



CREATING A 3 BY 3 DISPLAY WALL USING QUADRO MOSAIC

DA-06561-001_v01 | October 2012

Application Note



DOCUMENT CHANGE HISTORY

DA-06561-001_v01

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HARDWARE

To create a 3 × 3 visualization display wall the following hardware is required.

DISPLAYS



Figure 1. 9 Identical Displays

WORKSTATION

- ▶ Three PCI Express ×16 Gen3 or Gen2 slots - Figure 2
 - Windows 7 (64-bit)
 - Windows 8 (64-bit)
 - Linux (64-bit)
- ▶ Three NVIDIA Quadro® K5000 graphics processing units (GPUs) – Figure 3
- ▶ Stereo bracket (if stereo display) – Figure 4
 - NVIDIA® part number 930-50764-0000-000. Connect to 4-pin header on the Quadro® K5000. Only one is needed per system.
- ▶ Quadro Sync card – Figure 5



Figure 2. PCI Express x16 Gen3 or Gen 2 Slots



Figure 3. Quadro K5000 GPUs



Figure 4. Stereo Bracket

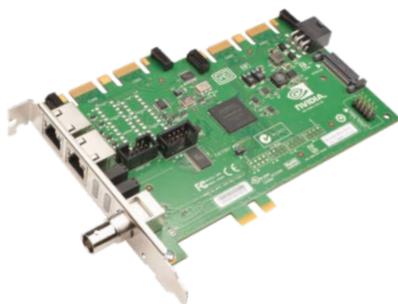


Figure 5. Quadro Sync Card

ATTACHING QUADRO SYNC TO QUADRO K5000

The Quadro Sync is attached to each Quadro K5000 cards via the sync ribbon cable. The Quadro Sync card can support up to 4 GPUs. The card requires either PCI or SATA power connector. It does not matter which connector on the Quadro Sync board each GPU is connected to. The connectors are bi-directional so it does not matter which side of the Quadro Sync board or GPU they go to.

Refer to the *Quadro Sync Installation Guide* for detailed information.

