



# NVIDIA L40 GPU Accelerator

## Product Brief

# Document History

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Version	Date	Authors	Description of Change
01	October 10, 2022	MD, SM	Initial release – Preliminary
02	October 13, 2022	MD, SM	Minor document modification

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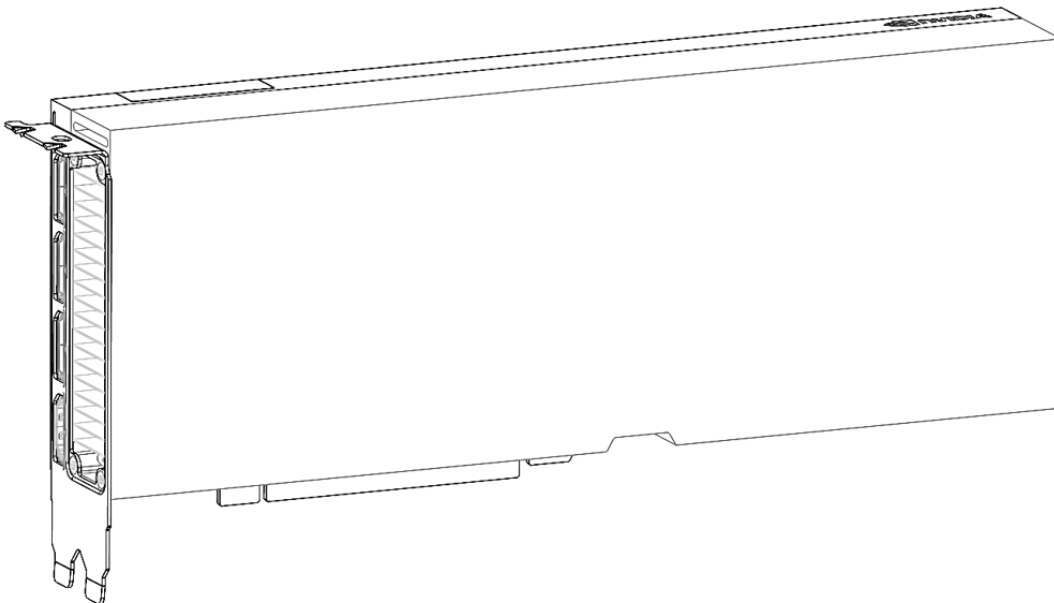
# Overview

The NVIDIA L40 GPU Accelerator is a full height, full-length (FHFL), dual-slot 10.5 inch PCI Express Gen4 graphics solution based on the latest NVIDIA Ada Lovelace Architecture. The card is passively cooled and capable of 300 W maximum board power.

The NVIDIA L40 supports the latest hardware-accelerated ray tracing, revolutionary AI features, advanced shading, and powerful simulation capabilities for a wide range of graphics and compute use cases in data center and edge server deployments. This includes NVIDIA Omniverse™, cloud gaming, batch rendering, virtual workstations, and deep learning training as well as inference workloads.

As part of the NVIDIA OVX™ server platform, L40 delivers the highest level of graphics, ray tracing, and simulation performance for NVIDIA Omniverse. With 48 GB of GDDR6 memory, even the most intense graphics applications run with the highest level of performance.

Figure 1. NVIDIA L40 PCIe Card



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# Specifications

## Product Specifications

Table 1 through Table 3 provide the product, memory, and software specifications for the NVIDIA L40 PCIe card.

Table 1. Product Specifications

Specification	NVIDIA L40
Product SKU	PG133 SKU 250 NVPN: 699-2G133-0250-xxx
Total board power	300 W default 300 W maximum TBD W minimum
Thermal solution	Passive
Mechanical Form Factor	Full-height, full-length (FHFL) 10.5", dual-slot
GPU SKU	AD102-895/895A
PCI Device IDs	Device ID: 0x26B5 Vendor ID: 0x10DE Sub-Vendor ID: 0x10DE Sub-System ID: 0x169D
GPU clocks	Base: TBD MHz Boost: TBD MHz
Performance States	P0
VBIOS	EEPROM size: 8 Mbit UEFI: Supported
PCI Express interface	PCI Express Gen4 x16 Lane and polarity reversal supported
Multi-Instance GPU (MIG)	Not supported
NVIDIA® NVLink®	Not supported
Zero Power	Not supported

