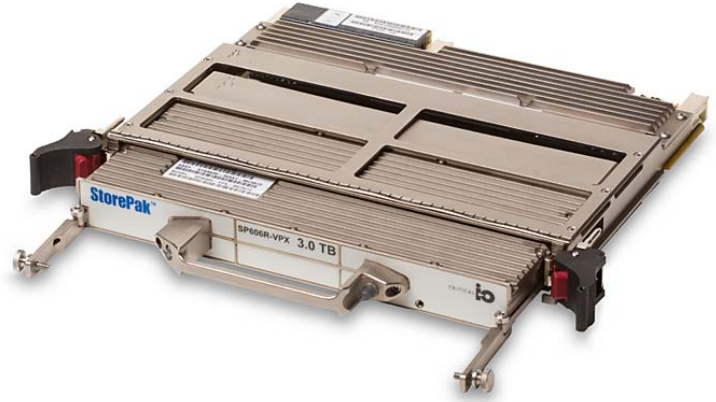


StorePak™ OpenVPX

SP606R-VPX Data Sheet: Removable SSD Module for 6U VPX (Drive Module & Carrier)

StorePak™ 6U VPX

StorePak is a single slot **removable** SSD (solid state drive) module that provides up to 46TB of solid state storage. StorePak is designed to be used either stand-alone as Direct Attached Storage, or in conjunction with Critical I/O's StoreEngine storage manager for data recorder or NAS applications.. The StorePak™ removable SSD module is specifically designed for easy removal and replacement of on board storage. Since there are no tools needed to remove StorePak, it is ideal for applications where removal of onboard storage must be accomplished quickly. StorePak provides high performance and high capacity rugged solid state storage all within a small size, weight, and power (SWaP) footprint. StorePak supports high bandwidth data recording, file serving, and general purpose RAID applications where quick and easy removal of on board SSDs is essential.



High Density

A single StorePak module can provide up to 46 Terabytes (46 TB) of solid state storage in one 6U VPX slot. Multiple configurations of StorePak are available which feature various storage capacities, performance capabilities, and SSD types.

Scalable Storage

StorePak can be easily scaled by aggregating multiple StorePaks to offer even greater capacities and performance. StorePaks can operate independently or as a single storage resource.

Hot Swap & Hot Plug

StorePak allows the user to “hotplug” or “hotswap” their storage without powering down the system. This is ideal for applications where it is not feasible or desired to power down the system in order to remove/replace the SSD storage.

Multi-Mode Operation

When StorePak is used stand-alone, it provides a high performance unmanaged DAS capability with hardware RAID 0/1/10/1E. When used in conjunction with a StoreEngine storage manager module, StorePak also provides high performance data recording/playback capability, fully managed Direct Attached Storage (RAID), as well as a NAS file sharing capability.

Hardware Based RAID 0/1/10/1E

StorePak supports hardware RAID 0 (striping, for highest performance), RAID 1 (mirroring), or RAID 10/1E (mirroring/striping) for additional data protection. Sustained RAID 0 data rates of up to 2.5 GBytes/sec can be achieved using a single StorePak, and multiple StorePaks may be combined to achieve even higher rates. StorePak SSDs can also be used as individual drives (non-RAID) or with host based RAID 5.

StorePak Features:

- High Capacity – up to 46 TB in a single StorePak
- Easily removable SSD module
- Rugged 6U Air Cooled VPX format
- SSD module supports 100,000 insertion cycles
- Small SWaP (size, weight and power) footprint
- Six configurable 4-lane PCIe Gen 2 backplane ports
- Data plane and expansion plane PCIe connectivity
- Low Power - 35 Watts (typical)
- High Performance - up to 2.5 GBytes/s per StorePak
- Hardware RAID 0/1/10/1E (or host based RAID 5)
- Scalable & Expandable (cascade StorePaks)
- Air and conduction cooled versions available



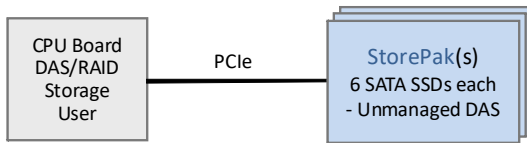
StorePak combines a removable SSD storage module with a fixed carrier base

StorePak Usage Models

StorePak can be used stand-alone as a unmanaged Direct Attached Storage (DAS) attached to a host CPU board using a PCIe connection to the host. StorePaks may also be used in conjunction with a StoreEngine storage manager blade to provide a flexible set of storage capabilities including recording and NAS file sharing.

