



# Cooling Options for Thermal Control in Dell PowerEdge Servers

Customize the cooling options for installed server hardware

Dell Product Group | Server Engineering  
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## Revisions

| Date         | Description     |
|--------------|-----------------|
| January 2015 | Initial release |

## Acknowledgements

This paper was produced by the Server Engineering Team.

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# PowerEdge server thermal control options

Dell PowerEdge servers include proprietary thermal controls that automatically manage server component temperatures. These controls utilize sensor monitoring and information about hardware that is installed to minimize fan speeds, airflow, and power consumption without sacrificing reliability.

Adjusting the thermal controls in a PowerEdge server can be helpful if your server has a third-party PCIe card that needs additional cooling other than the default settings. Another example may be that the exhaust temperature of a server is too high for the switch mounted behind the server. In both cases, you would want to customize the fan control settings as described in this best practices guide.

This guide describes the fan control options and suggests some potential usages. Although these controls allow for customization of cooling, the server will never allow speeds to go below the threshold that is required to cool the server and any adapters provided by Dell. These options apply only to server system fans and do not influence fans located in peripheral devices such as power supplies or PCIe cards.

## Fan Offset option

With the Fan Offset option you can increase the system fan speed in four incremental steps.

- Low Fan Speed — Increases fan speeds by a low amount
- Medium Fan Speed — Increases fan speeds by a moderate amount
- High Fan Speed — Increases fan speeds by a large amount
- Max Fan Speed — Increases fan speeds to full speed
- Off (Default) — Baseline fan speed is applied with no offset

Note: Increasing the server fan speed to reduce component temperature and increase airflow will also increase server power consumption.

These settings add a predefined amount of fan speed to the baseline established by the automatic controls and are equally divided between the typical baseline and the maximum speed of the server fans. The automatic controls continue to maintain component temperatures based on sensor readings that may increase fan speeds beyond the user defined offset.

The fan speed offset increases all fan speeds by the same percentage. Some hardware configurations that have higher baseline fan speeds will have lower offsets for reaching the maximum speed. The amount of cooling provided by an offset and the percent increase in speed varies by server model.

Adjusting the Fan Offset setting can improve system cooling if your server has a third-party PCIe card adapter installed. However, the feature can be used to increase system cooling for other purposes. Figure 1 illustrates how the fan speed offset (shown in blue) increases the fan speed above the baseline (shown in grey).



# FAN OFFSETS

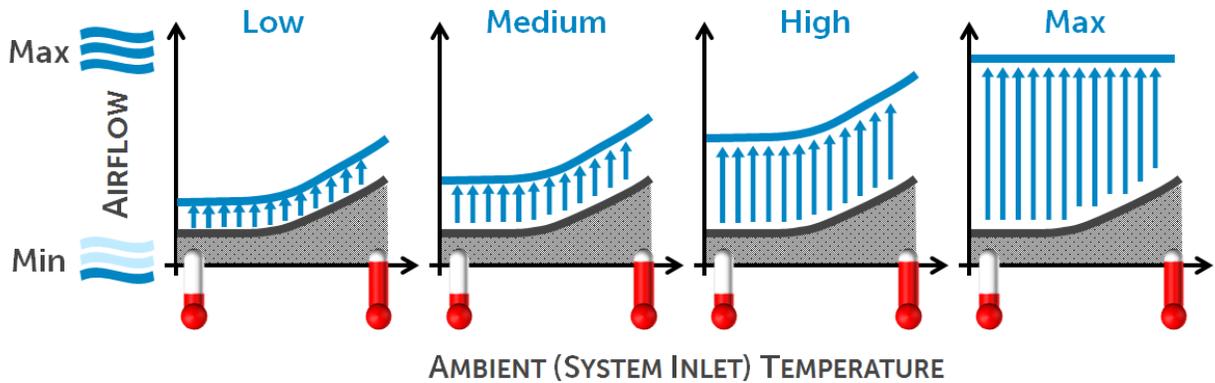


Figure 1 Fan speed offset

## Minimum Fan Speed (MFS) option

The Minimum Fan Speed option lets you set a baseline that the fan speed cannot go below. This setting is defined granularly as a percentage of the fan speed range (or % PWM).

System fans can run higher than the fan speed set by the MFS option (unless set to 100%), but not lower. For example, setting MFS at 35% limits the fan speed to never go lower than 35% PWM.

Note: 0% PWM does not mean the fan is off, but means it is the lowest fan speed available.

Figure 2 illustrates how the MFS setting works in conjunction with the automatic controls.

Note: Other subsystems in a server, like the CPU, may require fan speeds higher than the MFS or automatic baseline. This will generally occur during moderate to high usage of the computing subsystem.