Specification	NVIDIA L40
Connectors	One PCIe 16-pin auxiliary power connector Four DisplayPort connectors
Weight	Board: 1,051 grams (excluding bracket, and extenders) Bracket with screws: 20 grams Enhanced straight extender: 35 grams Long offset extender: 48 grams Straight extender: 32 grams

Table 2. Memory Specifications

Specification	Description
Memory clock	9,001 MHz
Memory type	GDDR6
Memory size	48 GB
Memory bus width	384 bits
Peak memory bandwidth	864 GB/s

Table 3. Software Specifications

Specification	Description <sup>1</sup>
SR-IOV support	Supported -- 32 VF (virtual functions)
BAR address (physical functions)	BAR0: 16 MiB BAR1: 64 GiB (Display Off mode; default) BAR1: 8 GiB (Display On, 8 GB BAR1 mode) BAR1: 256 MiB (Display On, 256 MB BAR1 mode) BAR3: 32 MiB
BAR address (virtual functions)	Display Off Mode (default): <ul style="list-style-type: none"> <li>• BAR0: 8 MiB (32 VF × 256 KiB)</li> <li>• BAR1: 64 GiB, 64-bit (32 VF × 2 GiB)</li> <li>• BAR3: 1 GiB, 64-bit (32 VF × 32 MiB)</li> </ul> Display On Modes: VF BAR sizes are not applicable to Display On modes
Message signaled interrupts	MSI-X: Supported MSI: Not supported
ARI Forwarding	Supported
Driver support	Linux: R525 or later Windows: R525 or later
Secure Boot	Supported (See "Root of Trust" section)

Specification	Description <sup>1</sup>
CEC firmware	Not Supported
NVIDIA® CUDA® support	CUDA 12.0 or later
Virtual GPU software support	Supports vGPU 15.1 or later: NVIDIA Virtual Compute Server Edition
Operating modes	Display Off mode (default) Display On, 8 GiB BAR1 mode Display On, 256 MiB BAR1 mode
PCI class code	0x03 – Display controller
PCI subclass code	0x02 – 3D controller (Display Off) 0x00 – VGA controller (Display On)
Primary boot device capability	Supported in Display On modes
ECC support	Enabled (default); can be disabled by software
SMBus (8-bit address)	0x9E (write), 0x9F (read)
IPMI FRU EEPROM I2C address	0x50 (7-bit), 0xA0 (8-bit)
Reserved I2C addresses	0xAA, 0xAC
SMBus direct access	Supported
SMBPBI	Supported

**Note:**

<sup>1</sup>The KiB, MiB, and GiB notation emphasize the “power of two” nature of the values. Thus,

- 256 KiB =  $256 \times 1024$
- 16 MiB =  $16 \times 1024^2$
- 64 GiB =  $64 \times 1024^3$

The operator is given the option to configure this power setting to be persistent across driver reloads or to revert to default power settings upon driver unload.



# Environmental and Reliability Specifications

Table 4 provides the environment conditions specifications for the NVIDIA L40 PCIe card.

**Table 4. Board Environmental and Reliability Specifications**

Specification	Description
Ambient operating temperature	0°C to 50°C
Ambient operating temperature (short term) <sup>1</sup>	-5°C to 55°C
Storage temperature	-40°C to 75°C
Operating humidity (short term) <sup>1</sup>	5% to 93% relative humidity
Operating humidity	5% to 85% relative humidity
Storage humidity	5% to 95% relative humidity
Mean time between failures (MTBF)	Uncontrolled environment: <sup>2</sup> TBD hours at 35°C Controlled environment: <sup>3</sup> TBD hours at 35°C

Notes: Specifications in this table are applicable up to 6,000 feet.

<sup>1</sup>A period not more than 96 hours consecutive, not to exceed 15 days per year.

<sup>2</sup>Some environmental stress with limited maintenance (GF35).

