Greatest Performance Hard Drive (G-Drive)
-- Partial Specification --

Henry V. Pham

The **Greatest Performance Hard Drive** (**G-Drive**) with **Patent application number**: '**PCT/US21/72563** w/ **PCT/IB2021/000961**' which **was submitted** on **2021/11/23** is invented to provide the greatest performance for storage hard drives in real life systems with **RDMA** (**R**otation **D**ivision **M**ultiple **A**ccess) technology. The **Cloud-OS** was invented with the **RDMA technology** to allow each user has a chance to access their data on every rotation of the hard drive disk. This invention will introduce the new Hard Drive with new Geometry Disk Layout, dual CPUs, and dual Actuators with additional Writer Port to provide the Hard Drive with greatest write and read performance. The G-Drive will have three controllers; the main controller will communicate with the host and control the other two actuator controllers. The main controller will pass the host read and modify commands to Actuator-1 controller, and pass the host write commands to Actuator-2 controller. The Actuator-1 controller will handle the read/modify commands from host. The Actuator-2 controller will handle host write commands data to the outer SMR temporary zones (25% outer LBAs), then both controllers will manage and organize the data to their target locations when they have a chance. This will improve the random operations performance close to the sequential operations. Each actuator controller has its own CPU to control its Actuator for Servo heads and arms moments. The G-Drive will have additional LED flashing at a fix position with a Photo Sensor to track and count every rotation of the disk. This LED feature will help the Servo Controller to seek to a specific location, Sector, Track or Zone faster and more accurate. The G-Drive disk will be divided into **36 clove Rotational Zones**, and the data disk space will be divided into **16 Radius Zones** within the Data Radius with the same space from each other. This 16 Radius Zones create **16 Circular Tracks**; these tracks will be the **Radius Sector Info Tracks**. With this Geometry Disk Layout and the LED at 0° degree of the disk, the G-Drive will perform greatest seeking to any location, sector or LBA faster and more accurate than the current hard drive technology. The G-Drive will write data LBA outward direction opposite with the current hard drive technology. The LBA outward direction orientation will provide the OS easier to organize the system files, system data and the user data.

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Existing Hard Drive Layout and Issues

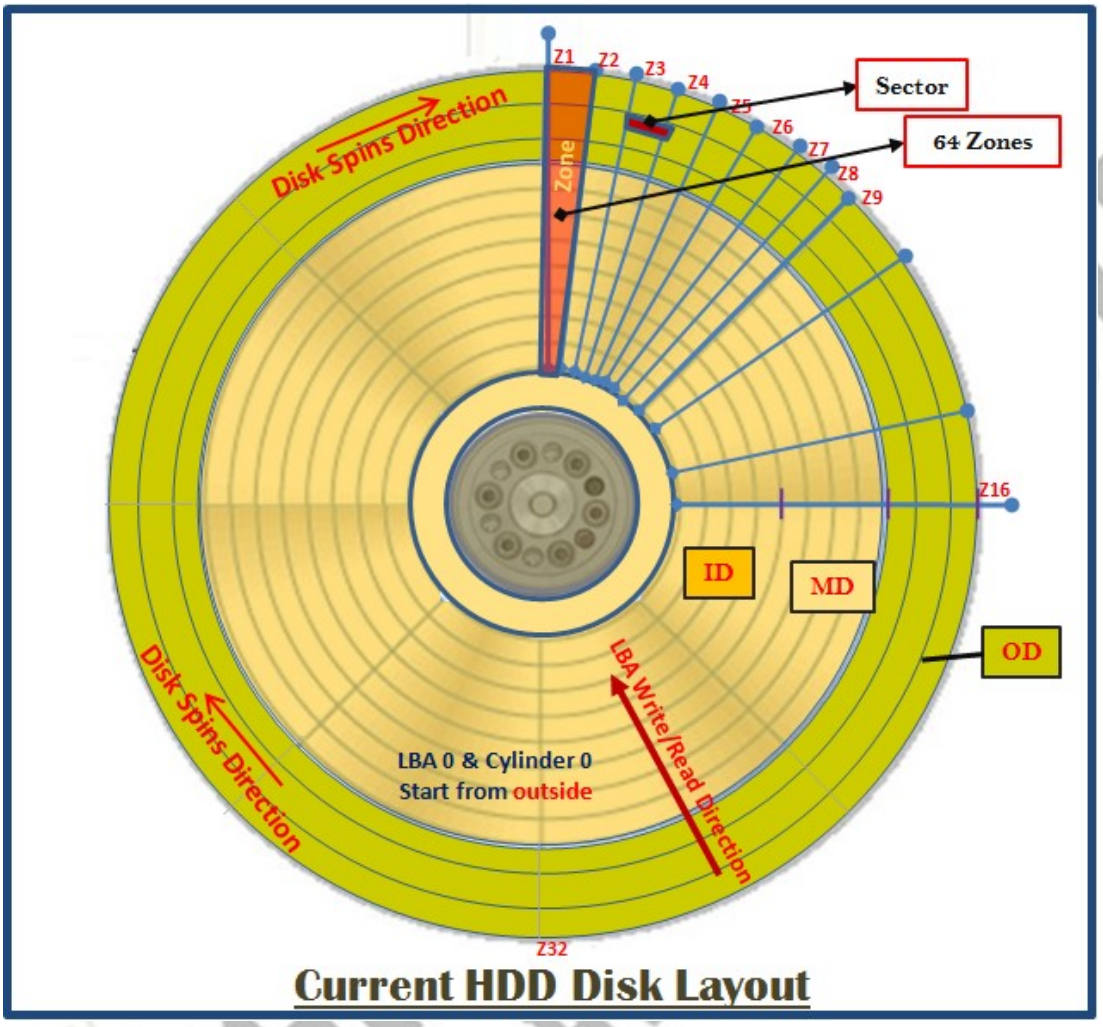

Figure-1: Current HDD Disk Layout

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Greatest Performance Hard Drive (G-Drive)
-- Partial Specification --