## MINIMUM FAN SPEED

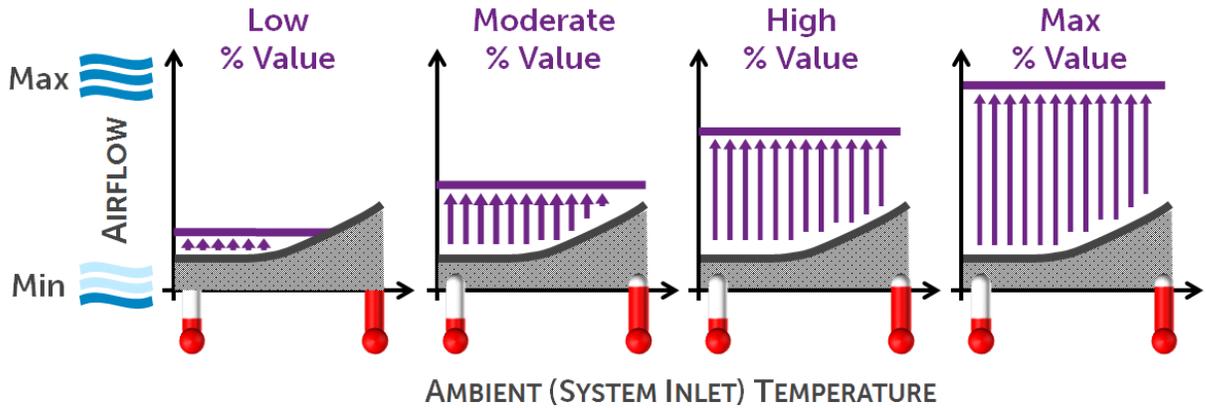


Figure 2 Illustrates how the Minimum Fan Speed setting creates a fan speed floor or lower bound

## Combining Fan Offset and MFS settings

Fan Offset and MFS options can be used together for a combined result. Figure 3 highlights how the fan offset and MFS might be used together to achieve a desired result.

## COMBINED SETTINGS

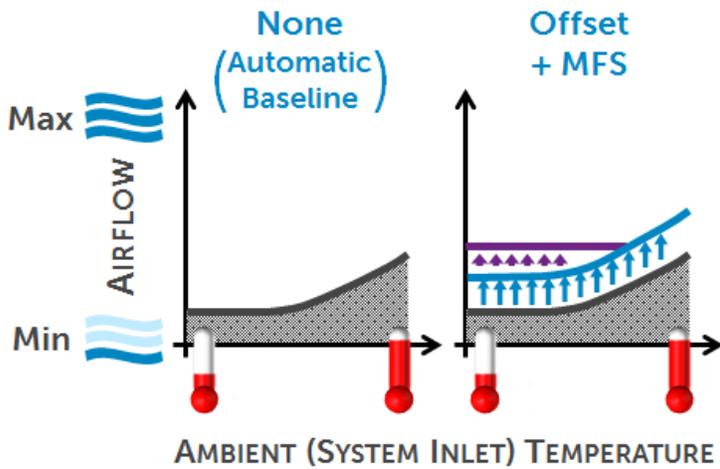


Figure 3 Illustrates how options can be combined



## Maximum Exhaust Temperature option

The Maximum Exhaust Temperature option allows the system fan speeds to be regulated to prevent the system exhaust air temperature from exceeding the chosen threshold. Two important things to note regarding this option:

1. Maintaining the desired exhaust temperature cannot be guaranteed under all conditions. For example, if a system with a rich configuration of components is operating under full utilization and operating in a high ambient temperature environment, the system may not have enough cooling headroom to maintain a low exhaust temperature. The default value is 70°C (158 °F), and will be maintained under all conditions.
2. It is also possible that there may not be any changes to the fan speed as a result of this setting if the system configuration, inlet ambient conditions, and server workload do not have a higher exhaust ambient temperature than the desired setting.

All of the custom fan speed options are persistent, which means that once they are set and applied, they do not automatically change to the default setting during system reboot, power cycling, iDRAC, or BIOS updates. A few Dell servers may or may not support some or all of these custom user-cooling options. If the options are not supported, they are not displayed or you cannot provide a custom value.

| Exhaust Temperature Setting   | Resultant Relative Airflow   |
|---|--|
|  70C (Default) |  |
|  60C           |  |
|  55C           |  |
|  50C           |  |

Figure 4 Illustrates how airflow increases to maintain an exhaust temperature limit

# Customizing the thermal settings on a PowerEdge server

There are a number of user interfaces available for customizing the fan speed settings in a PowerEdge server. The following is a brief summary of these interfaces.