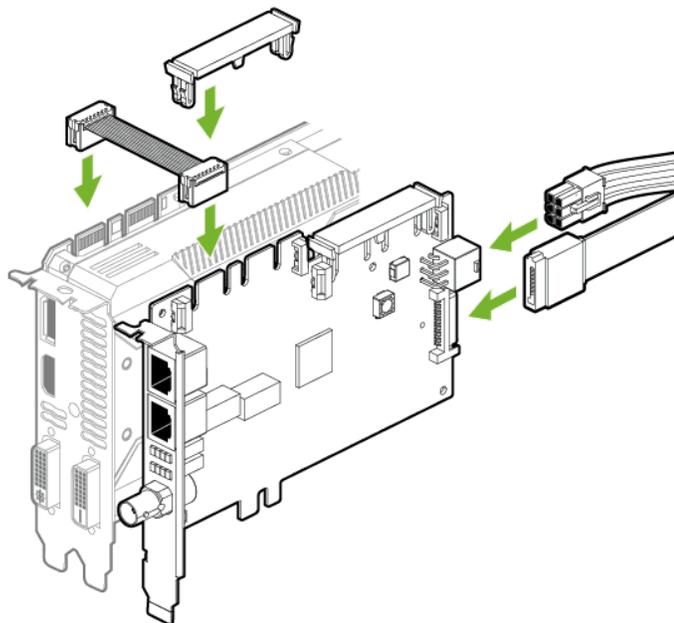


Figure 6. Quadro Sync Installation

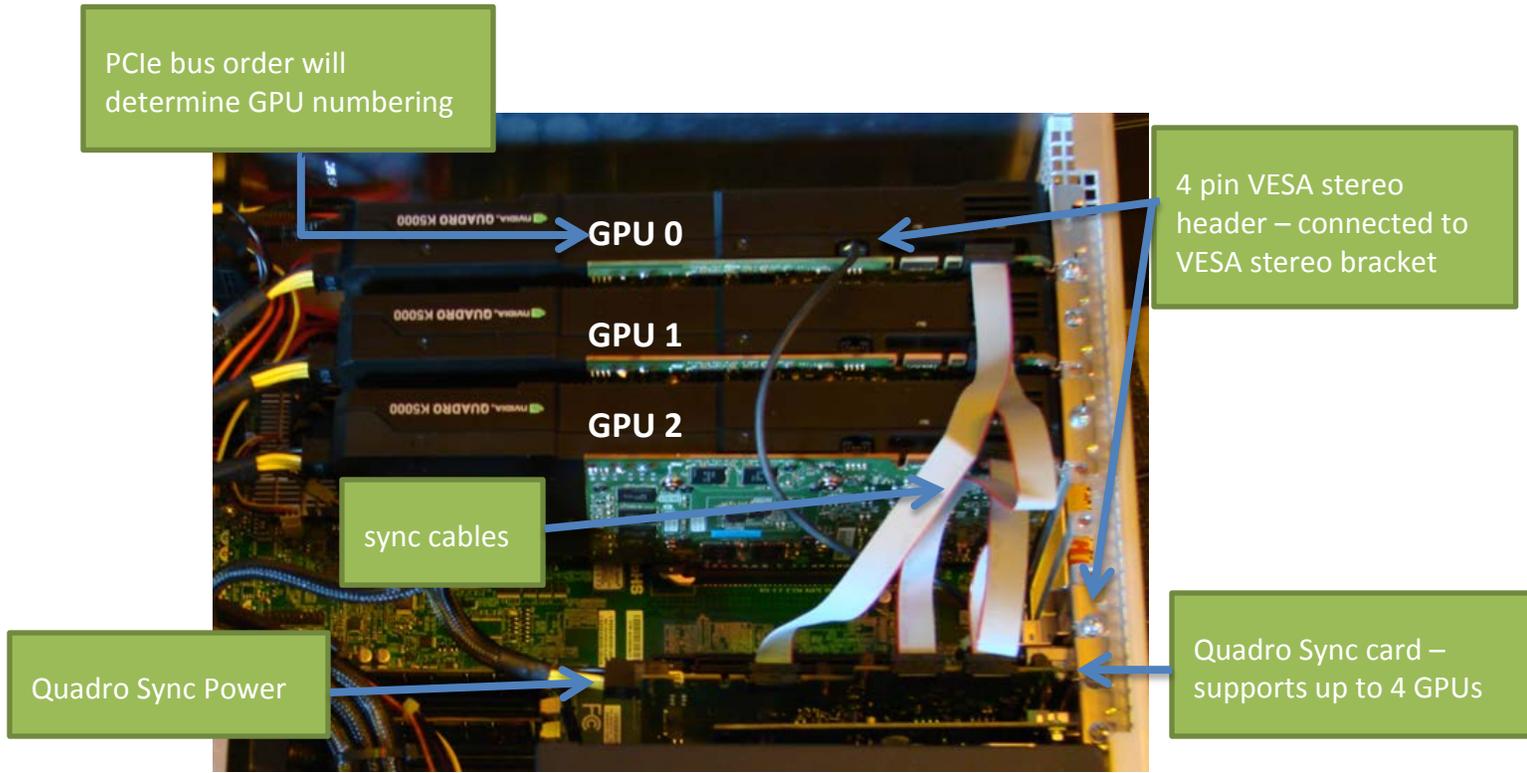


Figure 7. Three Quadro K5000 + Quadro Sync in Box Technologies 8950 Workstation

IDENTIFYING GPU ORDERING

The system BIOS of a workstation will enumerate the GPU order. This will vary between different workstations. It is possible to identify the GPU order based on the motherboard connections. GPU 0 is generally the lowest PCI Express number on the motherboard. Table 1 shows the PCI Express layout for a modern dual CPU system. The user manual or label in the chassis of most workstations includes a PCI Express slot map.



CAUTION: On newer chipsets the PCI Express bus is directly integrated on the CPU. Some systems require dual CPUs in order to support 3 or 4 GPUs.

Table 1. Dual CPU PCIe Layout

	CPU 0		CPU 1	
PCIe lane order	PCIe 2	PCIe 3	PCIe 3	PCIe 2
Physical order	Slot 2	Slot 4	Slot 6	Slot 8
GPU number	0	1	3	2

Note: In this 4 GPU example the PCIe order doesn't follow the physical order of PCIe slots. Slot 8 would enumerate before Slot 6.

SOFTWARE INSTALLATION

DRIVER INSTALLATION

NVIDIA® Mosaic plus Quadro Sync requires NVIDIA Driver Release R310 branch or newer. Download and install the latest ODE driver for Quadro. The latest drivers can be downloaded from the NVIDIA Web site: <http://www.nvidia.com/drivers>.

NVIDIA Driver Downloads

Option 1: Manually find drivers for my NVIDIA products.

Product Type:	Quadro	▼
Product Series:	Quadro Sync Series	▼
Product:	Quadro Sync	▼
Download Type:	Quadro ODE Graphics Driver	▼
Operating System:	Windows 7 64-bit	▼
Language:	English (US)	▼

SEARCH

Figure 8. Driver Downloads

MOSAIC UTILITY

Download and install the latest Mosaic utility from the NVIDIA Web site:
<http://www.nvidia.com/drivers>.



Note: Download and save the Mosaic utility to the Desktop, disk, or another easily accessible folder. Don't run the installation as the utility is a command line tool not an installer.

NVIDIA Driver Downloads

Option 1: Manually find drivers for my NVIDIA products.

Product Type:	Quadro	▼
Product Series:	Quadro Series	▼
Product:	Quadro 6000	▼
Download Type:	Mosaic Utility	▼
Operating System:	Windows 7 64-bit	▼
Language:	English (US)	▼

SEARCH

MOSAIC UTILITY

Version:	1.2.4
Release Date:	2012.03.05
Operating System:	Windows 7, Windows 7 64-bit
Language:	English (U.S.)
File Size:	0.473 MB

DOWNLOAD

Figure 9. Mosaic Utility Download

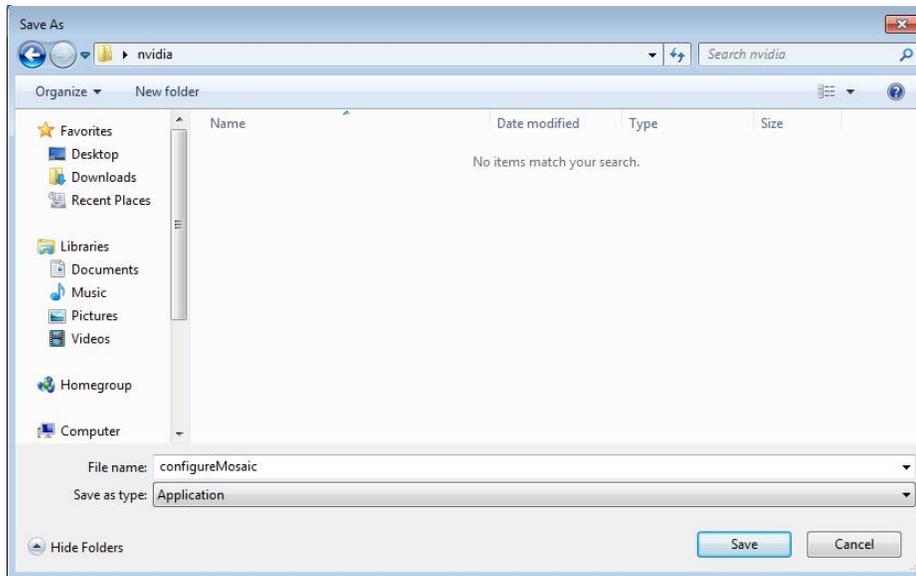


Figure 10. Save Mosaic Utility to an Accessible Folder



Note: Mosaic Utility is a command line tool. Run via the cmd.exe shell on Windows. Save the utility to a disk. The program is named `configuremosaic.exe`.

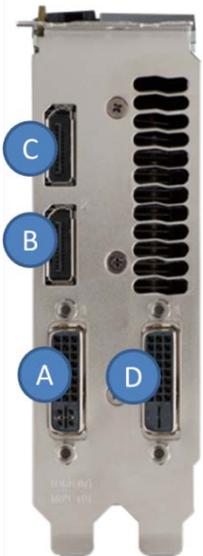
ATTACHING THE DISPLAYS TO THE QUADRO K5000

The Quadro K5000 has four display connectors. All four can be connected and operated at one time. The ports the Quadro K5000 will auto-enumerate depending on whether or not a display connector is attached.