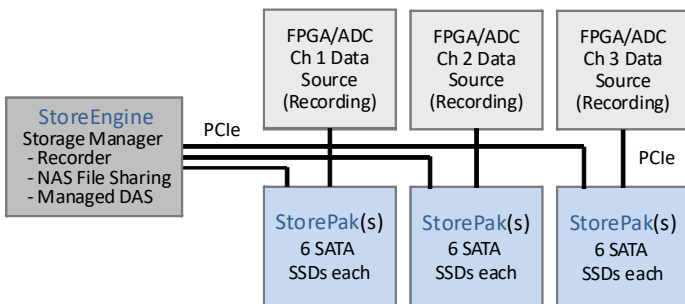
StorePak Stand-alone: Unmanaged Direct Attached Storage with Hardware RAID

When used stand-alone, StoreEngine provides a simple unmanaged DAS capability (i.e. raw drives), which are connected to a host CPU board using PCIe. Individual drive images can be exposed to the host, or hardware RAID 0/1/10/1E can be configured.



StorePak + StoreEngine: Multi-Channel Data Recorder

A more complex application of StorePak/StoreEngine combination is shown below. Here one StoreEngine is managing three StorePaks, each StorePak receiving a different channel of data. This example system provides up to 138 TB of recording capacity, with a recording rate of up to 6 GBytes/s.



PCIe Connectivity

The standard SC601P-VPX configuration provides the following PCIe backplane connectivity. This is designed to be compatible with selected VPX payload slot profiles. Certain x4 ports may be merged to x8 width.

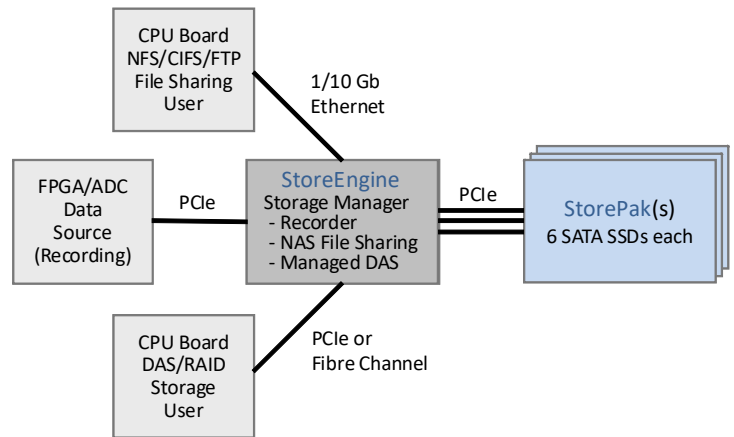
- P1: 4x - x4 PCIe Gen2 fat pipes
- P2: 2x - x4 PCIe Gen2 fat pipes

StorePak + StoreEngine: Multi-mode Operation

The StorePak/StoreEngine combination can provide concurrently:

- High performance data recording capabilities at rates of over 2000 MB/s per StorePak.
- NAS file sharing capabilities using NFS, CIFS, or FTP over 1/10 Gb Ethernet.
- Fully managed Direct Attached Storage (DAS, aka RAID) capabilities using PCIe or Fibre Channel.
- Hardware based RAID 0/1/10/1E for all modes of operation.

An example of using the StorePak/StoreEngine combination is shown below. In this example StorePak/StoreEngine is being used concurrently for three different modes of operation: NAS file sharing, high performance data recording, and DAS RAID.