The G-Drive Layout

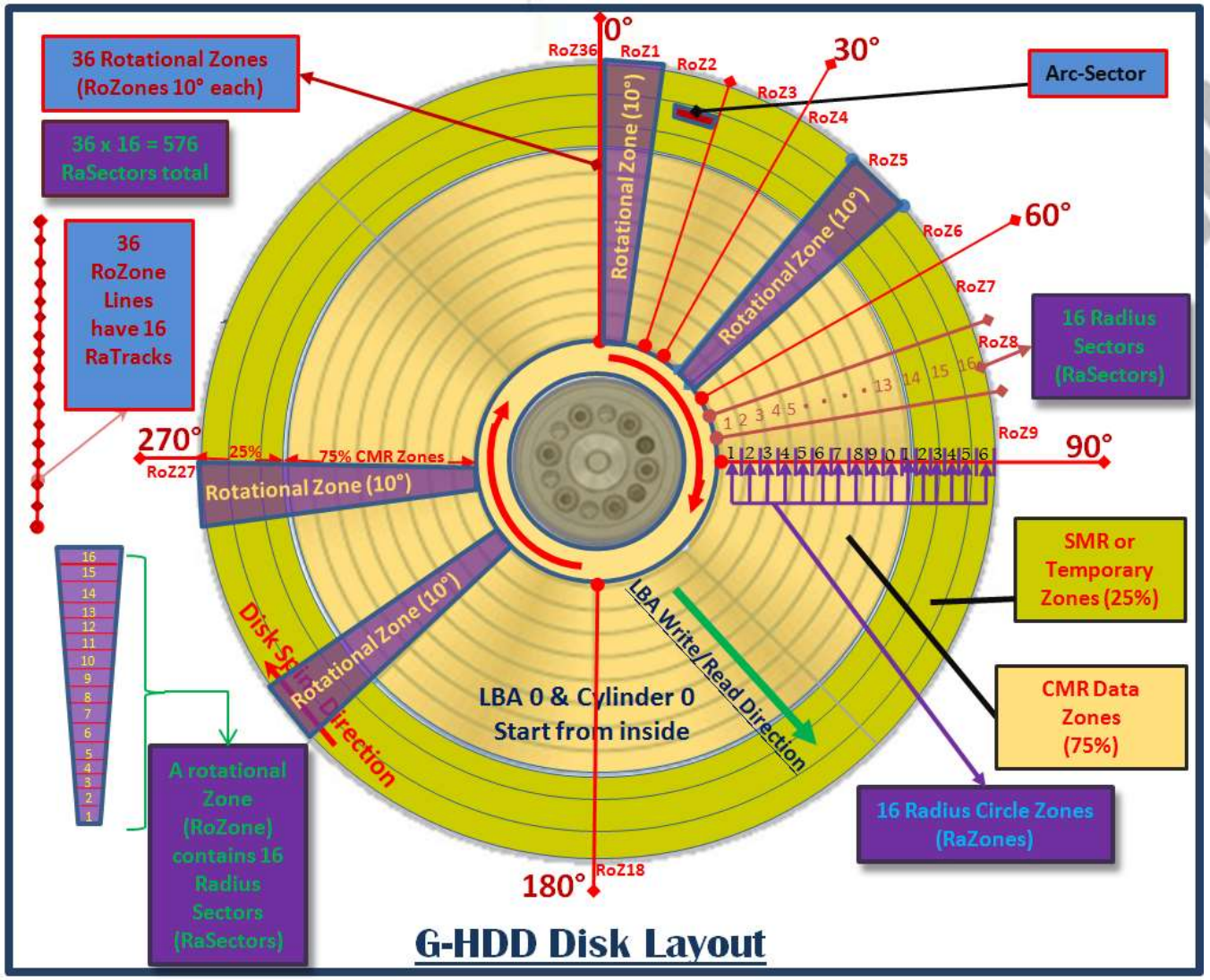

Figure-2: The G-Drive Full Disk Layout

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Greatest Performance Hard Drive (G-Drive)
-- Partial Specification --