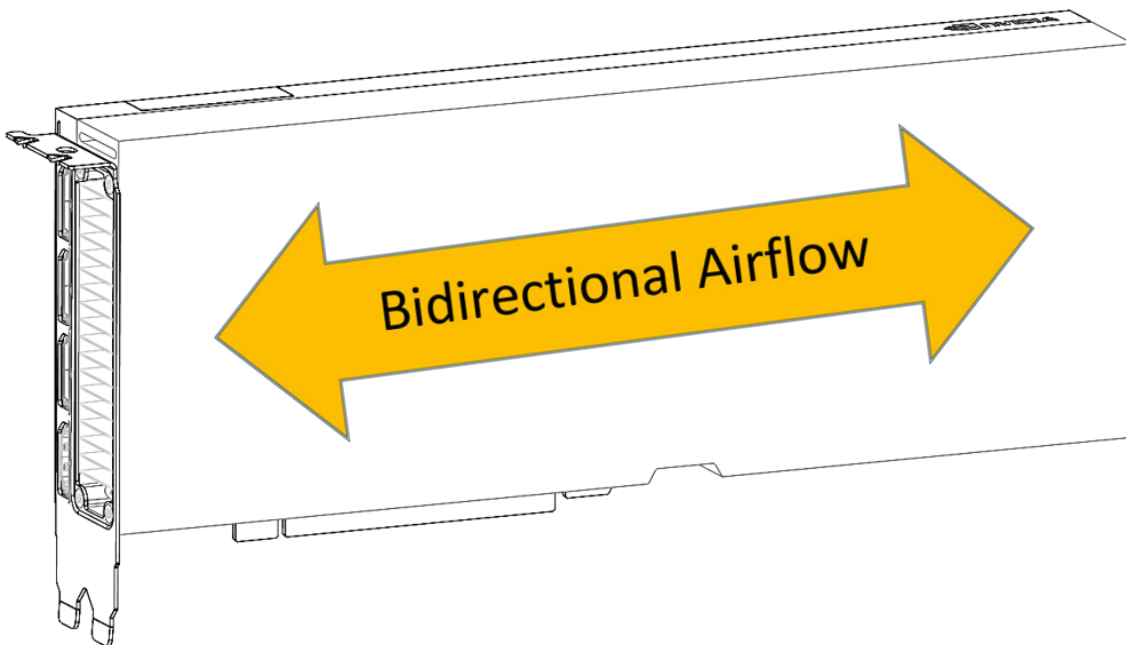
<sup>3</sup>No environmental stress with optimum operation and maintenance (GB35).

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# Airflow Direction Support

The NVIDIA L40 PCIe card employs a bidirectional heat sink, which accepts airflow either left-to-right or right-to-left directions.

Figure 2. L40 Airflow Direction



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# Product Features

## PCI Express Interface Specifications

The following subsections describe the PCIe interface specifications for the NVIDIA L40 PCIe card.

### PCIe Support

The NVIDIA L40 GPU card supports PCIe Gen4. Either a Gen4 x16, Gen4 x8, or Gen3 x16 interface should be used when connecting to the NVIDIA L40 PCIe card.

### Single Root I/O Virtualization Support

Single Root I/O Virtualization (SR-IOV) is a PCIe specification that allows a physical PCIe device to appear as multiple physical PCIe devices. Per PCIe specification, each device can have up to a maximum of 256 virtual functions (VFs). The actual number can depend on the device. SR-IOV is enabled in an NVIDIA L40 PCIe card with 32 VFs supported.

For each device, SR-IOV identifies two function classes:

- ▶ Physical functions (PFs) constitute full-featured functionality. They are fully configurable, and their configuration can control the entire device. Naturally, a PF also has full ability to move data in and out of the device.
- ▶ Virtual functions (VFs), which lack configuration resources. VFs exist on an underlying PF, which may support many such VFs. VFs only have the ability to move data in and out of the device. They cannot be configured and cannot be treated like a full PCIe device. The OS or hypervisor instance must be aware that they are not full PCIe devices.

The NVIDIA L40 requires that SBIOS and software support in the operating system (OS) instance or hypervisor is configured to enable support for SR-IOV. The OS instance or hypervisor must be able to detect and initialize PFs and VFs.

### Interrupt Messaging

The NVIDIA L40 PCIe card only supports the MSI-X interrupt messaging protocol. The MSI interrupt protocol is not supported.