StorePak SSD Security Options

The following data protection options are available for the SSDs within the StorePak:

- **Password Protection** - All StorePak SSDs options implement a user definable drive password. This optional password is required to unlock the SSD and gain access to data.
- **AES-256 Full Drive Encryption** - SSDs implement password protection and full drive AES-256 encryption of all data stored on the SSD.
- **TCG/Opal Security Model** - TCG/Opal SSDs implement AES encryption and password protection in a standardized manner as defined by Trusted Computing Group TCG/Opal specification.
- **FIPS 140-2 Level 1** - The Federal Information Processing Standard (FIPS) 140-2 defines requirements for secure cryptographic modules including SSDs. FIPS-140-2 requires a stringent certification process to which the SSD must be subjected prior to achieving FIPS validation.

StorePak SSD Flash Media Options

All standard StorePak configurations include six SSDs internally. On a special order basis, StorePaks may be configured with fewer than six SSDs. Contact Critical I/O for more information.

StoreEngine supports the use of several standard different types of SATA SSDs, depending on specific application requirements. All standard StorePak configurations use MLC or 3DTLC SSDs. Other SSD types such as eMLC or pSLC may be available on a special order basis. Contact Critical I/O.

SSD Flash Technology Characteristics:

- **MLC** – Two Level Cell (MLC) SSDs provide excellent sequential read/write performance, moderate random read/write performance, good endurance, and high storage capacity
- **3DTLC** – 3D Triple-Level Cell (TLC) SSDs provide similar reliability and endurance but with higher storage capacity as compared to MLC SSDs. 3DTLC SSDs often implement high temperature performance throttling.
- **eMLC** - Enhanced Multi-Level Cell SSDs offer excellent retention and reliability, very good write endurance, excellent sequential read/write performance, moderate random read/write performance, and high storage capacity.
- **pSLC** – Psuedo Single Level Cell SSDs offer excellent retention and reliability, excellent write endurance, excellent sequential and read/write performance, but with reduced storage capacity and higher cost.

StorePak Power

StorePak is powered by a combination of backplane 12V and 5.0V. Typical and maximum power levels are shown in the Technical Specification section, but actual StorePak power usage is highly dependent on storage access rates and patterns.

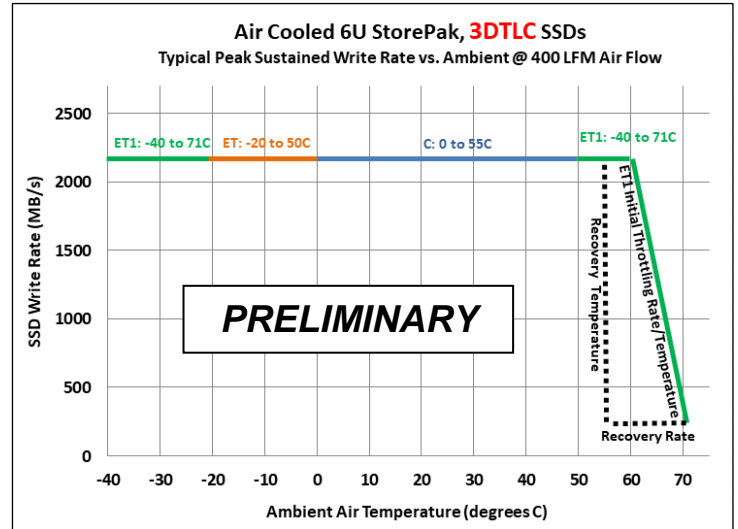
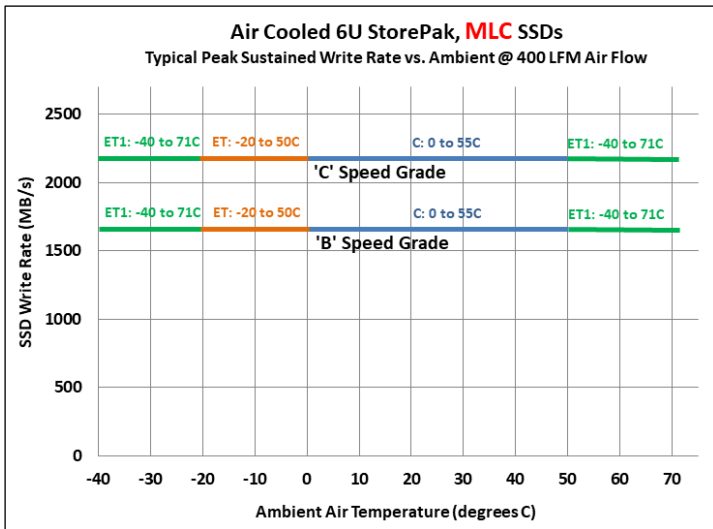
3DTLC Performance Considerations