For example if only Ports A and D are connected these would be identified as Display 0 and 1. If we added a display to Port B then A=0, B=1 and D=2.



Note: To connect four DVI displays from one card, use two DisplayPort-to-DVI dongles.



Port	Connector Type
A	DVI-I
B	DisplayPort
C	DisplayPort
D	DVI-D

Figure 11. Quadro K5000 Back Plane

IDENTIFYING DISPLAY CONNECTION PORT NUMBERS

Figure 12 shows the rear connection of our workstation.

- ▶ GPU 0 is in PCIe Slot 2
- ▶ GPU 1 is in PCIe Slot 4
- ▶ GPU 2 is in PCIe Slot 6

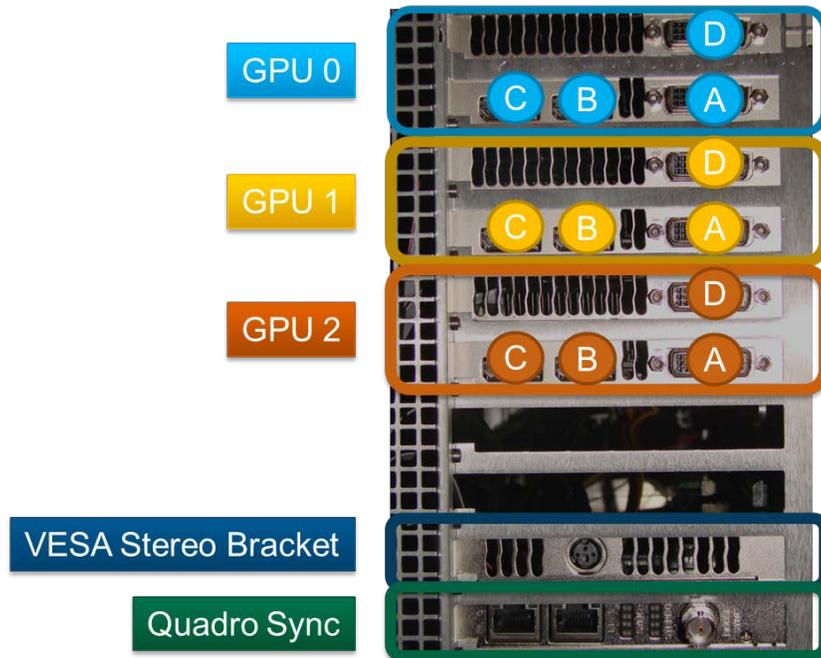


Figure 12. Workstation Rear Connection

For a 3 × 3 wall we are going to use Ports A, B and C for the connections. For each port we can describe these in terms of GPU display numbers (Figure 13).

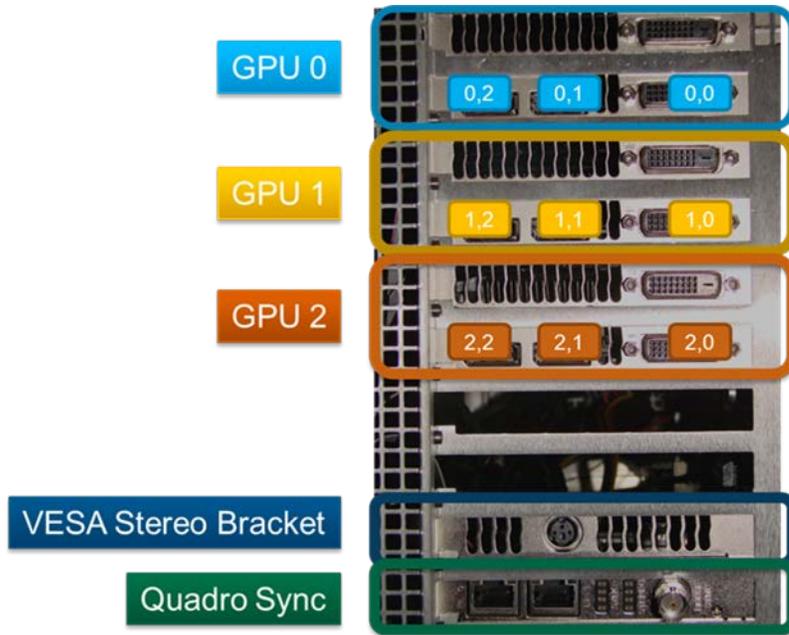


Figure 13. Display Connection Port Numbers

UNDERSTANDING MOSAIC DISPLAY TOPOLOGIES

Mosaic display topologies are defined as grid expressed by rows and columns.



Figure 14. Mosaic 3 by 3 Display Numbers

For a 3 by 3 configuration the grid is numbered top left to bottom right and going left to right across the rows.

We want to connect GPU 0, Port 0 to the top left corner. Each row is being driven by a single GPU. In doing this we will connect the default layout for Mosaic.



Figure 15. 3 by 3 Grid Default GPU Connections



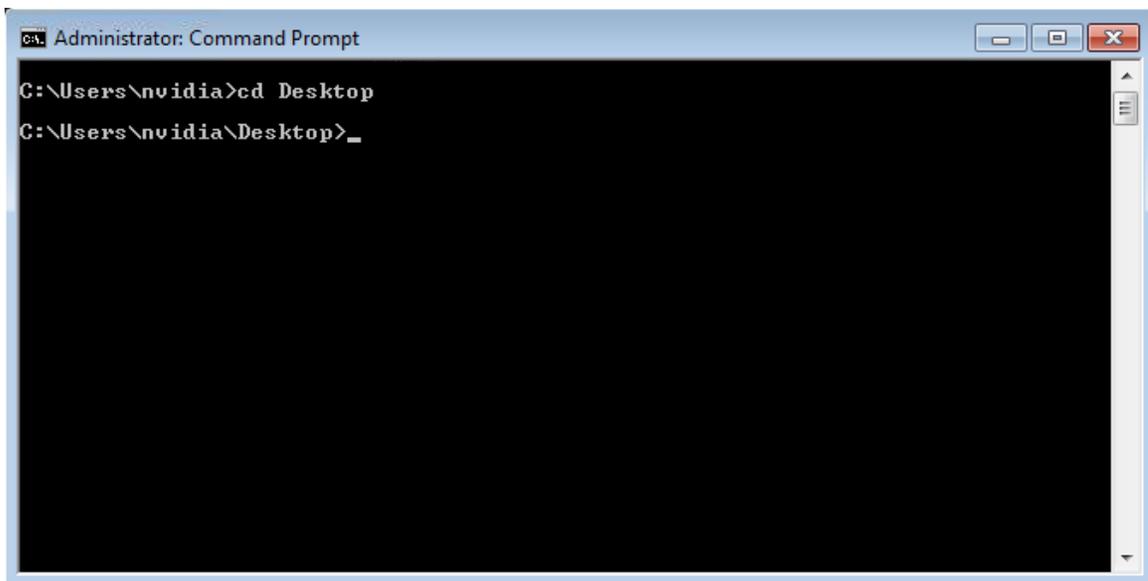
Note: Use the `configuremosaic.exe` tool to enable Mosaic. Run it from `cmd.exe`. Make sure the command shell has Administrator rights.

```
configuremosaic.exe set rows=3 cols=3
```