- iDRAC GUI
  - Web browser based
  - Requires network connection (Note: Alternate access via USB A-A cable also possible)
  - GUI based and easy to navigate
  - No reboot required
- HII (Human Interface Infrastructure) browser
  - Accessed through BIOS Setup (F2)
  - Does not require network connection since setup is done directly on the server through BIOS setup
- IPMI (Intelligent Platform Management Interface)
- WSMAN (Web Service Management)
- RACADM (Remote Access Controller Admin)
  - Requires network connection and remote access to the server

Figure 5 illustrates user interaction with a server using the various interfaces.

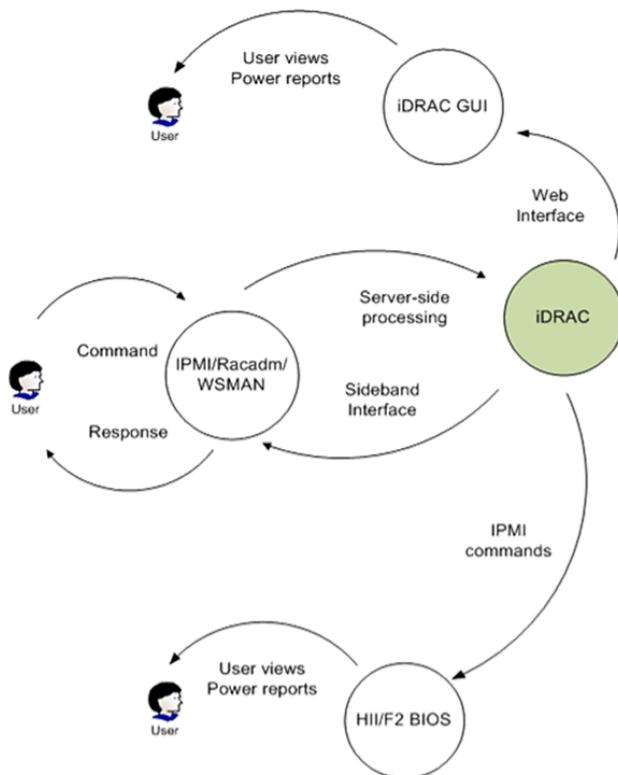


Figure 5 Illustrates the user paths for changing thermal settings



## Customizing fan speed using HII

To access the iDRAC Settings options (BIOS setup screen), press F2 at boot, then select iDRAC Settings. To customize thermal settings, select Thermal.



