



# Windows

## ONTAP SAN Host

NetApp

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# Windows

## NVMe/FC Host Configuration for Windows Server 2019 with ONTAP

### Supportability

NVMe/FC is supported on ONTAP 9.7 or later for Windows Server 2019.

Note that the Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, use MSDSM as the Microsoft Multipath I/O (MPIO) option.

See the [Hardware Universe](#) for a list of supported FC adapters and controllers. For the most current list of supported configurations & versions, see the [NetApp Interoperability Matrix](#).

### Known limitations

Windows Failover Cluster (WFC) is not supported with ONTAP NVMe/FC because ONTAP does not currently support persistent reservations with NVMe/FC.

Note that the external driver shipped by Broadcom for Windows NVMe/FC is not a true NVMe/FC driver but a translational SCSI to NVMe driver. This translational overhead does not necessarily impact performance, but it does negate the performance benefits of NVMe/FC. Thus, on Windows servers, NVMe/FC and FCP performance is the same, unlike on other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

### Enabling NVMe/FC on a Windows initiator host

Follow these steps to enable FC/NVMe on the Windows initiator host:

1. Install OneCommand Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
  - EnableNVMe = 1
  - NVMeMode = 0
  - LimTransferSize=1
3. Reboot the host.

### Configuring the Broadcom FC adapter in Windows for NVMe/FC

With the Broadcom adapter for FC/NVMe in a Windows environment, a **hostnqn** is associated with each host bus adapter (HBA) port. The **hostnqn** is formatted as follows.

### Example

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765  
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

## Enabling MPIO for NVMe devices on the Windows host

1. Install Windows Host Utility Kit 7.1 to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.
5. From the **MPIO** tab, click **Details**.
6. Set the following MSDSM settings:
  - PathVerifiedPeriod: **10**
  - PathVerifyEnabled: **Enable**
  - RetryCount: **6**
  - RetryInterval: **1**
  - PDORemovedPeriod: **130**
7. Select the MPIO Policy **Round Robin with Subset**.
8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD ->  
30
```

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\ UseCustomPathRecoveryInterval  
DWORD-> 1
```

9. Reboot the host.

The NVMe configuration is now complete on the Windows host.

## Validating NVMe/FC

1. Validate that the Port Type is FC+NVMe.

Now that NVMe is enabled, you should see the **Port Type** listed as **FC+NVMe**, as follows.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd listhba
```

#### Manageable HBA List

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type     : FC+NVMe
Model        : LPe32002-M2
```

```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model        : LPe32002-M2
```

2. Validate that NVMe/FC subsystems have been discovered.

The `nvme-list` command lists the NVMe/FC discovered subsystems.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list 10:00:00:10:9b:1b:97:65
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:65

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                  : 20:09:d0:39:ea:14:11:04
Node WWN                  : 20:05:d0:39:ea:14:11:04
Controller ID             : 0x0180
Model Number              : NetApp ONTAP Controller
Serial Number             : 81CGZBPU5T/uAAAAAAB
Firmware Version          : FFFFFFFF
Total Capacity            : Not Available
Unallocated Capacity      : Not Available
```

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                  : 20:06:d0:39:ea:14:11:04
Node WWN                  : 20:05:d0:39:ea:14:11:04
Controller ID             : 0x0181
Model Number              : NetApp ONTAP Controller
Serial Number             : 81CGZBPU5T/uAAAAAAB
Firmware Version          : FFFFFFFF
Total Capacity            : Not Available
Unallocated Capacity      : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd nvme-list 10:00:00:10:9b:1b:97:66
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:66

```
NVMe Qualified Name      : nqn.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                  : 20:07:d0:39:ea:14:11:04
Node WWN                  : 20:05:d0:39:ea:14:11:04
Controller ID             : 0x0140
Model Number              : NetApp ONTAP Controller
Serial Number             : 81CGZBPU5T/uAAAAAAB
Firmware Version          : FFFFFFFF
Total Capacity            : Not Available
Unallocated Capacity      : Not Available
```

```
NVMe Qualified Name      : nqn.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                  : 20:08:d0:39:ea:14:11:04
Node WWN                  : 20:05:d0:39:ea:14:11:04
Controller ID             : 0x0141
Model Number              : NetApp ONTAP Controller
Serial Number             : 81CGZBPU5T/uAAAAAAB
Firmware Version          : FFFFFFFF
Total Capacity            : Not Available
Unallocated Capacity      : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

### 3. Validate that namespaces have been created.

The `nvme-list-ns` command lists the namespaces for a specified NVMe target that lists the namespaces connected to the host.

```
PS C:\Program Files\Emulex\Util\OCManager> .\HbaCmd.exe nvme-list-ns
10:00:00:10:9b:1b:97:66 20:08:d0:39:ea:14:11:04 nq
.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159 0
```

Active Namespaces (attached to controller 0x0141):

NSID	DeviceName	SCSI Bus Number	SCSI Target Number	SCSI OS LUN
0x00000001	\\.\PHYSICALDRIVE9	0	1	0
0x00000002	\\.\PHYSICALDRIVE10	0	1	1
0x00000003	\\.\PHYSICALDRIVE11	0	1	2
0x00000004	\\.\PHYSICALDRIVE12	0	1	3
0x00000005	\\.\PHYSICALDRIVE13	0	1	4
0x00000006	\\.\PHYSICALDRIVE14	0	1	5
0x00000007	\\.\PHYSICALDRIVE15	0	1	6
0x00000008	\\.\PHYSICALDRIVE16	0	1	7

## NVMe/FC Host Configuration for Windows Server 2016 with ONTAP

### Supportability

NVMe/FC is supported on ONTAP 9.7 or later for Windows Server 2016.