USING MOSAIC UTILITY

The Mosaic Utility is designed to setup Mosaic from a command line. Refer to “Configuremosaic Option” section for all the options.

1. Open cmd.exe in windows to run the utility.



```
Administrator: Command Prompt
C:\Users\nvidia>cd Desktop
C:\Users\nvidia\Desktop>_
```

2. Change to the directory where the configuremosaic.exe file is saved. In this example it is saved on the Desktop.



Note: Mosaic is laid out in a grid setting defined by rows and columns. For a nine display set-up we have 3 rows with 3 columns. Each display needs to run the same resolution.

3. Type “configuremosaic test rows=3 cols=3.” This will test if the grid is valid. It will also printout all the valid resolutions that can be supported for Mosaic.

```

<?xml version="1.0"?>
<test version="1.2.4" valid="1">
  <grids>
    <grid rows="1" columns="2">
      <displaymode width="1920" height="1080" bpp="32" freq="60" />
      <displays>
        <display displayid="0x80061082" overlapcolumn="0" overlaprow="0" rotation="0" />
        <display displayid="0x80061081" overlapcolumn="0" overlaprow="0" rotation="0" />
      </displays>
      <gridstatus>
        <gridflags />
        <displayflags displayid="0x80061082" />
        <displayflags displayid="0x80061081" />
      </gridstatus>
      <displaymodelist>
        <displaymode width="640" height="480" bpp="32" freq="60" />
        <displaymode width="720" height="480" bpp="32" freq="60" />
        <displaymode width="720" height="576" bpp="32" freq="50" />
        <displaymode width="800" height="600" bpp="32" freq="60" />
        <displaymode width="800" height="600" bpp="32" freq="75" />
        <displaymode width="1024" height="768" bpp="32" freq="60" />
        <displaymode width="1024" height="768" bpp="32" freq="75" />
        <displaymode width="1152" height="864" bpp="32" freq="75" />
        <displaymode width="1176" height="664" bpp="32" freq="50" />
        <displaymode width="1176" height="664" bpp="32" freq="50" />
        <displaymode width="1280" height="720" bpp="32" freq="50" />
        <displaymode width="1280" height="720" bpp="32" freq="60" />
        <displaymode width="1280" height="768" bpp="32" freq="60" />
        <displaymode width="1280" height="800" bpp="32" freq="60" />
        <displaymode width="1280" height="800" bpp="32" freq="75" />
        <displaymode width="1280" height="960" bpp="32" freq="60" />
        <displaymode width="1280" height="960" bpp="32" freq="75" />
        <displaymode width="1280" height="1024" bpp="32" freq="60" />
        <displaymode width="1280" height="1024" bpp="32" freq="75" />
        <displaymode width="1360" height="768" bpp="32" freq="60" />
        <displaymode width="1360" height="768" bpp="32" freq="60" />
        <displaymode width="1600" height="900" bpp="32" freq="60" />
        <displaymode width="1600" height="1024" bpp="32" freq="60" />
        <displaymode width="1600" height="1200" bpp="32" freq="60" />
        <displaymode width="1680" height="1050" bpp="32" freq="60" />
        <displaymode width="1768" height="992" bpp="32" freq="50" />
        <displaymode width="1768" height="992" bpp="32" freq="60" />
        <displaymode width="1920" height="1080" bpp="32" freq="50" />
        <displaymode width="1920" height="1080" bpp="32" freq="60" />
      </displaymodelist>
    </grid>
  </grids>
</test>

```



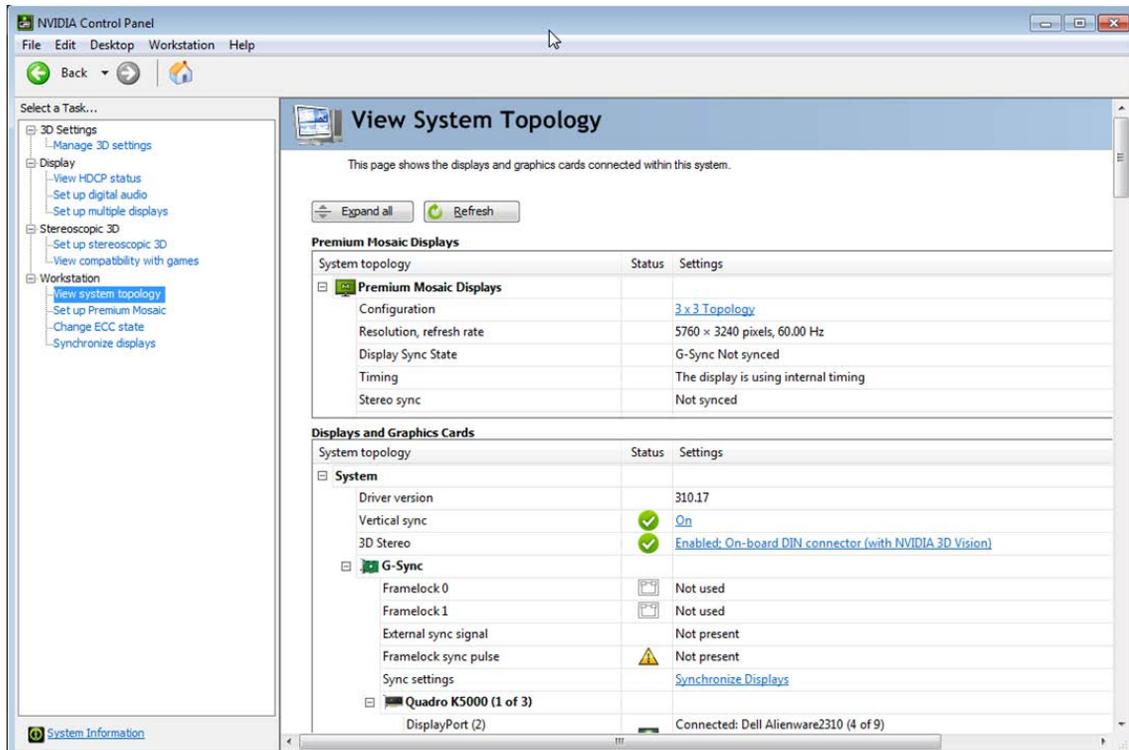
Note: The output of the tool is on xml format. You can redirect the output to a file and open it in a xml viewer for easier reading. `configuremosaic.exe test rows=3 cols=3 > test_report.xml`