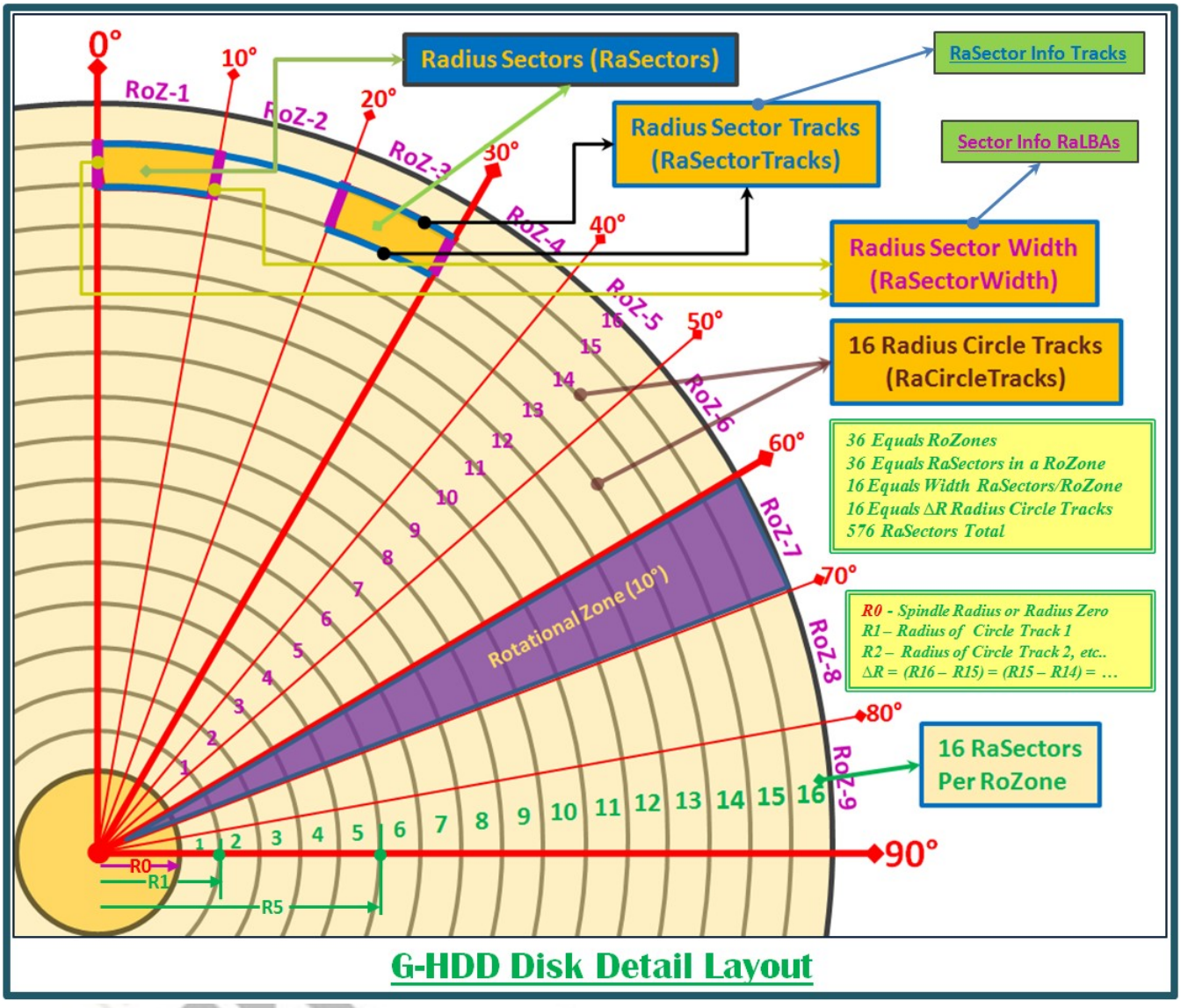

Figure-3: The G-Drive Quart-Section Disk Layout

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Greatest Performance Hard Drive (G-Drive)
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RoZone Info (Assume Disk Radius 3.5 inches [8.89 cmd] with 0.5 inches [1.27 cm] Spindle Radius)			
RaSector No.	Radius (cm)	RaSector Area (cm^2)	RaSector Track Length (cm)
1	1.74630	0.1250	0.30480
2	2.22250	0.1650	0.38790
3	2.69880	0.2040	0.47100
4	3.17500	0.2440	0.60250
5	3.65120	0.2830	0.63730
6	4.12750	0.3240	0.72040
7	4.60375	0.3630	0.80350
8	5.08000	0.3760	0.88660
9	5.55625	0.4680	0.96980
10	6.03250	0.4820	1.05290
11	6.50875	0.5210	1.13600
12	6.98500	0.5610	1.21910
13	7.46125	0.6000	1.30220
14	7.93750	0.6400	1.38540
15	8.41375	0.6800	1.46850
16	8.89000	0.7190	1.55160
Total Area of Data Disk Space = 36 * 6.755 cm^2 ~= 243 cm^2			

Table-1: The G-Drive Geometry RaSectors Calculation

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Greatest Performance Hard Drive (G-Drive)
-- Partial Specification --