## Polarity Inversion and Lane Reversal Support

Lane Polarity Inversion and Lane Reversal, as defined in the PCIe specification, are supported on the NVIDIA L40 PCIe card.

## Root of Trust

The NVIDIA L40 provides a primary root of trust within the GPU that provides the following:

- ▶ Secure boot
- ▶ Secure firmware upgrade
- ▶ Firmware rollback protection
- ▶ Support for in-band firmware update disable (established after each GPU reset)
- ▶ Secure application processor recovery

## Display

This section details the operating modes for NVIDIA L40.

### Display On and Off

The L40 PCIe card supports three operating modes as described by Table 5.

Table 5. Display Modes

Display Mode	BAR Address (Physical Functions)
Display Off (default)	BAR1: 64 GiB (Display Off mode; default)
Display On 8GB BAR1 Mode	BAR1: 8 GiB (Display On, 8 GB BAR1 mode)
Display On 256MB BAR1 Mode	BAR1: 256 MiB (Display On, 256 MB BAR1 mode)

## Display Off Mode

The default Display Off mode supports SR-IOV and is required to run NVIDIA Virtual GPU software. NVIDIA L40 supports all four editions of NVIDIA Virtual GPU software:

- ▶ NVIDIA RTX™ Virtual Workstation (RTX vWS)
- ▶ NVIDIA Virtual PC (vPC)
- ▶ NVIDIA Virtual Applications (vApps)
- ▶ NVIDIA AI Enterprise (NVAIE)

## Display On 8GB BAR1 Mode

The Display On, 8GB BAR1 mode is the recommended configuration for scalable visualization system deployments. In this mode, the NVIDIA L40 card requires a BAR1 size of 8 GB and can drive up to four VESA® DisplayPort™ monitors through the integral DisplayPort connectors on the card's bracket.

Synchronizing content across multiple monitors driven from different L40 cards is accomplished by use of the NVIDIA® Quadro® Sync II card. The following document provides usage guidance for this technology:

*Quadro Sync II User's Guide* (DU-08348-001)

## Display On 256MB BAR1 Mode

The Display On, 256MB BAR1 mode is the recommended configuration for professional desktop systems. In this mode, the NVIDIA L40 card can drive up to four DisplayPort monitors through the integral DisplayPort connectors on the card's bracket.

Synchronizing content across multiple monitors driven from different L40 cards is accomplished by use of the Quadro Sync II card. The following document provides usage guidance for this technology:

*Quadro Sync II User's Guide* (DU-08348-001)

## Switching Operating Modes

For running NVIDIA L40 in the Display On modes, register on the NVIDIA Developer Zone and download the DisplayModeSelector tool.

System requirements should be checked before switching modes. After switching modes, the system must be rebooted for the configured modes to take effect.

## Frame Lock

The NVIDIA L40 supports frame lock by use of the NVIDIA Quadro Sync II board. See the *Quadro Sync II Board Specification* (BD-08152-001) and *Quadro Sync II User's Guide* (DU-08348-001) for details. The L40 frame lock and stereo connectors are on the north edge of the NVIDIA L40 PCIe card.

## Display Bracket

The L40 card provides a display bracket that may be removed for system configurations that do not use the NVIDIA bracket.

## Programmable Power

The Programmable Power feature provides the ability to configure the power cap of the card for system power and thermal budget or performance-per-watt reasons.

The power cap can be modified using either of these two NVIDIA tools:

- ▶ In-band: `nvidia-smi` (power cap adjustment must be reestablished after each new driver load)
- ▶ Out-of-band: SMBPBI (power cap adjustment remains in force across driver loads and system boots)

Power limit specifications for the NVIDIA L40 are presented in Table 1.

## `nvidia-smi`

`nvidia-smi` is an in-band monitoring tool provided with the NVIDIA driver and can be used to set the maximum power consumption with driver running in persistence mode. An example command to reduce the power cap to 150 W is shown:

```
nvidia-smi -pm 1
nvidia-smi -pl 150
```

To restore the NVIDIA L40 back to its default TDP power consumption, either the driver module can be unloaded and reloaded, or the following command can be issued:

```
nvidia-smi -pl 300
```

## SMBPBI

An out-of-band channel exists through the SMBus Post-Box Interface (SMBPBI) protocol to set the power limit of the GPU. This also requires that the NVIDIA driver be loaded for full functionality. The power cap can be adjusted through the following asynchronous command:

Table 6. SMBPBI Commands

Specification	Value
Opcode	10h – Submit/poll asynchronous request
Arg1	0x01 – Set total GPU power limit
Arg2	0x00

Using SMBPBI, the configured power limit setting can be made persistent across driver reloads. Refer to the *SMBus Post-Box Interface (SMBPBI) Design I*(DG-06034-002) for full implementation details.