- To set the configuration type:
`configuremosaic.exe set rows=3 cols=3 res=1920,1080,60`



Note: `res=1920,1080,60` is the resolution per display. If the resolution command is not used the resolution will default to the displays' native resolution.

- The Desktop will now span across the nine displays. The NVIDIA Control Panel System Topology display will show the setting and resolution.



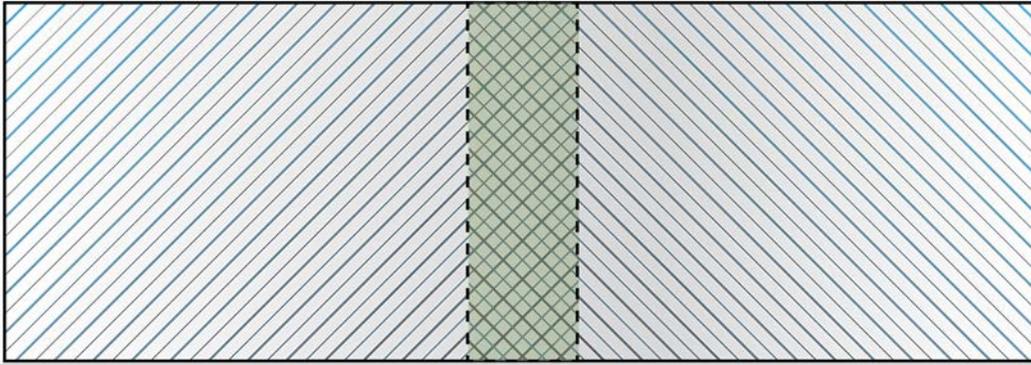
Note: If you use powershell, instead of the command prompt, some of the options need to have parenthesis added. For example:

```
configuremosaic set rows=3 cols=3 res="1920,1080,60"
```

SETTING OVERLAP OR BEZEL CORRECTION

Using configure mosaic tool Mosaic can match the overlap between two projectors or correct for bezels between displays. To set a 180 pixel overlap use the following command line:

```
configuremosaic set rows=1 cols=2 overlapcol=180 res=1920,1080,60
```



180 pixel overlap

Figure 16. Two Channels with 180 Pixel Overlap

The total display resolution will now be 3660 (3840-180) pixels.

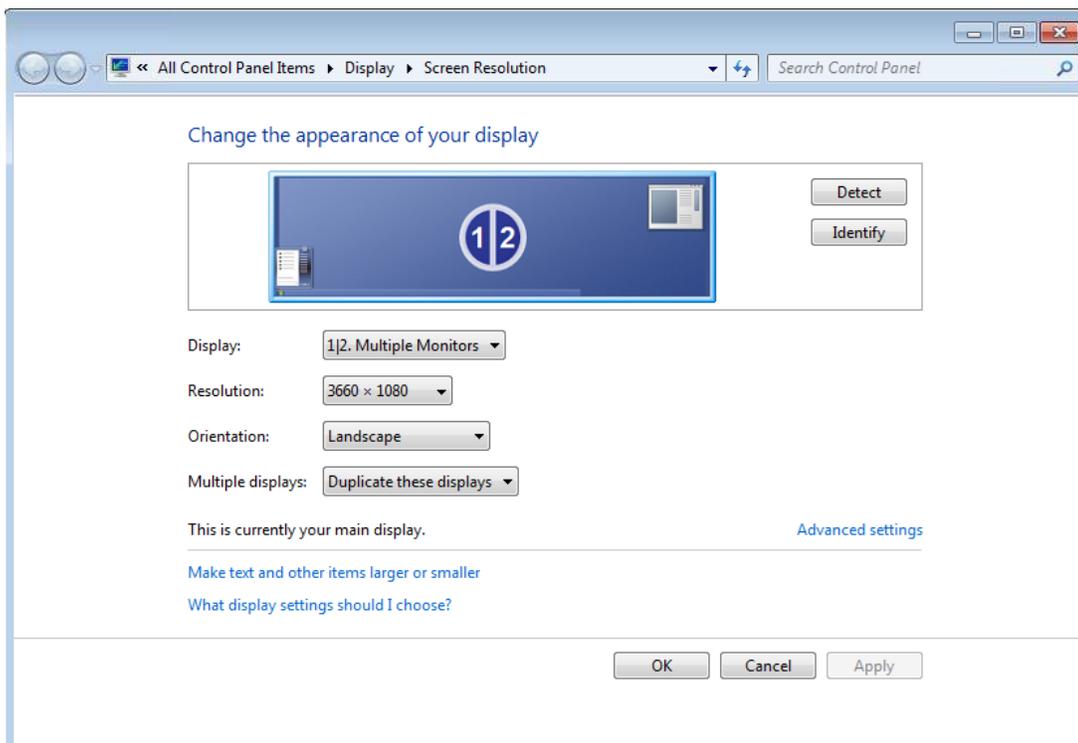


Figure 17. Screen Resolution with Overlap



Note: Overlap is not the same as edge-blending. Overlap is setting the desktop to create the overlap region between two projectors. Edge-blending requires intensity roll-off between the projectors.

Edge-blending can be done in the GPU using NVIDIA's Warp and Intensity API. This API is available to developers. Contact QuadroSVS@nvidia.com for more details.

