HDD Roadmap

HDD Capacity, GBytes

Availability Year

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Hitachi Global Storage Technologies
HGST Areal Density Perspective

Production Year

Areal Density Megabits/in²

1st Thin Film Head

3375

25% CGR

1st MR Head

Deskstar 16GP

100% CGR

Travelstar 80GN

Deskstar 180GXP

Travelstar 30GN

Microdrive II

Ultrastar 146Z10

Future Areal Density Progress

Perpendicular Recording

Superparamagnetic effect

1st AFC Media

HGST Disk Drive Products

Industry Lab Demos

HGST Disk Drives w/AFC

Demos w/AFC

IBM RAMAC (First Hard Disk Drive)

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Hitachi Global Storage Technologies
Areal Density of Magnetic HDD and DRAM

DRAM projections after 2001 are based on industry capacities and constant chip area.

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Lithographic critical feature roadmap for GMR heads and semiconductor IC

Year of Production

Critical Feature (umeters)

IC Features
IC Gate
P2w
IC General
Head Features
GMRw

Robert Fontana

San Jose Research Center

Hitachi Global Storage Technologies
Evolution of Magnetic Read/Write Sensors

1970
Ferrite Inductive MnFe Read/Write Head
Wire wound coil
Machined Pole Pieces
Gap Width Controlled By Films And Assembly Tolerances

1980
Thin Film Inductive Write
Coil, Pole Geometries Controlled By Semiconductor Type Process
NiFe Poles
Two Contact Structure

1990
Thin Film Inductive Write
MR Read Head
Write Wide-Read Narrow
Four Contact Structure
SAL
NiFe MR Film

1997
Thin Film Inductive Write
GMR Read Head
Write Wide-Read Narrow
Four Contact Structure
Pinned, Free Films
Antiferromagnetic
Exchange Film
CIP Operation

>2003
PerpendicularThin Film Inductive Write
CPP Read Head

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<th>Year</th>
<th>Areal Density Gbits/in²</th>
<th>Product</th>
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<td>1991</td>
<td>0.132</td>
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Evolution of Slider/Air Bearing Surface

1975
100 % Mini
Ferrite Slider
Machined Rails
Wire Wound Coils
Glass Bonded Core
LxWxH 4x3.2x0.86 mm
55 mg mass

1987
70 % Micro
TiC/Alumina Slider
Machined Rails
Taper Flat
Thin Film Head
2.8x2.24x0.6 mm
16.2 mg

1990
50 % Nano
TiC/Alumina Slider
Etched Pattern
Tri-Rail
MR Head
2.0x1.6x.43 mm
1.6 mg

1995-1997
50 % Nano
TiC/Alumina Slider
Etched Pattern
Tri-Rail
MR/GMR Head
1.25x1.0x.30 mm
1.6 mg

2003
20 % Femto
TiC/Alumina Slider
Etched Pattern
GMR Head
0.85x0.70x0.23 mm
0.6 mg

Abs3y.cdr

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Hitachi Global Storage Technologies
Magnetic Disk Media Trends
Areal Density/Disk Coercivity Evolution

AFC Media in Red

Server Data Regression Line
Slope = 1.0

Range of Possible Future Values

- **Server**
- **Desktop**
- **Mobile**

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A Magnetic Media Roadmap

Areal Density, Gbits/in\(^2\)

Product Ship Year

- Conventional Longitudinal Media
- AFC Longitudinal Media
- Perpendicular Media
- Patterned Media
- Range of Future Values

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Longitudinal Recording

Perpendicular Recording

Recording Technologies

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Spacing-Areal Density Perspective

- Lab Demos
- 2.5 inch Mobile HDD
- 3.5 inch Server HDD
- 3.5 inch Desktop HDD

Head/Media Spacing, nm vs. Areal Density, Gbits/in² graph with various data points for different HDD types.
Physical spacing and disk surface evolution

- Ultrastar 36ZX
- Ultrastar 36XP
- Ultrastar 18ZX
- Ultrastar 18XP
- Ultrastar 2XP
- Ultrastar XP
- Travelstar 36GT
- Travelstar 18GT
- Travelstar 6GT
- Travelstar 6GN
- Travelstar 18GN
- Travelstar 3GN
- Travelstar 30GN
- Travelstar 40GN
- Travelstar 80GN
- Travelstar 146Z10
- Travelstar 73LZX
- Travelstar 30LZX
- Travelstar 80LZX

Key features:
- Magnetic Spacing
- Slider Overcoat
- Magnetic Element
- Recession
- Physical Spacing
- Overcoat
- Magnetic Film
- Disk Substrate
- Lube

- Textured Disk
- Smoother Disk

- Server Products-3.5 Inches
- Mobile Products-2.5
- Lab Demos

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Magnetic Hard Disk Drive Internal Data Rate

Data rate = Linear Density x RPM x Disk Diam.

3.5 inch Server Products
40 % CGR

2.5 inch Mobile Products

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Server HDD Access/Seek Time
Performance Increase

Accessing
Seeking
Rotating

seek time \(\sim\) (inertia/power) \(1/3 \times\) (data band) \(2/3\)
rotational time \(\sim\) (RPM) \(-1\)
(latency)

Availability Year

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As specified MTBF, khrs.
Advanced Storage Roadmap

Superparamagnetic Effect

Enhanced Magnetic Disk Drive

Advanced Storage Technology

Area Density, Gbits/in²

Availability Year

130 Gbits/in²
106 Gbits/in²
63.2 Gbits/in²
35.3 Gbits/in²
20.3 Gbits/in²
12.1 Gbits/in²
5 Gbits/in² Demo
3 Gbits/in² Demo
1 Gbit/in² Demo
10 K RPM Integrated Head/Suspension
Giant MR Head/Pico Slider
Ramp Load/Unload, Glass Substrates

Lab Demos
3.5 Inch FF
2.5 Inch FF
>10 Inch FF

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