G-Drive High Level Hardware Design

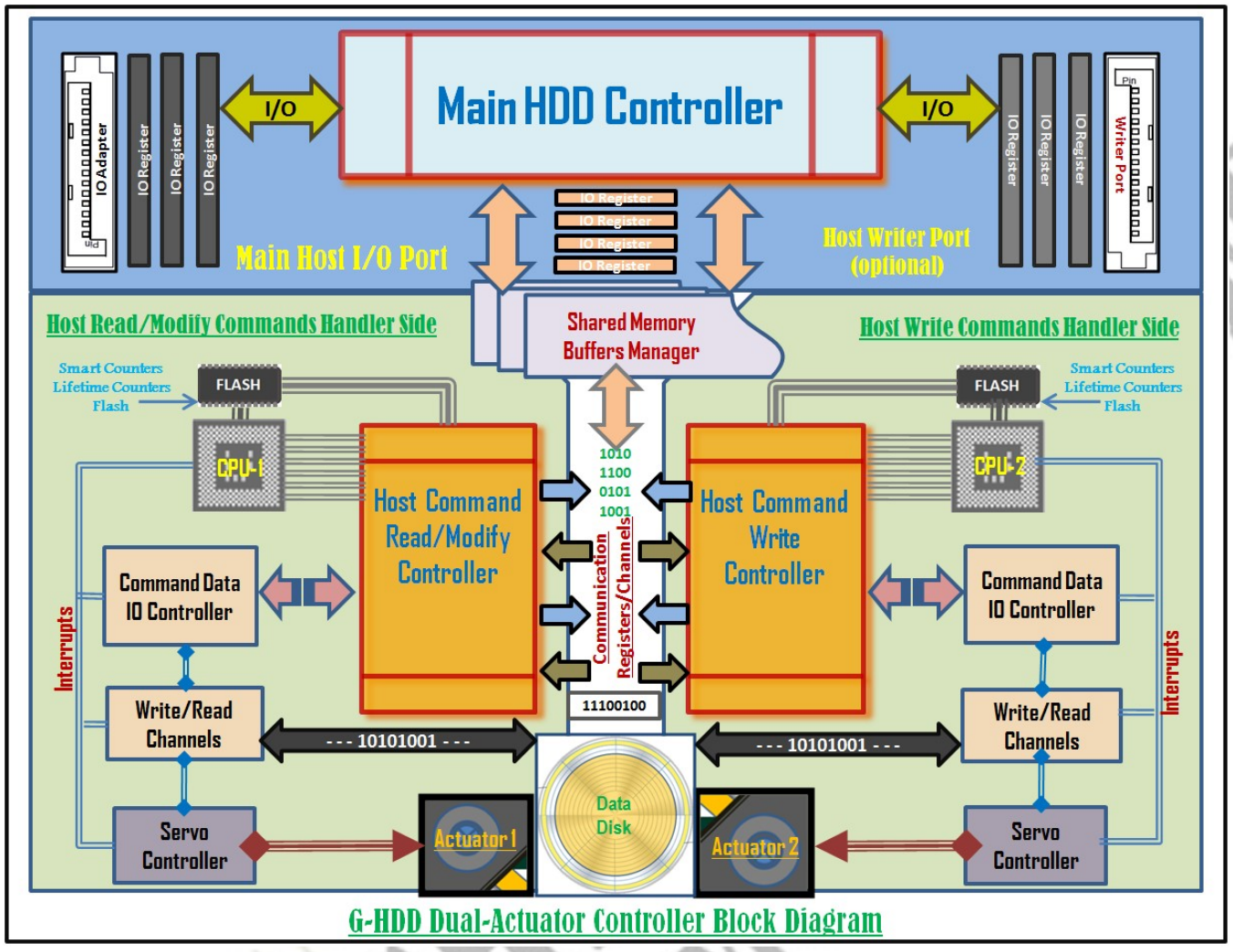

Figure-4: G-Drive Hardware Block Diagram

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G-Drive Main Process

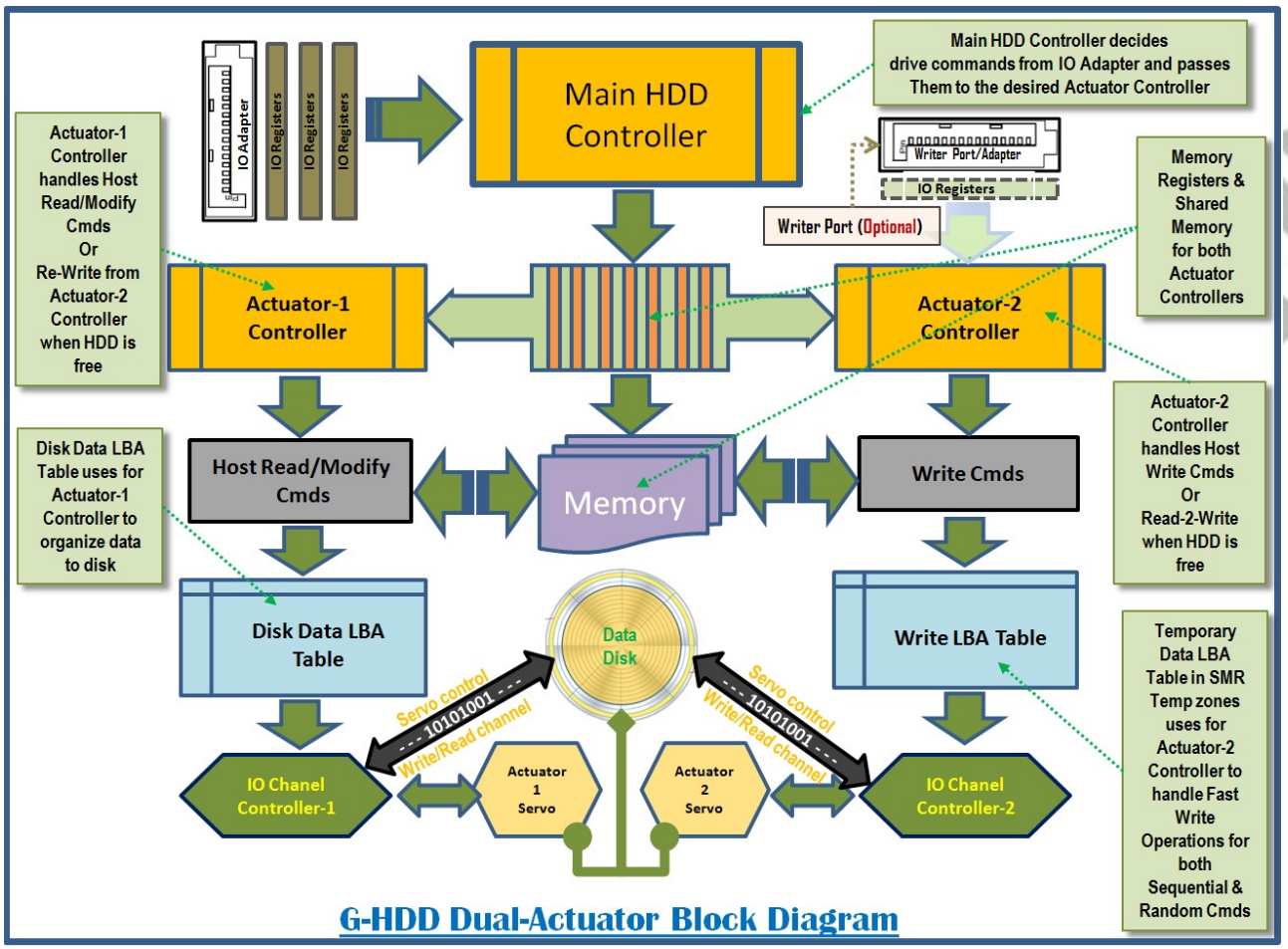

Figure-5: G-Drive Process Block Diagram

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G-Drive Process Flow Details