Figure 17 shows a representation of a display without bezel correction. The half circle within the display appears to be distorted.



Tip: For Bezel correction use negative values for the overlapcol option. For example, overlapcol=-180 will set the bezel correction.

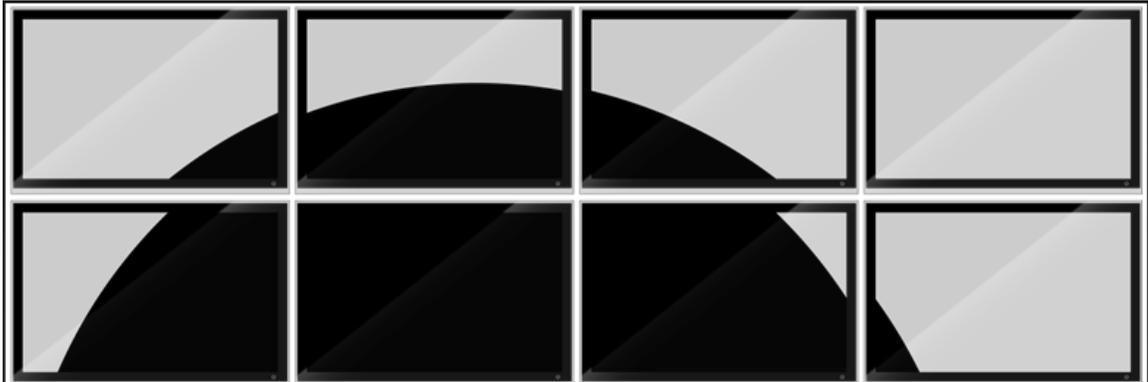


Figure 18. Two Rows, Four Columns without Bezel Correction

To correct for this we can set the bezel correction (Figure 18). The bezel may be non-uniform between rows and columns. Mosaic Utility allows you to adjust for this non-uniformity.

```
configuremosaic set rows=2 cols=4 overlapcol=-50 overlaprow=-100
```

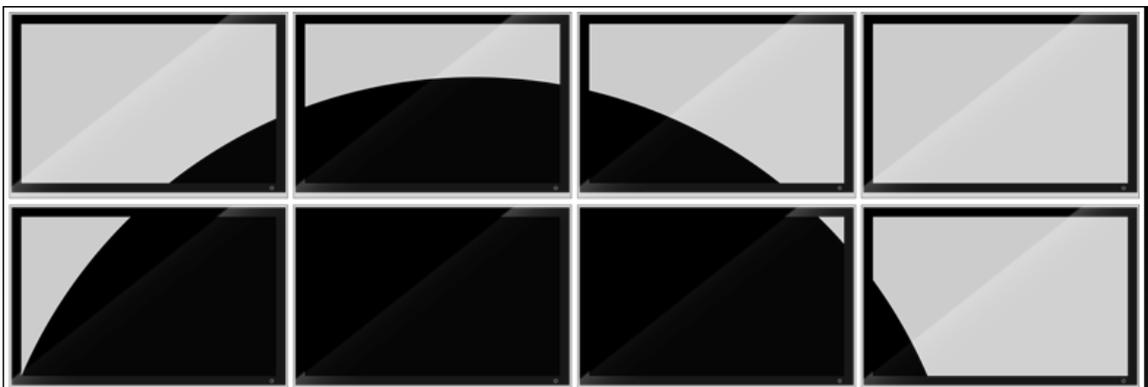


Figure 19. Mosaic with Bezel Correction Turned On

CONFIGUREMOSAIC OPTIONS

Usage: `configuremosaic <command> [arguments]`

Command options: `help`, `query`, `test`, `set`, `disable`.

HELP

Prints out help file all the options.

Usage: **`configuremosaic.exe help`**



Tip: Use “`configuremosaic help`” to printout the latest options.

QUERY

Returns information on the current system or configuration.

Usage: **`configuremosaic query [query command]`**

[query command] =

- `gpu` – display the list of physical GPUs and attached displays
- `lgpu` – display the list of possible logical GPUs
- `current` – display the current display grid
- `all` – display all the above information

Example: 4 GPUs in one system

```

configuremosaic query gpu
<?xml version="1.0"?>
<query version="1.2.4">
  <physicalgpus>
    <physgpu gpuid="0x000200">
      <name>Quadro K5000</name>
      <displays>
        <display displayid="0x80061082" outputid="0x010000" type="dfp">
          <shortname>DFP0</shortname>
          <name>Dell Alienware2310</name>
        </display>
      </displays>
    </physgpu>
    <physgpu gpuid="0x000300">
      <name>Quadro K5000</name>
      <displays>
        <display displayid="0x80071082" outputid="0x010000" type="dfp">
          <shortname>DFP0</shortname>
          <name>Dell Alienware2310</name>
        </display>
      </displays>
    </physgpu>
    <physgpu gpuid="0x008400">
      <name>Quadro K5000</name>
      <displays>
        <display displayid="0x80041082" outputid="0x010000" type="dfp">
          <shortname>DFP0</shortname>
          <name>Dell Alienware2310</name>
        </display>
      </displays>
    </physgpu>
    <physgpu gpuid="0x008500">
      <name>Quadro K5000</name>
      <displays>
        <display displayid="0x80051082" outputid="0x010000" type="dfp">
          <shortname>DFP0</shortname>
          <name>Dell Alienware2310</name>
        </display>
      </displays>
    </physgpu>
  </physicalgpus>
</query>

```

Example: Single display attached

```
configuremosaic query current
<?xml version="1.0"?>
<query version="1.2.4">
  <grids>
    <grid rows="1" columns="1">
      <displaymode width="1920" height="1080" bpp="32" freq="120" />
      <position x="0" y="0" />
      <displays>
        <display displayid="0x80051082" overlapcolumn="0" overlaprow="0"
rotation="0" />
      </displays>
    </grid>
  </grids>
</query>
```

TEST AND SET

Set or test one or more display grids. Use the token “nextgrid” to separate multiple grids. If successful the command will return “valid=1” at the top of the xml output.

