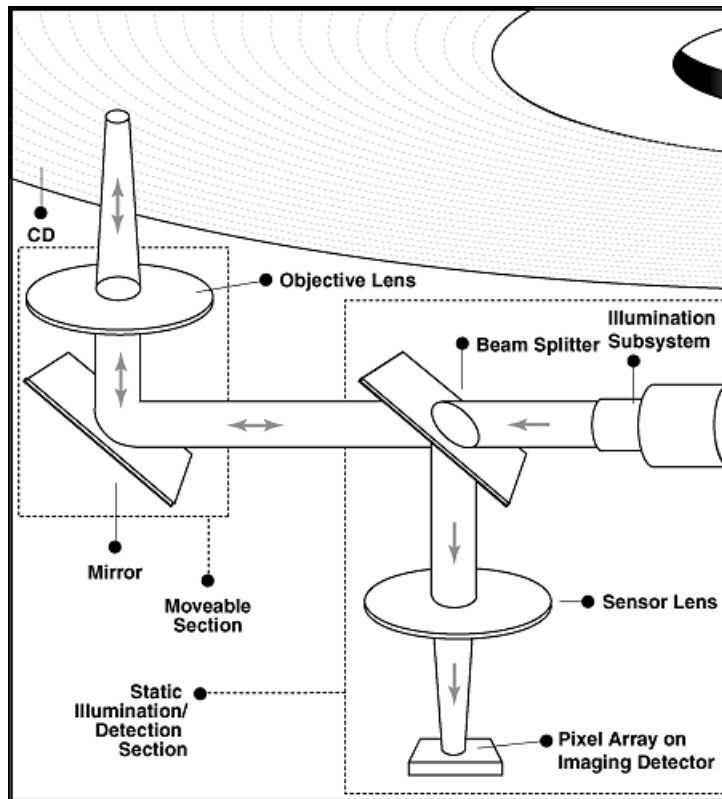
How it Works

The Multiple Beam approach to illuminating and detecting multiple tracks uses a diffracted laser beam in conjunction with a multiple beam detector array. A conventional laser diode is sent through a diffraction grating which splits the beam into seven discrete beams, spaced evenly to illuminate seven tracks. The seven beams pass through a beam splitting mirror to the objective lens and onto the surface of the disc. Focus and tracking are accomplished with the central beam. Three beams on either side of the center are readable by a detector array as long as the center is on track and in focus.

The reflected beams return via the same path and are directed to the multiple beam detector array by the beam splitter mirror. The detector contains seven discrete detectors spaced to align with seven reflected tracks. Conventional detectors are also provided for focus and tracking.

This design uses a conventional approach to tracking and seeks. Performance is far greater than that of conventional drives while maintaining lower, more disc tolerant rotational speeds.