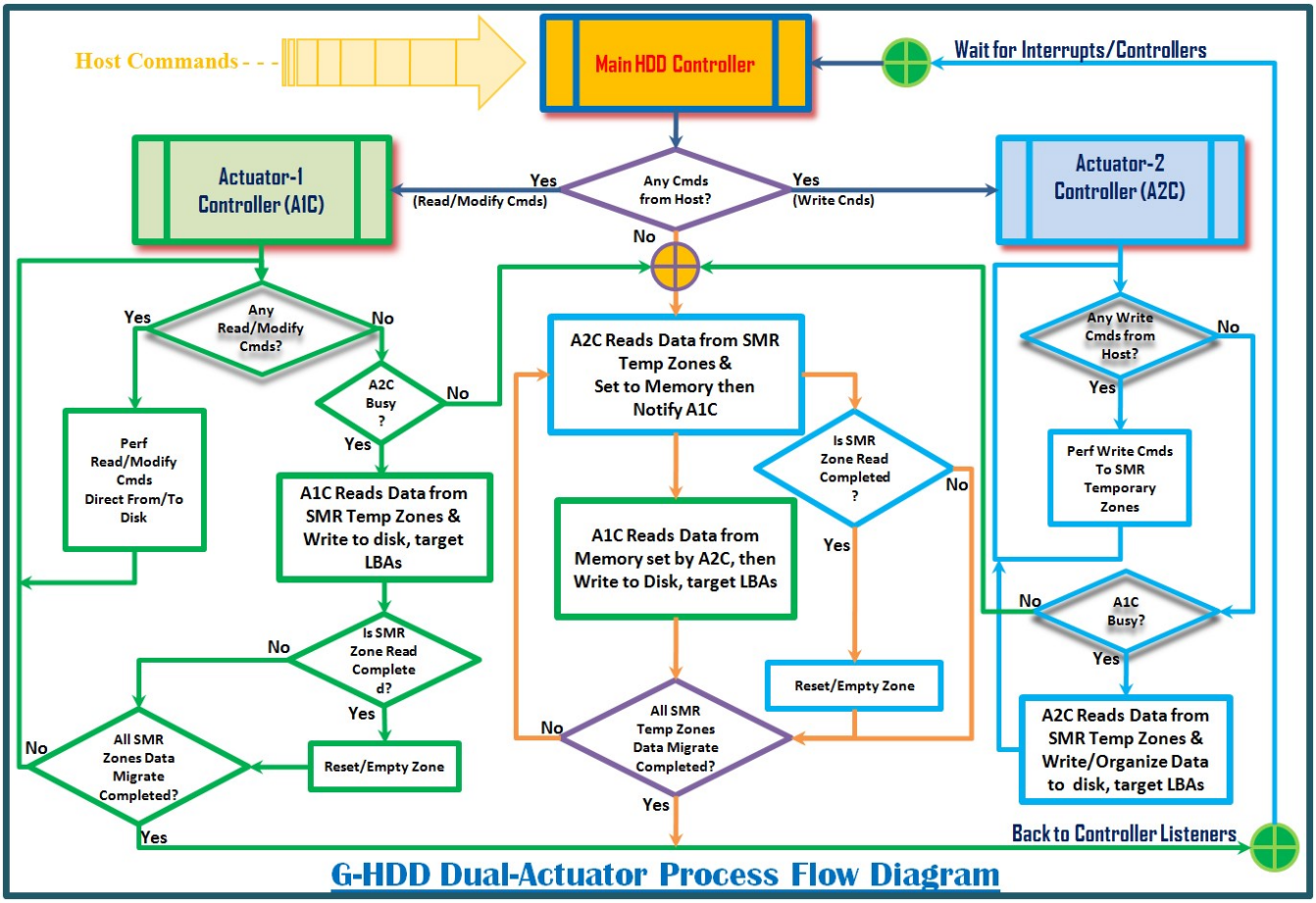

Figure-6: G-Drive Process Flow Diagram

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-- Partial Specification --

G-Drive Sample LBA Division and Zones Mapping

1TB G-Drive	Total LBAs	CMR LBAs (75%)	SMR Temp LBAs (25%)	Zone Length
Disk1 (Head1)	488374272	366280704	122093568	2000h
Disk2 (Head2)	488374272	366280704	122093568	2000h
Disk3 (Head3)	488374272	366280704	122093568	2000h
Disk4 (Head4)	488374272	366280704	122093568	2000h
Entire Disk	1953497088	1465122816	488374272	

Table-2: 1TB of G-Drive with 4 Disks LBAs Division

1TB G-Drive	Total LBAs	Start CMR LBA	Start SMR Temp LBA	Zone Length
Disk1 (Head1)	488374272	0 (00h)	366280704 (15D50000h)	2000h
Disk2 (Head2)	488374272	488374272 (1D1C0000h)	854654976 (32F10000h)	2000h
Disk3 (Head3)	488374272	976748544 (3A380000h)	1343029248 (500D0000h)	2000h
Disk4 (Head4)	488374272	1465122816 (57540000h)	1831403520 (6D290000h)	2000h

Table-3: 1TB of G-Drive with 4 Disks LBAs Mapping

G-Drive Host Write Operations

1. Host Sequential Write Operations:

Host SEQ Write Operation		
Cmd No.	Write LBA	Blocks
1	0 (00000000h)	512 (200h)
2	512 (00000200h)	512 (200h)
3	1024 (00000400h)	256 (100h)
4	1280 (00000500h)	256 (100h)
5	1536 (00000600h)	1024 (400h)
--	---	---

SEQ Write Operation (Temporary)	
Write SMR LBA	Blocks
15D50000h	512 (200h)
15D50200h	512 (200h)
15D50400h	256 (100h)
15D50500h	256 (100h)
15D50600h	1024 (400h)
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Sequential Write Cmds From Host → Write Sequentially to Temp SMR Zones