Usage: **configuremosaic <test|set> <grid options> [nextgrid <grid options>]....**

Example: Test if rows=1 and cols=2 is valid and print out the valid resolutions.

```
configuremosaic test rows=1 cols=2
<?xml version="1.0"?>
<test version="1.2.4" valid="1">
  <grids>
    <grid rows="1" columns="2">
      <displaymode width="1920" height="1080" bpp="32" freq="120" />
      <displays>
        <display displayid="0x80061082" overlapcolumn="0" overlaprow="0"
          rotation="0" />
        <display displayid="0x80071082" overlapcolumn="0" overlaprow="0"
          rotation="0" />
      </displays>
      <gridstatus>
        <gridflags>
          <warningflags flags="0x02">
            <flag>DRIVER_WILL_BE_RELOADED</flag>
          </warningflags>
        </gridflags>
        <displayflags displayid="0x80061082" />
        <displayflags displayid="0x80071082" />
      </gridstatus>
      <displaymodelist>
        <displaymode width="1680" height="1050" bpp="32" freq="60" />
        <displaymode width="1680" height="1050" bpp="32" freq="100" />
        <displaymode width="1680" height="1050" bpp="32" freq="110" />
        <displaymode width="1680" height="1050" bpp="32" freq="120" />
        <displaymode width="1920" height="1080" bpp="32" freq="60" />
        <displaymode width="1920" height="1080" bpp="32" freq="100" />
        <displaymode width="1920" height="1080" bpp="32" freq="110" />
        <displaymode width="1920" height="1080" bpp="32" freq="120" />
      </displaymodelist>
    </grid>
  </grids>
</test>
```



Tip: Common error with Mosaic is that not all the displays support the same display resolution. The test option will print out the list of all the valid resolutions for a given setup. If you use

```
Configuremosaic.exe test rows=1 cols=2 > my_test_file.xml
```

The output from test will saved in an xml file for easier reading.

Example – Set rows=1 cols=4

```

configuremosaic set rows=1 cols=4
<?xml version="1.0"?>
<set version="1.2.4" valid="1">
  <grids>
    <grid rows="1" columns="4">
      <displaymode width="1920" height="1080" bpp="32" freq="60" />
      <displays>
        <display displayid="0x80061082" overlapcolumn="0"
          overlaprow="0" rotation="0" />
        <display displayid="0x80071082" overlapcolumn="0"
          overlaprow="0" rotation="0" />
        <display displayid="0x80041082" overlapcolumn="0"
          overlaprow="0" rotation="0" />
        <display displayid="0x80051082" overlapcolumn="0"
          overlaprow="0" rotation="0" />
      </displays>
    </grid>
  </grids>
</set>

```

This results in one large desktop as shown by Screen Resolution properties.

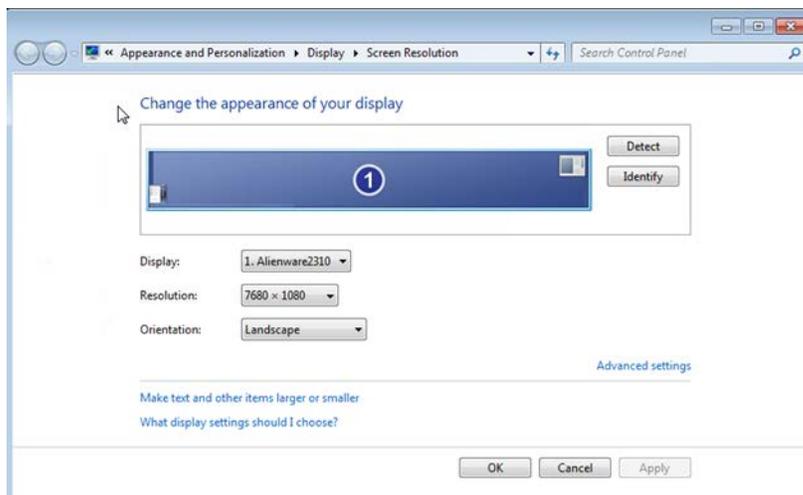
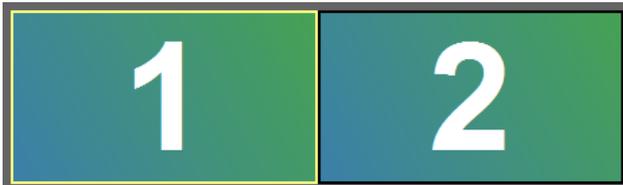


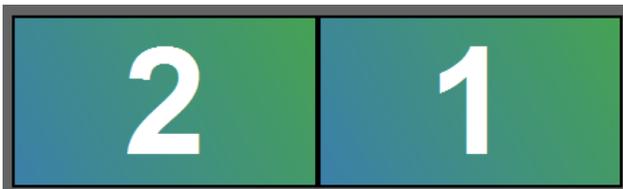
Figure 20. Screen Resolution after Setting 1 Row by 4 Columns

GRID OPTIONS

- ▶ rows = the number of rows in the grid
- ▶ cols = the number of columns in the grid
- ▶ passivestereo = enables passive stereo
- ▶ out=GPU_id, display_id – specifies the output order. i.e to flip the display order from:



to:

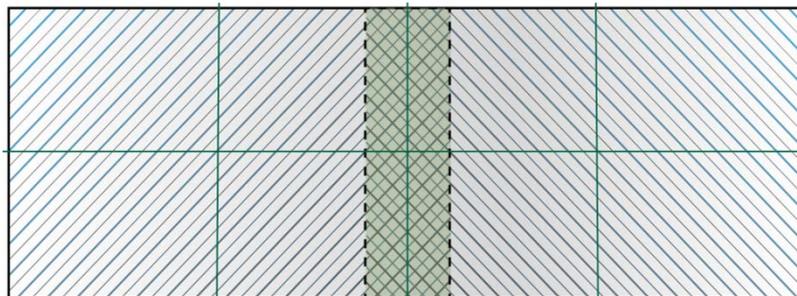


Use: `configuremosaic set rows=1 cols=2 out=0,1 out=0,0`

The GPU_id and out_id are explained earlier in this application note

- ▶ overlap=COL, ROW – specifies the overlap for the entire grid
- ▶ overlapcol= specifies overlap between columns - col1,col2, col3,...