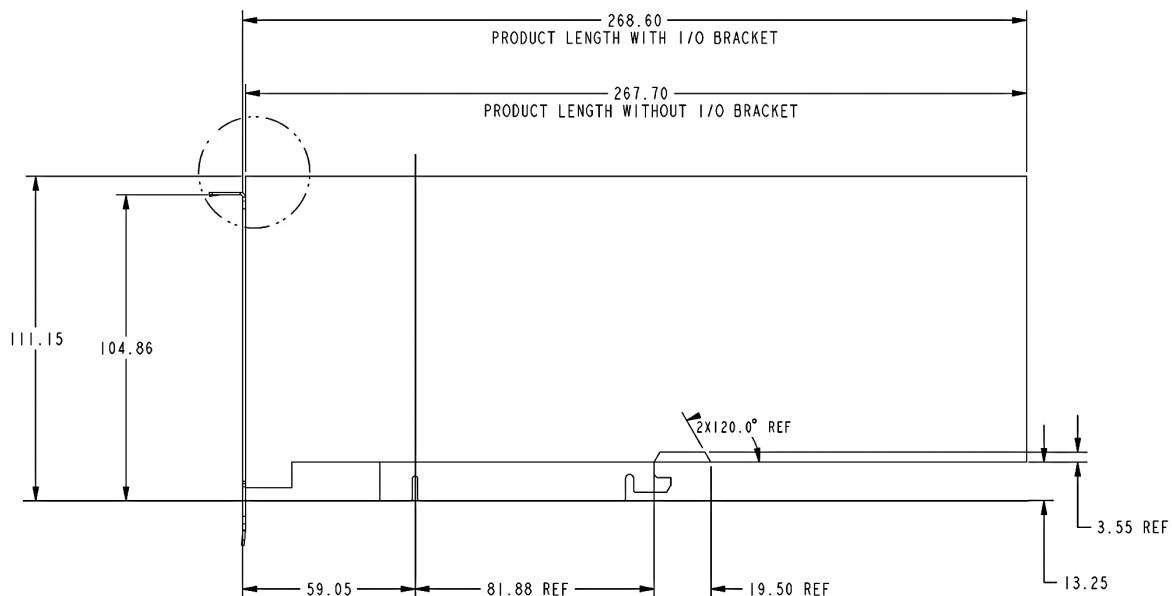
## IPMI FRU EEPROM

The NVIDIA L40 supports the Intelligent Platform Management Interface (IPMI) FRU Specification v1.0 r1.3. See Table 3 for the FRU EEPROM I2C address.

## Form Factor

In this product specification, nominal dimensions are shown.

Figure 3. NVIDIA L40 PCIe Card Dimensions



# Power Connector

This section details the power connector for the NVIDIA L40 PCIe card.

## Power Connector Placement

The board provides a PCIe 16-pin power connector on the east edge of the board.