3DTLC SSDs implement internal thermal performance throttling to limit SSD internal temperatures. This can result in reduced maximum sustained StorePak read/write rates at higher temperatures.

Typical maximum sustained rates vs. temperature for MLC vs 3DTLC StorePaks are shown in the charts below. For 3DTLC, the maximum data read/write rates that can be sustained in a given application are also highly dependent on temperature, airflow, thermal environment, and data access patterns and duty cycles.

The 3DTLC rate limits shown are typical, and are the result of thermal protection rate throttling of the SSDs within the StorePak.

Once a 3DTLC SSD has entered a thermal throttling state, the sustainable rate will drop to a lower 'recovery rate'. The StorePak temperature must then drop below a 'recovery temperature' before full performance is restored as indicated by the dashed lines in the chart.



StorePak Model Numbers (Not all model number combinations are valid)

Standard StorePak 6U model numbers are defined as: **SP606R-VPX-YYxxxxxW-ZZZ**, where:

YY = SSD Class (MC = MLC "C" speed grade, MB = MLC "B" speed grade, 3D = 3DTLC)

xxxxx = aggregate raw StorePak capacity in GBytes (e.g., 12000 = 12000GB or 12TB)

W = Encryption (blank = password only, E = AES-256, T = TCG/Opal AES, F = FIPS 140-2 level 1 AES)

ZZZ = Temperature range (blank = 0C to 55C, ET = -20C to 55C, ET1 = -40C to +71C)

Example: SP606R-VPX-MC6000E-ET1

Air Cooled 6U VPX StorePak, 6000GB MLC, AES-256, ET1: -40C to +71C

Typical StorePak Performance Characteristics (see notes)

DAS (direct block access) Performance

StorePak Model#	Sequential Read (RAID0, 1 MB block)	Sequential Write (RAID0, 1 MB block)	Sequential Write (RAID5, 1 MB block)
SP606R-VPX-MCxxxxxZ	2500 MByte/s	2200 MByte/s	1200 MByte/s
SP606R-VPX-MBxxxxxZ	2000 MByte/s	1700 MByte/s	900 MByte/s
SP606R-VPX-3TxxxxxZ	2500 MByte/s	2200 MByte/s	1200 MByte/s

Recording Mode Performance (with StoreEngine)

StorePak Model#	Read (1 MB block)	Write (1 MB block)
SP606R-VPX-MCxxxxxZ	2500 MByte/s	2200 MByte/s
SP606R-VPX-MBxxxxxZ	2000 MByte/s	1700 MByte/s
SP606R-VPX-3TxxxxxZ	2500 MByte/s	2200 MByte/s

NAS (NFS) Performance (with StoreEngine and 10GbE)

StorePak Model#	Sequential Read (RAID0, 1 MB block)	Sequential Write (RAID0, 1 MB block)	Sequential Write (RAID5, 1 MB block)	Random Read/Write (RAID5, 64 KB block)
SP606R-VPX-MCxxxxxZ	1200 MByte/s	1000 MByte/s	500 MByte/s	250 MByte/s
SP606R-VPX-MBxxxxxZ	1100 MByte/s	900 MByte/s	400 MByte/s	250 MByte/s
SP606R-VPX-3TxxxxxZ	1200 MByte/s	1000 MByte/s	500 MByte/s	250 MByte/s