Table-4: 1TB of G-Drive during Host Sequential Write Operations

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Greatest Performance Hard Drive (G-Drive)
-- Partial Specification --

SEQ-2-SEQ Write LBA Connection Map			
Write SMR LBA	Disk CMR LBA	Blocks	Cmds Sequence
15D50000h	0 (00000000h)	2560 (A00h)	1,2,3,4,5
15D50A00h	2560 (00000A00h)		

Table-5: 1TB of G-Drive during Host SEQ Write Operations LBA Connection Map

2. Host Random Write Operations:

Host RND Write Operation		
Cmd No.	Write LBA	Blocks
1	1024 (00000400h)	256 (100h)
2	1536 (00000600h)	1024 (400h)
3	0 (00000000h)	512 (200h)
4	1280 (00000500h)	256 (100h)
5	512 (00000200h)	512 (200h)
--	---	---

SEQ Write Operation (Temporary)	
Write SMR LBA	Blocks
15D50000h	256 (100h)
15D50100h	1024 (400h)
15D50500h	512 (200h)
15D50700h	256 (100h)
15D50800h	512 (200h)
---	---

Random Write Cmds From Host → Write Sequentially to Temp SMR Zones

Table-6: 1TB of G-Drive during Host Random Write Operations (Round-1)

Host RND Write Operation (2nd Round)		
Cmd No.	Write LBA	Blocks
6	3328 (00000D00h)	256 (100h)
7	8192 (00002000h)	1024 (400h)
8	2816 (00000B00h)	512 (200h)
9	9728 (00002600h)	256 (100h)
10	9216 (00002400h)	512 (200h)
--	---	---

SEQ Write Operation (Temporary)	
Write SMR LBA	Blocks
15D50A00h	256 (100h)
15D50B00h	1024 (400h)
15D50F00h	512 (200h)
15D51100h	256 (100h)
15D51200h	512 (200h)
---	---

RND Write Cmds From Host → Write Sequentially to Temp SMR Zones

Table-7: 1TB of G-Drive during Host Random Write Operations (Round-2)

Greatest Performance Hard Drive (G-Drive)
-- Partial Specification --

RND-2-SEQ Write LBA Connection Map			
Write SMR LBA	Disk CMR LBA	Blocks	Cmds Sequence
15D50000h	0 (00000000h)	2560 (A00h)	3,5,1,4,2
15D50A00h	2560 (00000A00h)		
15D50A00h	2816 (00000B00h)	768 (300h)	8,6
15D50D00h	3584 (00000E00h)		
15D50D00h	8192 (00002000h)	1792 (700h)	7,10,9
15D51400h	9984 (00002700h)		

Table-8: 1TB of G-Drive during Host RND Write Operations LBA Connection Map

G-Drive Dual Actuator Layout

Figure-7 shows a sample of Dual Actuator layout of the G-Drive of 2 CPUs.