Note that the Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, use MSDSM as the Microsoft Multipath I/O (MPIO) option.

See the [Hardware Universe](#) for a list of supported FC adapters and controllers. For the most current list of supported configurations & versions, see the [NetApp Interoperability Matrix](#).

### Known limitations

Windows Failover Cluster (WFC) is not supported with ONTAP NVMe/FC because ONTAP does not currently support persistent reservations with NVMe/FC.

Note that the external driver shipped by Broadcom for Windows NVMe/FC is not a true NVMe/FC driver but a translational SCSI → NVMe driver. This translational overhead does not necessarily impact performance, but it does negate the performance benefits of NVMe/FC. Thus, on Windows servers, NVMe/FC and FCP performance is the same, unlike on other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.



## Enabling NVMe/FC on a Windows initiator host

Follow these steps to enable FC/NVMe on the Windows initiator host:

1. Install OneCommand Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
  - EnableNVMe = 1
  - NVMEMode = 0
  - LimTransferSize=1
3. Reboot the host.

## Configuring the Broadcom FC adapter in Windows for NVMe/FC

With the Broadcom adapter for FC/NVMe in a Windows environment, a **hostnqn** is associated with each host bus adapter (HBA) port. The **hostnqn** is formatted as follows.

*Example*

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765  
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

## Enabling MPIO for NVMe devices on the Windows host

1. Install Windows Host Utility Kit 7.1 to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.
5. From the **MPIO** tab, click **Details**.
6. Set the following MSDSM settings:
  - PathVerifiedPeriod: **10**
  - PathVerifyEnabled: **Enable**
  - RetryCount: **6**
  - RetryInterval: **1**
  - PDORemovedPeriod: **130**
7. Select the MPIO Policy **Round Robin with Subset**.

8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD -> 30
```

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\ UseCustomPathRecoveryInterval  
DWORD-> 1
```

9. Reboot the host.

The NVMe configuration is now complete on the Windows host.

## Validating NVMe/FC

1. Validate that the Port Type is FC+NVMe.

Now that NVMe is enabled, you should see the **Port Type** listed as **FC+NVMe**, as follows.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd listhba
```

#### Manageable HBA List

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type     : FC+NVMe
Model        : LPe32002-M2
```

```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model        : LPe32002-M2
```

2. Validate that NVMe/FC subsystems have been discovered.

The `nvme-list` command lists the NVMe/FC discovered subsystems.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list 10:00:00:10:9b:1b:97:65
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:65

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                 : 20:09:d0:39:ea:14:11:04
Node WWN                 : 20:05:d0:39:ea:14:11:04
Controller ID            : 0x0180
Model Number             : NetApp ONTAP Controller
Serial Number            : 81CGZBPU5T/uAAAAAAB
Firmware Version         : FFFFFFFF
Total Capacity           : Not Available
Unallocated Capacity     : Not Available
```

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                 : 20:06:d0:39:ea:14:11:04
Node WWN                 : 20:05:d0:39:ea:14:11:04
Controller ID            : 0x0181
Model Number             : NetApp ONTAP Controller
Serial Number            : 81CGZBPU5T/uAAAAAAB
Firmware Version         : FFFFFFFF
Total Capacity           : Not Available
Unallocated Capacity     : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd nvme-list 10:00:00:10:9b:1b:97:66
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:66

```
NVMe Qualified Name      : nqn.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                  : 20:07:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0140
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

```
NVMe Qualified Name      : nqn.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159
Port WWN                  : 20:08:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0141
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

### 3. Validate that namespaces have been created.

The `nvme-list-ns` command lists the namespaces for a specified NVMe target that lists the namespaces connected to the host.