Figure 4. PCIe 16-Pin Power Connector

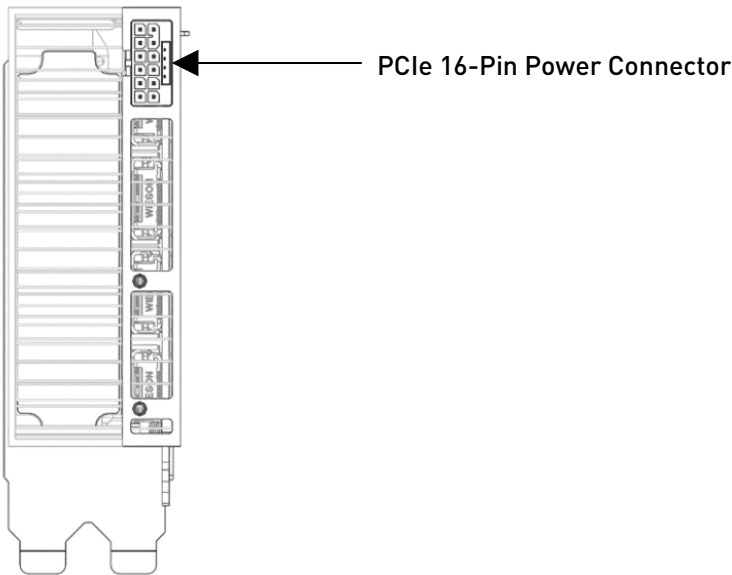
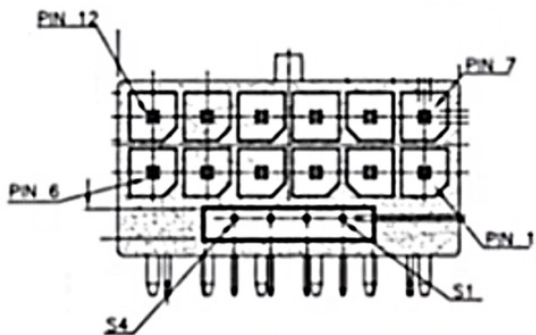


Figure 5 shows the pin assignments for the PCIe 16-pin power connector, per PCIe CEM 5.0 specification.

Figure 5. PCIe 16-Pin Power Connector Pin Assignments



**12V PWR Cable Plug Pin Assignment**

Pin	Signal
1 to 6	+12 V
7 to 12	Ground
S1	CARD_PWR_STABLE
S2	CARD_CBL_PRES#
S3	SENSE0
S4	SENSE1



Table 7 lists the power level options identifiable by the PCIe 16-pin power connector per CEM5 PSU, and the corresponding Sense0 and Sense1 logic. The NVIDIA card senses the Sense0 and Sense1 levels and recognizes the power available to the NVIDIA card from the power connector. If the power level identified by Sense0 and Sense1 is equal to or greater than what the NVIDIA card needs from the 16-pin connector, the NVIDIA card operates per normal. If the power level identified by Sense0 and Sense1 is less than the default power cap of the NVIDIA card, the card will not boot.

The NVIDIA L40 requires up to 300 W from the 16-pin power connector. Thus, the top three rows of Table 7 are acceptable. The configuration [Sense0=1, Sense1=1] will prevent the NVIDIA L40 from booting.

Table 7. PCIe CEM 5.0 16-Pin PCIe PSU Power Level vs. Sense Logic

Power Level	Sideband 3 (Sense0)	Sideband 4 (Sense1)
451 - 600 W	0	0
301 - 450 W	1 (float)	0
151 - 300 W	0	1 (float)
Up to 150 W	1 (float)	1 (float)

Table 8 lists supported auxiliary power connections for the NVIDIA L40 GPU card.

Table 8. Supported Auxiliary Power Connections

Board Connector	PSU Cable
PCIe 16-pin	PCIe 16-pin
PCIe 16-pin	CPU 8-pin to PCIe 16-pin

## CPU 8-Pin to PCIe 16-Pin Power Adapter

A CPU 8-pin to PCIe 16-pin power adapter for systems that do not have native PCIe 16-pin power connectors may be used. Figure 6 illustrates an example power adapter.