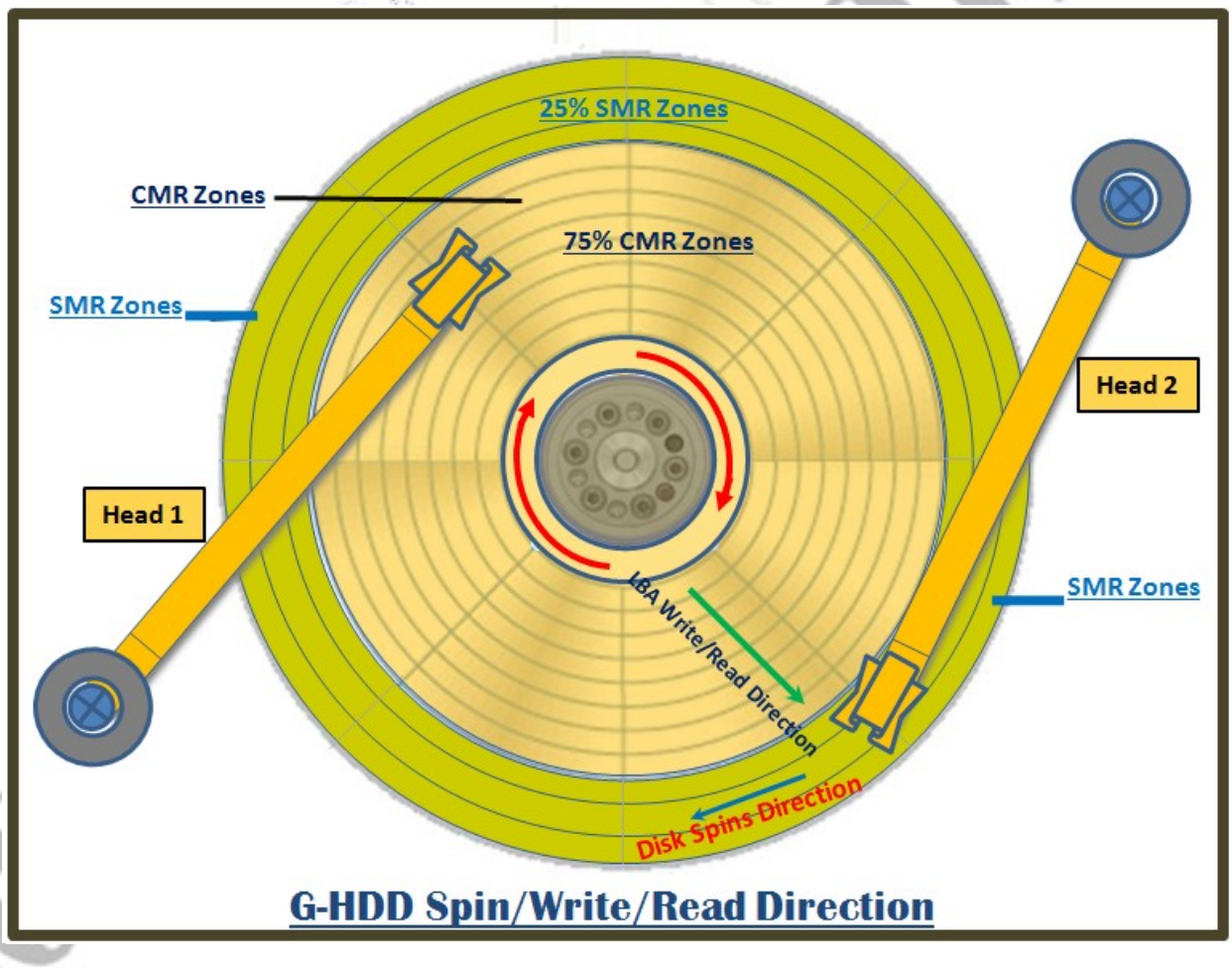

Figure-7: G-HDD Dual-Actuator Layout

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G-Drive RPM/Servo Tracking LED Sensor

Figure-8 shows a sample of the LED with a photo sensor. The LED is attached to the disk spindle at the disk Radius-0 at 0° degree (R0). The LED will flash when rotate to the photo Sensor at a fix point (**0° degree Position**) of the drive, and the controllers will be notified the R0 is passing by the 0° Degree Position. This feature will help the Servo controllers to monitor, track, and seek a Write/Read head to the specific location on the disk. With combination of the disk Geometry, the G-Drive controllers can use RPS (Rotation Positioning System) technique to calculate and locate a specific LBA or Zone with a list of RaZones that the head flies over while seeking inward or outward by the RPM of the disk and the speed of the head and actuators motion.

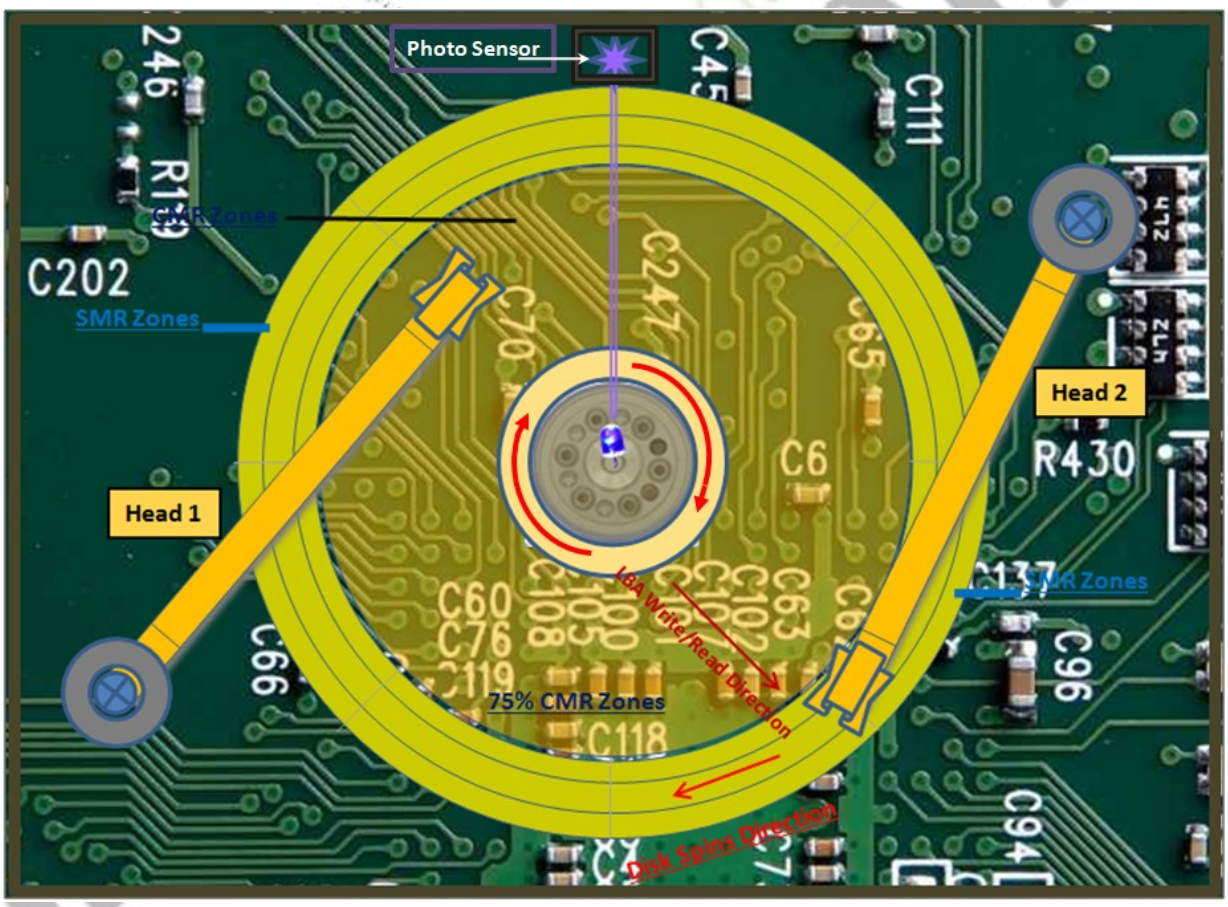

Figure-8: G-Drive RPM/Servo Tracking LED-Photo or Laser Sensor

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G-Drive Components and Actuator Layout

Figure-9 shows a sample G-Drive components and Actuators layout.