Broad Beam Illumination

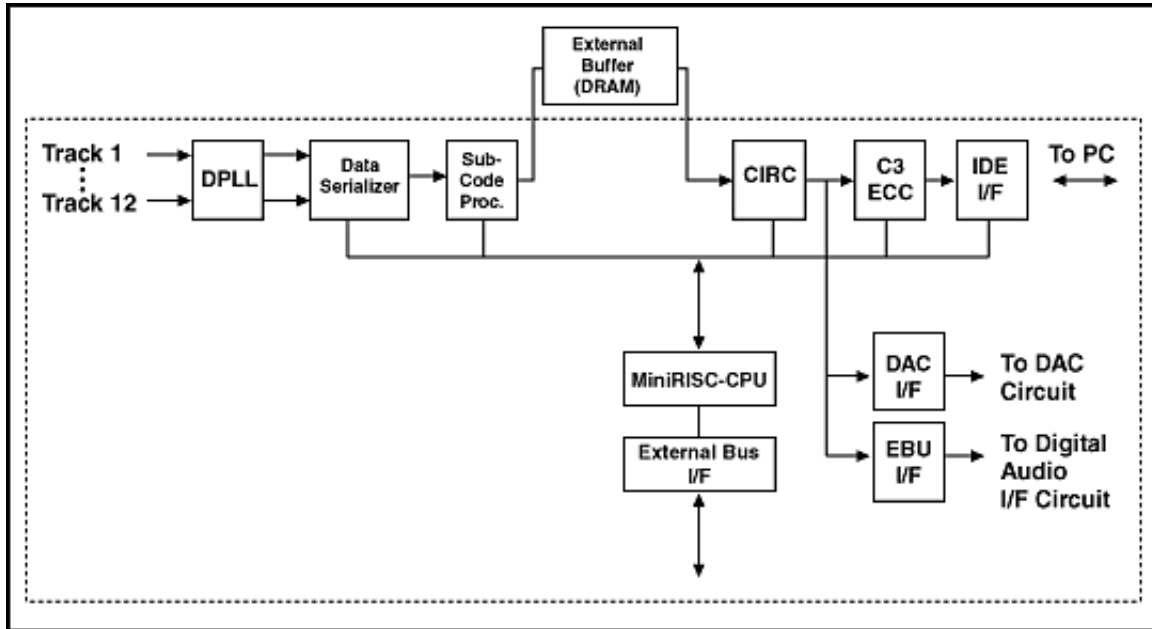
**How it Works**

The Broad Beam Illumination design deploys a wider incoherent laser beam to illuminate several tracks at once, as compared to conventional CD-ROM drives that read a single track at a time. Also the split head design in TrueX drives, allow the movable portion of the pickup to be separated, reducing weight and decreasing access times.

The static illumination/detection section provides a broad incoherent light beam that is projected through a beam splitter onto the movable head section. A mirror directs the illuminating beam, focused by the objective lens, toward the disc surface. The beam reflects back from the disc surface toward the detector by the same mirror. The reflected beam travels its original path to the beam splitter, which turns the reflected beam towards the detector, through the sensor lens and onto the surface of the detector.

The use of incoherent laser light to illuminate the disc surface reduces the interference patterns that develop when coherent light waves strike a surface. Incoherent light provides a clean, more accurate image of the disc surface on the detector, reducing errors and increasing performance.

Zen Parallel Processing ASIC



How it Works

The Zen ASIC is a common element, present in both the Multiple Beam and the Broad Beam designs. This single ASIC processes the higher volume of data read by each of Zenís read methods. It integrates analog interface elements, DPLL, DSP servo-motor controller, parallel to serial data converter, data decoding and error detection/correction, ATAPI interface and a CPU. Provisions have been made to allow the connection of an external SCSI or 1394 interface chip if required. The DVD product will include different data format and error detection areas.

Enabling New Applications for CD-ROM

Run applications directly from Zen TrueX CD drives–

By narrowing the transfer rate performance gap between CD-ROM and hard disks, users can now run applications directly from the CD, eliminating the “installation” process time. This kind of performance enables software developers end users to run applications directly off CD ROMs as opposed to cluttering their hard drive.

Entertainment/Education Titles–

By offering near hard disk performance from CD-ROM, users can run multimedia game and educational titles directly from CD without performance degradation and unnecessary hard disk utilization.

Internet enhanced by CD–

By narrowing the performance gap between dial-up access to the Internet and CD-ROM transfer rate, Zen TrueX™ drives will allow content providers to distribute complex data to Internet users via CD-ROM, eliminating the need to access the “World Wide Wait” for frequently used data.

Interactive/multimedia video–

The increased speed of Zen TrueX drives allow interactive CD-ROM applications to be delivered without compromise in image size or frame rate, as required by conventional CD-ROM.

Features	Technical Benefits	User Benefit
Parallel Pick-Up	<ul style="list-style-type: none">• Reduced rotation speed• No disc speed “kick-downs”	<ul style="list-style-type: none">• Quieter• Constant data rate• Improved reliability
TrueX	<ul style="list-style-type: none">• Breaks today's performance ceiling• Hard drive-like performance• Sustained transfer rate across entire disc• Developers do not have to optimize for minimum transfer rate (i.e. 4X)	<ul style="list-style-type: none">• “As Advertised” performance• Faster games and multimedia content• Smoother playback, full-screen video, high frame rate• Users benefit with or without developer modification

Conclusion

By pioneering advancements in optical components, Zen Research will not only break the performance barriers of conventional CD-ROM and DVD-ROM drives but also put truth and accuracy back into CD and DVD ratings with its TrueX sustained ratings.

By incorporating Zen's TrueX technology, CD and DVD drives will read multiple tracks concurrently, without faster rotation. This increases performance and the quality of the data.

Zen's patented **Parallel Processing ASIC**, will allow CD and DVD drives that support **TrueX**, optimal data transfer rates through its advanced integrated signal processing and error correction circuitry.

Finally, **Zen Tools**, will allow software developers to record CD and DVD media across ten tracks to take advantage of Zen's multi-track access, while maintaining industry standard recording methods.

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