Figure 6. CPU 8-Pin to PCIe 16-Pin Power Adapter

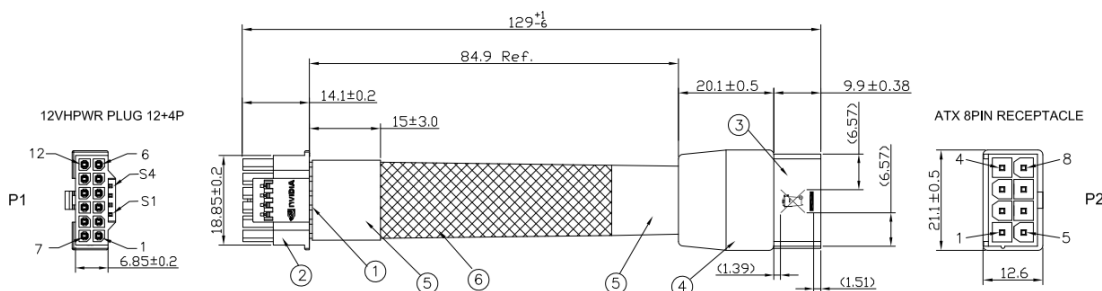
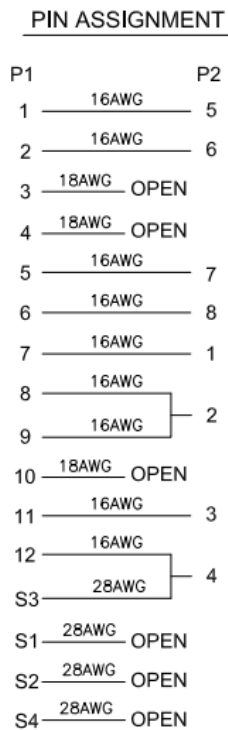


Figure 7 shows CPU 8-Pin to PCIe 16-Pin power adapter pin assignments.

Figure 7. CPU 8-Pin to PCIe 16-Pin Power Adapter Pin Assignments



The power adapter must support the four Sideband signals, hardware-strapped per Table 9. Strapping corresponding to the “151 – 300 W” power level PCIe CEM 5.0 specification (shown in Row 3 of Table 7), or strapping rows 1 and 2 of Table 7 are acceptable for the NVIDIA L40 PCIe card. When using a CPU 8-pin to PCIe 16-pin power adapter, the NVIDIA L40 recognizes that there is sufficient power available on its PCIe 16-pin auxiliary power connector.

Table 9. Power Adapter Sideband Signals

Sideband 1 Card Power Stable	Sideband 2 Card Cable Present	Sideband 3 Sense0	Sideband 4 Sense1
1 (float)	1 (float)	0	1 (float)

## Extenders

The NVIDIA L40 PCIe extender options are TBD.

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# Support Information

## Certification

- ▶ Windows Hardware Quality Lab (WHQL):
  - Certified Windows 7, Windows 8.1, Windows 10, Windows 11
  - Certified Windows Server 2012 R2, Windows Server 2019, Windows Server 2022
- ▶ Ergonomic requirements for office work W/VDTs (ISO 9241)
- ▶ EU Reduction of Hazardous Substances (EU RoHS)
- ▶ Joint Industry guide (J-STD) / Registration, Evaluation, Authorization, and Restriction of Chemical Substance (EU) – (JIG / REACH)
- ▶ Halogen Free (HF)
- ▶ EU Waste Electrical and Electronic Equipment (WEEE)

## Agencies

- ▶ Australian Communications and Media Authority and New Zealand Radio Spectrum Management (RCM)
- ▶ Bureau of Standards, Metrology, and Inspection (BSMI)
- ▶ Conformité Européenne (CE)
- ▶ Federal Communications Commission (FCC)
- ▶ Industry Canada - Interference-Causing Equipment Standard (ICES)
- ▶ Korean Communications Commission (KCC)
- ▶ Underwriters Laboratories (cUL, UL)
- ▶ Voluntary Control Council for Interference (VCCI)

# Languages

Table 10. Languages Supported

Languages	Windows <sup>1</sup>	Linux
English (US)	Yes	Yes
English (UK)	Yes	Yes
Arabic	Yes	
Chinese, Simplified	Yes	
Chinese, Traditional	Yes	
Czech	Yes	
Danish	Yes	
Dutch	Yes	
Finnish	Yes	
French (European)	Yes	
German	Yes	
Greek	Yes	
Hebrew	Yes	
Hungarian	Yes	
Italian	Yes	
Japanese	Yes	
Korean	Yes	
Norwegian	Yes	
Polish	Yes	
Portuguese (Brazil)	Yes	
Portuguese (European/Iberian)	Yes	
Russian	Yes	
Slovak	Yes	
Slovenian	Yes	
Spanish (European)	Yes	
Spanish (Latin America)	Yes	
Swedish	Yes	
Thai	Yes	
Turkish	Yes	

**Note:**

<sup>1</sup>Microsoft Windows 7, Windows 8, Windows 8.1, Windows 10, Windows Server 2008 R2, Windows Server 2012 R2, and Windows 2016 are supported.

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