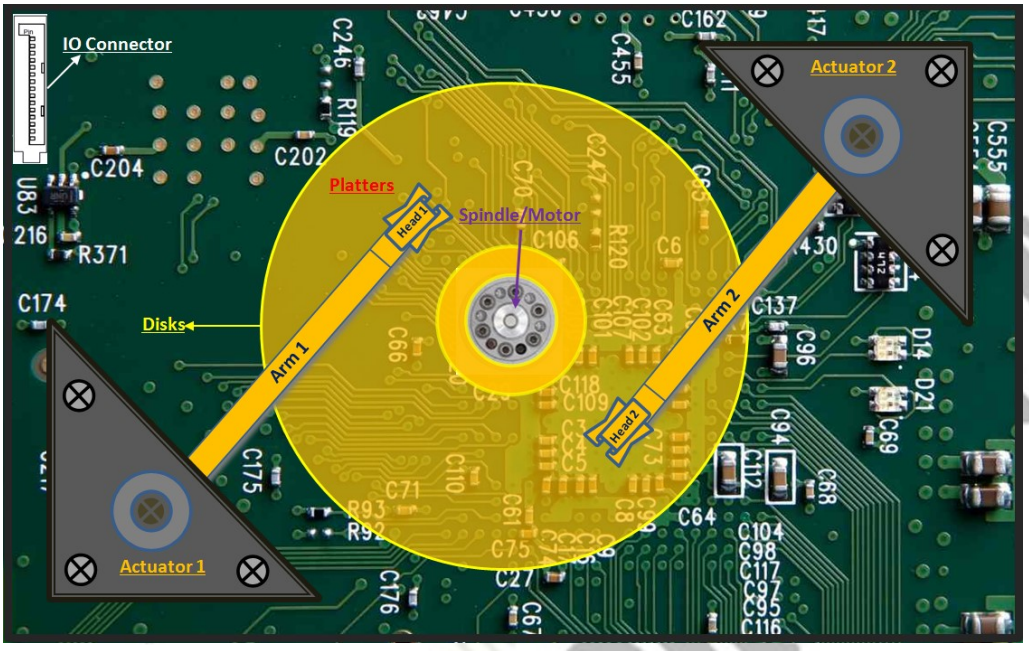

Figure-9: G-Drive Components/Actuators Layout

G-Drive 3.5 Inches Open Cover Sample

Figure-10 shows a sample 3.5 inches G-Drive open cover sample.

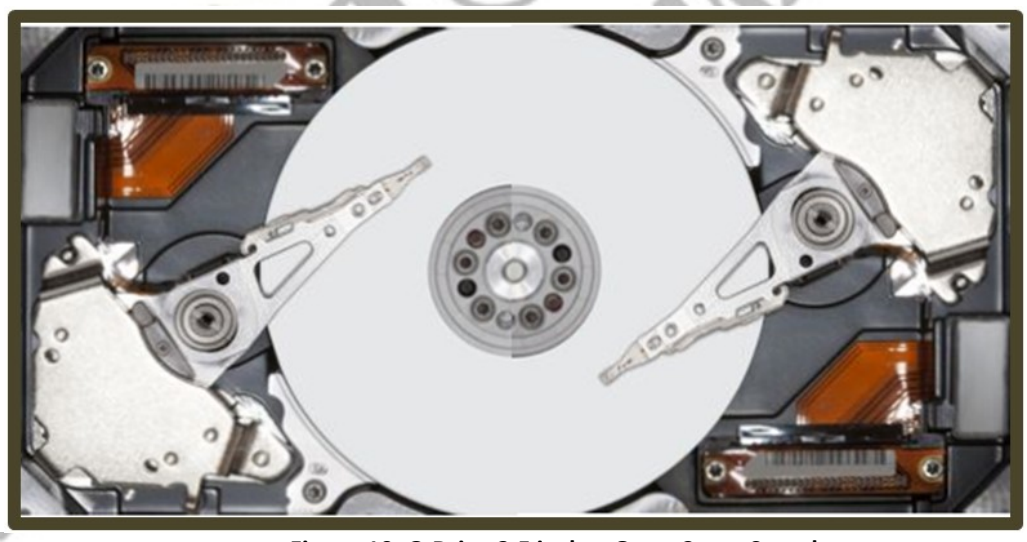

Figure-10: G-Drive 3.5 inches Open Cover Sample

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Conclusion

The patent **G-Drive** – Greatest Performance Hard Drive is designed with **State-of-the-Art Geometry** of 360° degree Disk Layout in combination of LED Radius at 0° degree detection will be a **big promise for the future storage disk hard drive; and ready for Quantum Recording Technology Hard Drive** to support **Quantum Number, Quantum Data, the future Data**. The **Cloud-OS** was invented with the **RDMA technology** to allow each user has a chance to access their data on every rotation of the hard drive disk. This patent will be a great improvement for Data Center with Cloud-OS supports. The G-Drive will provide the fastest data recording for video systems and great for flying object recorders, like aircrafts recording while flying at low altitude. The G-Drive is a perfect hard drive for the Cloud-OS computer systems. With this perfect computer system, the world will have great Data Center with fast data storage and great Cloud-OS network; this will bring the world to the next level of computing infrastructure. This is a big promise for the future of our younger generations. Our younger generations will use these as the great tools to invent beyond what we have today.

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References

- void writeSectors(int cylinder, int head, int sector, int blocks, Buffer data);
- void writeSectors(long lba, int blocks, Buffer data);
- void writeSectorsExtended(long lba, int blocks, Buffer data);
- void readSectors(int cylinder, int head, int sector, int blocks, Buffer data);
- void readSectors(long lba, int blocks, Buffer data);
- void readSectorsExtended(long lba, int blocks, Buffer data);
- void modifySectors(int cylinder, int head, int sector, int blocks, Buffer data);
- void modifySectors(long lba, int blocks, Buffer data);
- void modifySectorsExtended(long lba, int blocks, Buffer data);

Reference-1: Introduce new Modify Sectors commands to support Write to direct target LBAs