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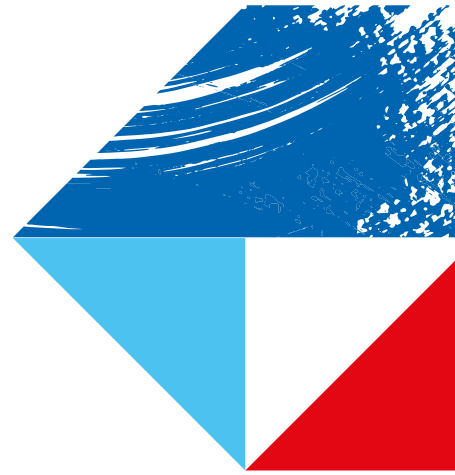
Lab Report

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Introduction

4U top-loading chassis are growing in popularity for storage solutions as they offer the highest density for packing 3.5" Enterprise Capacity HDDs. Models with 60 drive bays have been used for a while, but now models with more than 100 slots are available. One common problem is that many chassis for more than 60 drives are very long (sometimes more than 1 meter) and unable to fit into existing racks. The AIC JBOD Model J4078-01 is only 810 mm long and, while offering 78 slots, it's one of the shortest models in this class and fits into any existing rack.

Picture 1: J4078-01 in Toshiba Lab
We tested this model with the latest 16 TB HDDs in the Toshiba Lab.

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JBOD Features

The J4078-01 (AIC SKU: XJ1-40781-02) is a 4U (176 mm) high, 19" (434 mm) wide and only 810 mm long JBOD with capacity for 78 3.5" HDDs. It is equipped with dual 1+1 redundant 1600 W power supply modules and a dual SAS 12 GB/s expander.

It has three top cover lids and tool-less plastic drive bay frames. The on and mute button are conveniently located at the front of the JBOD, as is the front LED panel showing each drive's status.

HDD Models and Setup

We undertook our testing with 78 of the latest 16 TB SATA Enterprise Capacity HDDs, model MG08ACA16TE, analysing function, performance and power consumption. As this model also includes a dual expander structure suitable for SAS drives, we also checked the functionality with some 16 TB SAS 12 GB/s HDDs, model MG08SCA16TE.

Picture 2: Toshiba HDD

The JBOD is connected with two external mini-SAS-HDs to the host's HBA/Controller.

Compatibility / Function

The system was tested with the following different configurations:

- **OS:** Windows (Windows Server 2016) and Linux (Centos 7.6)

- **HBA/Controller:** Broadcom HBA9400-16e and Microchip Controller 3154-8e.

- **HDD:** Toshiba MG08ACA16TE (Func/Perf/Power) and MG08SCA16TE (Func)

- **RAID Structure:** RAID10 consisting of 78 Drives, HDD cache on

Basic Function: .... ok
SAS Expander detected: .... ok
Hot plug /re-insert: .... ok
Smart reading: .... ok
Enclousure Management: .... not tested

Performance and Power Consumption

JBOD on, no drives, SAS link to host on: .... 425 W
JBOD with 78 drives, maximum start-up power over 500 ms: .... 1000 W
JBOD with 78 raw drives at HBA idle: .... 945 W
Noise at 1 m Distance: .... 93 dB

As a consequence of the ultra compact size, high performance cooling is required to keep the SAS expander module and HDD temperatures within an acceptable range. Hence the noise and the power consumption of the fan modules is rather high.

For performance and related power consumption we tested with several synthetic workloads such as sequential writing of 64K blocks, sequential reading of 64K blocks, random reading of 4K blocks, and random writing of 4K blocks. An approximation of a realistic workload (a mix of 4K (20%), 64K (50%), 256K (20%) and 1M (10%) byte blocks) being randomly read and written was also included. We also tested a Windows-copy job from one logical volume to another logical volume on the same physical drives created as RAID of the 78 HDDs under test.

Picture 3: J4078-01 with 78 Toshiba HDDs

The temperature of the HDDs under load were also measured by reading out the S.M.A.R.T temperature values.

Workload	Power in W	IOPS	Bandwidth in MB/s
Sequential Write 64K	900		3900
Sequential Read 64K	955		6200
Random Write 4K	910	12000	
Random Read 4K	950	19500	
Mixed 4K/64K/256K/1M	955	3400	980
Windows Copy	890		700
Temperature Abient	25 °C		
Temperature HDD min.	27 °C		
Temperature HDD max.	33 °C		

Summary

78 drives of 16 TB each, making a total of 1.25 petabytes in a 4U 810 mm long box, is probably one of the densest data storage configurations currently achievable. Even under full load the drives stay cool (less than 10 °C above outside air temperature) due to the high-performance cooling and the excellent airflow design of this chassis. However, cooling of these ultra-high-density HDD packs comes at the cost of high noise levels and some significant power consumption for the fans. By comparison, the less dense 60-bay single expander AIC J4060-02 JBOD only requires 80 W (JBOD on, link up, no drives installed) against the 425 W consumed by the J4078-01. From a performance and functionality perspective, the dual 12 GB/s SAS expander structure proved that it supports all the features of dual-channel SAS Enterprise Capacity drives, as well as working optimally with SATA Models.

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