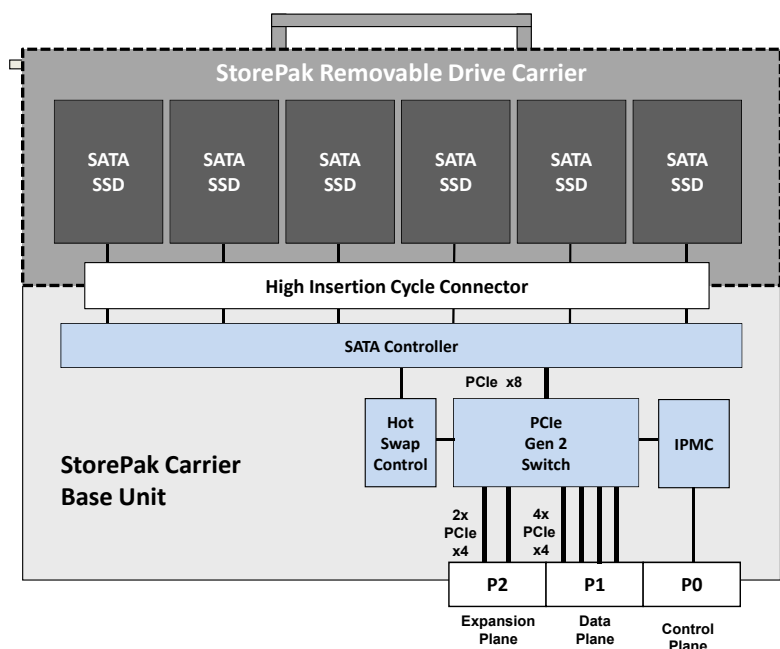
Notes:

- (1) Performance numbers shown are maximums using newly erased SSDs and SC601-VPX carrier board. Actual performance can vary greatly, and depends on the specifics of the application. Maximum performance of 3DTLC configurations may be reduced at high temperatures. Contact Critical I/O to discuss performance expectations.
- (2) Recording mode, RAID5 or NAS operation requires use of StoreEngine or other host SBC.
- (3) Performance data is subject to change.
- (4) 3DTLC performance data is preliminary.

Technical Specifications

Architecture	Air Cooled VPX 6U removable SSD storage module/carrier with up to 6 SATA SSDs
Storage Capacity	Up to 46 TB
Standard Interfaces	4 – PCIe x4 via P1 Backplane (data plane, can be merged into x8) 2 – PCIe x4 via P2 Backplane (expansion plane)
RAID Performance	up to 2500 MByte/s RAID 0 up to 1200 MByte/s RAID 5 (with StoreEngine)
Storage Security	Optional AES, TCG/Opal, or FIPS-140 full drive encryption
Management	Web based GUI (for StoreEngine based applications) StorePak Manager utility (for DAS applications)
Form Factor	6U VPX (1.0" pitch VITA 48) air cooled
Weight (StorePak + Carrier)	2 lb 15 oz (1332 grams)
Power Requirements	+5VDC at 11A maximum (maximum power is dependent on SSD type and aggregate data rate)
Power Consumption	35 Watts (typical, with six SATA SSDs)
Temperature	Std: Operating: 0C to +55C; Storage: 0C to +70C* ET: Operating: -20C to +55C; Storage: -40C to +85C* ET1: Operating: -40C to +71C; Storage: -40C to +85C*
Humidity	Std: Operating: 10-90%, non-condensing, Storage: 5-95%, non-condensing ET: Operating: 0-95%, non-condensing, Storage: 0-100%, condensing ET1: Operating: 0-95%, non-condensing, Storage: 0-100%, condensing
Vibration – Random	0.04g2/Hz (100-1000 Hz)
Shock	20g Peak sawtooth, 11ms duration
SSD Module Connector	100,000 insertion cycles
Supported Host Processors	x86, PowerPC
OS Software Support	VxWorks, Linux, Windows
Base Model Numbers	SP606R-VPX (removable SSD unit) + SC601-VPX (fixed base unit)

* Data retention duration is reduced with high temperature storage.



StorePak (SP606R-VPX) + Carrier Base Unit (SC601-VPX) Block Diagram