```
PS C:\Program Files\Emulex\Util\OCManager> .\HbaCmd.exe nvme-list-ns
10:00:00:10:9b:1b:97:66 20:08:d0:39:ea:14:11:04 nq
.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-
159 0
```

Active Namespaces (attached to controller 0x0141):

NSID	DeviceName	SCSI Bus Number	SCSI Target Number	SCSI OS LUN
0x00000001	\\.\PHYSICALDRIVE9	0	1	0
0x00000002	\\.\PHYSICALDRIVE10	0	1	1
0x00000003	\\.\PHYSICALDRIVE11	0	1	2
0x00000004	\\.\PHYSICALDRIVE12	0	1	3
0x00000005	\\.\PHYSICALDRIVE13	0	1	4
0x00000006	\\.\PHYSICALDRIVE14	0	1	5
0x00000007	\\.\PHYSICALDRIVE15	0	1	6
0x00000008	\\.\PHYSICALDRIVE16	0	1	7

## NVMe/FC Host Configuration for Windows Server 2012 R2 with ONTAP

### Supportability

NVMe/FC is supported on ONTAP 9.7 or later for Windows Server 2016.

Note that the Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, use MSDSM as the Microsoft Multipath I/O (MPIO) option.

See the [Hardware Universe](#) for a list of supported FC adapters and controllers. For the most current list of supported configurations & versions, see the [NetApp Interoperability Matrix](#).

### Known limitations

Windows Failover Cluster (WFC) is not supported with ONTAP NVMe/FC because ONTAP does not currently support persistent reservations with NVMe/FC.

Note that the external driver shipped by Broadcom for Windows NVMe/FC is not a true NVMe/FC driver but a translational SCSI → NVMe driver. This translational overhead does not necessarily impact performance, but it does negate the performance benefits of NVMe/FC. Thus, on Windows servers, NVMe/FC and FCP performance is the same, unlike on other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

## Enabling NVMe/FC on a Windows initiator host

Follow these steps to enable FC/NVMe on the Windows initiator host:

1. Install OneCommand Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
  - EnableNVMe = 1
  - NVMeMode = 0
  - LimTransferSize=1
3. Reboot the host.

## Configuring the Broadcom FC adapter in Windows for NVMe/FC

With the Broadcom adapter for FC/NVMe in a Windows environment, a **hostnqn** is associated with each host bus adapter (HBA) port. The **hostnqn** is formatted as follows.

*Example*

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765  
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

## Enabling MPIO for NVMe devices on the Windows host

1. Install Windows Host Utility Kit 7.1 to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.
5. From the **MPIO** tab, click **Details**.
6. Set the following MSDSM settings:
  - PathVerifiedPeriod: **10**
  - PathVerifyEnabled: **Enable**
  - RetryCount: **6**
  - RetryInterval: **1**
  - PDORemovedPeriod: **130**
7. Select the MPIO Policy **Round Robin with Subset**.

8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD -> 30
```

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\ UseCustomPathRecoveryInterval  
DWORD-> 1
```

9. Reboot the host.

The NVMe configuration is now complete on the Windows host.

## Validating NVMe/FC

1. Validate that the Port Type is FC+NVMe.

Now that NVMe is enabled, you should see the **Port Type** listed as **FC+NVMe**, as follows.



```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd listhba
```

#### Manageable HBA List

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type     : FC+NVMe
Model         : LPe32002-M2
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```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model         : LPe32002-M2
```

2. Validate that NVMe/FC subsystems have been discovered.

The `nvme-list` command lists the NVMe/FC discovered subsystems.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list 10:00:00:10:9b:1b:97:65
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:65

```
NVMe Qualified Name      : nqn.1992-  
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-159  
Port WWN                 : 20:09:d0:39:ea:14:11:04  
Node WWN                 : 20:05:d0:39:ea:14:11:04  
Controller ID           : 0x0180  
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Firmware Version        : FFFFFFFF  
Total Capacity           : Not Available  
Unallocated Capacity     : Not Available
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Controller ID           : 0x0181  
Model Number             : NetApp ONTAP Controller  
Serial Number            : 81CGZBPU5T/uAAAAAAB  
Firmware Version        : FFFFFFFF  
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```

Note: At present Namespace Management is not supported by NetApp Arrays.

```
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```

```
Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:66
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Controller ID           : 0x0140  
Model Number            : NetApp ONTAP Controller  
Serial Number           : 81CGZBPU5T/uAAAAAAB  
Firmware Version        : FFFFFFFF  
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Port WWN                 : 20:08:d0:39:ea:14:11:04  
Node WWN                 : 20:05:d0:39:ea:14:11:04  
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Note: At present Namespace Management is not supported by NetApp Arrays.

### 3. Validate that namespaces have been created.

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PS C:\Program Files\Emulex\Util\OCManager> .\HbaCmd.exe nvme-list-ns
10:00:00:10:9b:1b:97:66 20:08:d0:39:ea:14:11:04 nq
.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_interop-57-
159 0
```

Active Namespaces (attached to controller 0x0141):

NSID	DeviceName	SCSI Bus Number	SCSI Target Number	SCSI OS LUN
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0x00000002	\\.\PHYSICALDRIVE10	0	1	1
0x00000003	\\.\PHYSICALDRIVE11	0	1	2
0x00000004	\\.\PHYSICALDRIVE12	0	1	3
0x00000005	\\.\PHYSICALDRIVE13	0	1	4
0x00000006	\\.\PHYSICALDRIVE14	0	1	5
0x00000007	\\.\PHYSICALDRIVE15	0	1	6
0x00000008	\\.\PHYSICALDRIVE16	0	1	7

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