For example, `configuremosaic set rows=2 cols=4 overlapcol=0,180,0`



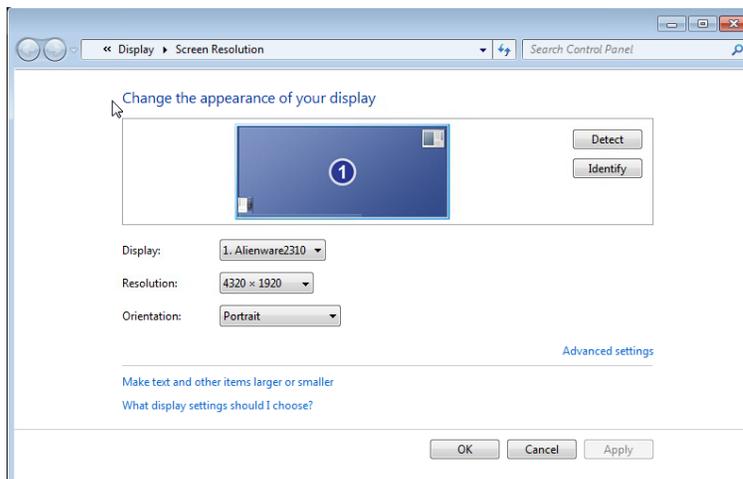
0 pixel
overlap

180 pixel
overlap

0 pixel
overlap

- ▶ overlaprow= specifies overlap between rows - row1,row2, row3,...
- ▶ rotate – specifies a rotation value for displays in a grid.

To configure each display in Portrait mode:
 configuremosaic set rows=1 cols=4 rotate=90



Tip: Do not set displays into portrait mode and then try and configure Mosaic, as this is not supported. Use the rotate option to rotate the displays in the grid.

DISABLE

Disable sets Mosaic to a 1 × 1 grid layout.

Usage: **configuremosaic disable**



Tip: configuremosaic set rows=1 cols=1 has the same effect as disable. You can specify which display in the grid becomes active by using the out option. For example:
 configuremosaic set rows=1 cols=1 out=0,0
 configuremosaic set rows=1 cols=1 out=1,0

ADVANCED OPTIONS

dohiccluster <master|slave|non-cluster>

This is related to using dual QuadroPlex 7000 as part of a display cluster. Contact QuadroSVS@nvidia.com for more details on this type of advanced setup.

FREQUENTLY ASKED QUESTIONS

Q: I have a question about NVIDIA's SVS products. Who should I contact?

A: Email: QuadroSVS@nvidia.com

Q: What OS is supported for Mosaic?

A: Windows XP, Windows 7, Windows 8 and Linux.

Q: What is the maximum of displays you can support with Mosaic?

A: We support up to 16 display outputs with the Quadro K5000 cards (8 display outputs on Windows XP and older versions of Quadro GPUs). For larger arrays, contact QuadroSVS@nvidia.com for solution options.

Q: What workstations can support three or four Quadro K5000 cards?

A: It is best to contact the workstation manufacturers to confirm that their system can support three or four GPUs, not only from a mechanical and electrical viewpoint but also to ensure that the system BIOS can correctly detect the GPUs and assign all necessary resources.

Q: Is a Quadro Sync card always required?

A: A Quadro Sync card should be used to enable Premium Mosaic which will ensure “tear free” image on the display. Premium Mosaic is required for:

- ▶ Overlap correction
- ▶ Warp plus blend functions
- ▶ Stereoscopic 3D

We recommend using the Quadro Sync with the Quadro K5000 when using projection displays and displays that have ultra-thin bezels.

A Quadro Sync card is not required for Premium MOSAIC between two Quadro K5000s in a Quadro SLI Compatible Systems -

http://www.nvidia.com/object/quadro_sli_compatible_systems.html

Q: Do all my displays need to be identical?

A: Yes. All the displays need to run the same resolution, refresh and backend timing for Mosaic.

Q: What is the maximum resolution that Mosaic can support?

A: The total horizontal or vertical resolution of the display cannot exceed 16 k pixels.

Q: Is Mosaic compatible with video wall controllers and splitters?

A: Yes. We have customers who use video splitters to increase the number of displays beyond 16. Contact QuadroSVS@nvidia.com for more details.

Q: Can I mix DisplayPort and DVI connections?

A: Yes, as long as all the displays use the same input type (all DVI in this case). You will need to use either a passive or active (powered) dongle depending on the display resolution you require.

Passive dongles support up to single-link DVI bandwidth (165 MHz) which is approximately 1920 × 1200 at 60 Hz resolution.

Most active dongles support up to 2560 × 1600 at 60 Hz (270 MHz) resolution.

NVIDIA certified active dongles support up to 1920 × 1200 at 120 Hz (330 MHz) resolution (NVIDIA part number: 030-0378-000 and Bizlink part number: KS10014-B07).

Q: My displays have HDMI connections. How do I connect to these?

A: Use a DVI-to-HDMI and/or DisplayPort-to-HDMI dongle or cable. The Quadro cards support native HDMI. When the driver detects an HDMI display it switches to HDMI signaling over the DVI or DisplayPort ports.

Q: Can Mosaic be used with cable and fiber extenders, and/or video switchers?

A: Yes. Some device extenders or switchers may not report the EDID correctly from the display device. We recommend that you use the Manage EDID function built into the display driver to capture the EDID from the display device and save to file. You can assign the EDID from the file to graphics output.

Q: What grid layouts do you support with Mosaic?

A:

Number of Displays	Supported Topologies (Rows x Columns)					
2	1 x 2	2 x 1				
3	1 x 3	3 x 1				
4	1 x 4	2 x 2	4 x 1			
5	1 x 5	5 x 1				
6	1 x 6	2 x 3	3 x 2	6 x 1		
7	1 x 7	7 x 1				
8	1 x 8	2 x 4	4 x 2	8 x 1		
9	1 x 9	3 x 3	9 x 1			
10	1 x 10	2 x 5	5 x 2	10 x 1		
11	1 x 11	11 x 1				
12	12 x 1	2 x 6	3 x 4	4 x 3	6 x 2	1 x 12
13	1 x 13	13 x 1				
14	1 x 14	2 x 7	7 x 2	14 x 1		
15	1 x 15	3 x 5	5 x 3	15 x 1		
16	1 x 16	2 x 8	4 x 4	8 x 2	16 x 1	

Note: The maximum horizontal or vertical resolution cannot exceed 16 k pixels. Some topologies will only work at lower resolution per screen.

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