Figure 6 iDRAC Settings - Thermal

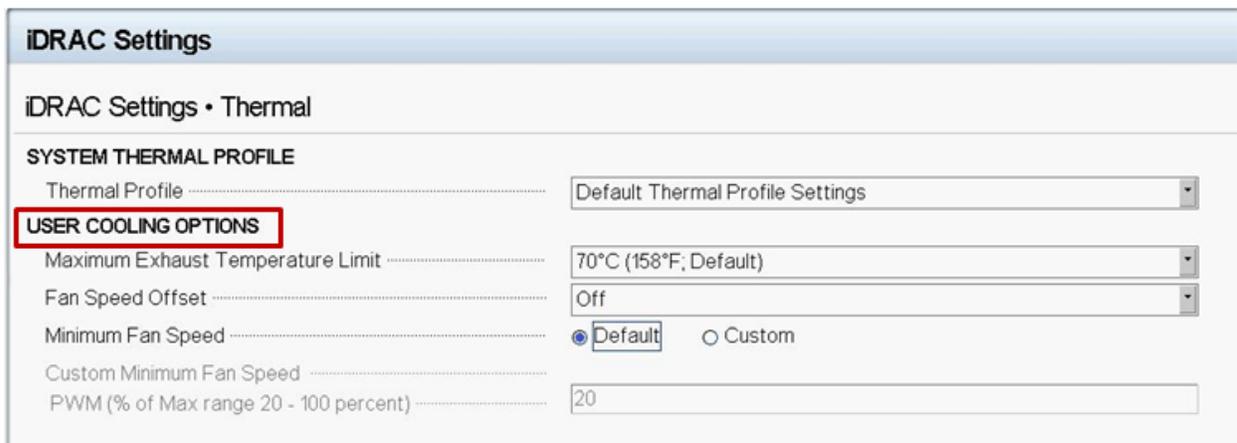


Figure 7 iDRAC Settings - User Cooling Options



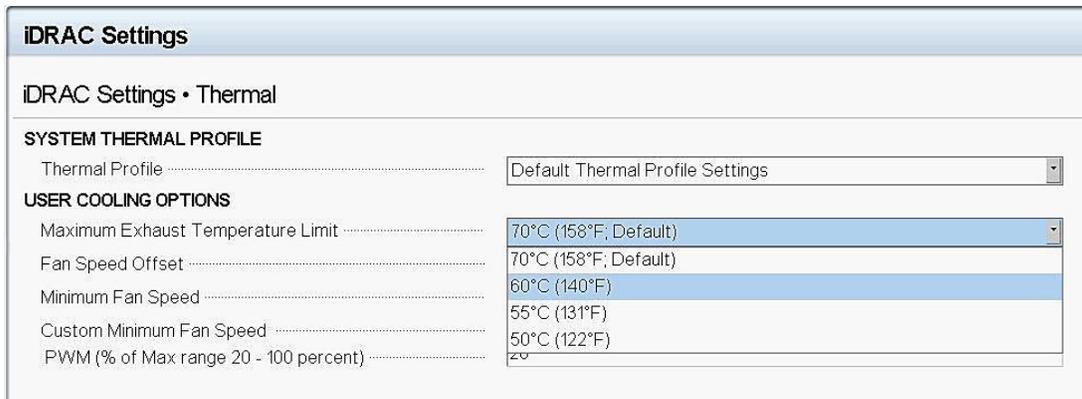


Figure 8 Setting Max Exhaust Temperature Limit

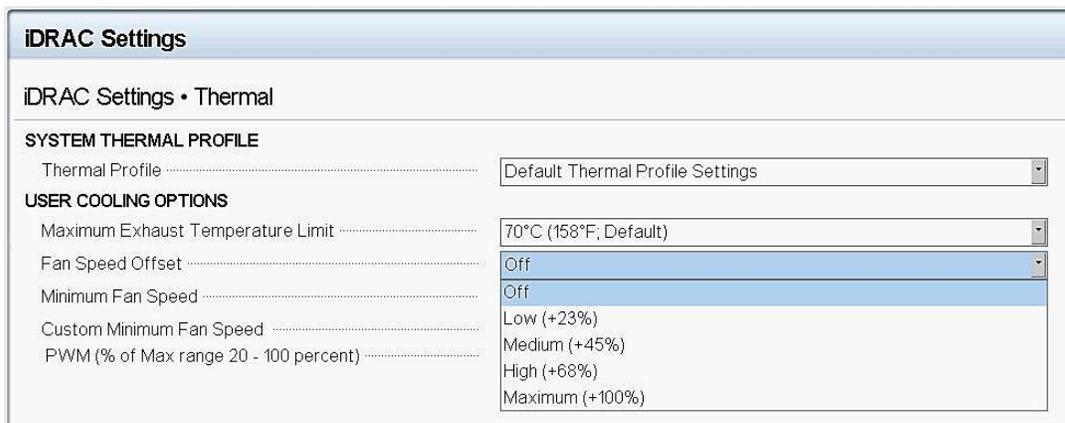


Figure 9 Setting Fan Speed Offset

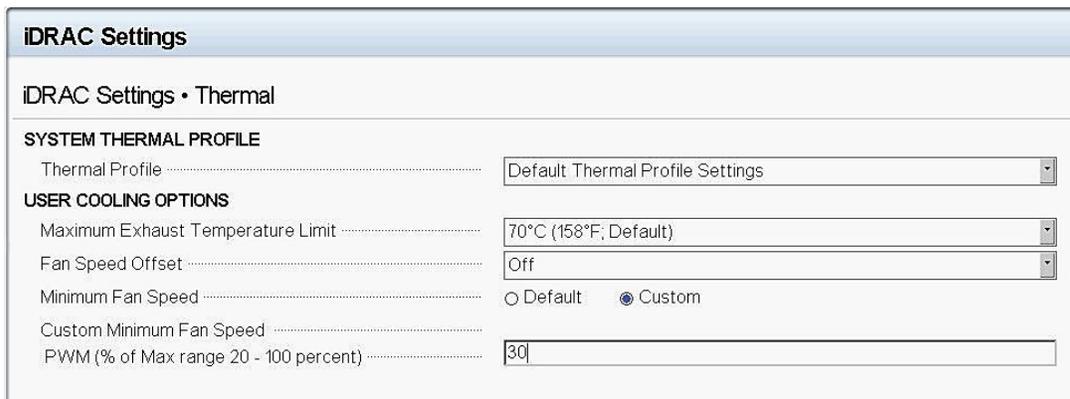


Figure 10 Setting Minimum Fan Speed (MFS)

In addition to the custom cooling options, you can change the System Thermal Profile to either maximize performance or power efficiency. The Thermal Profile settings determine the Automatic Baseline.



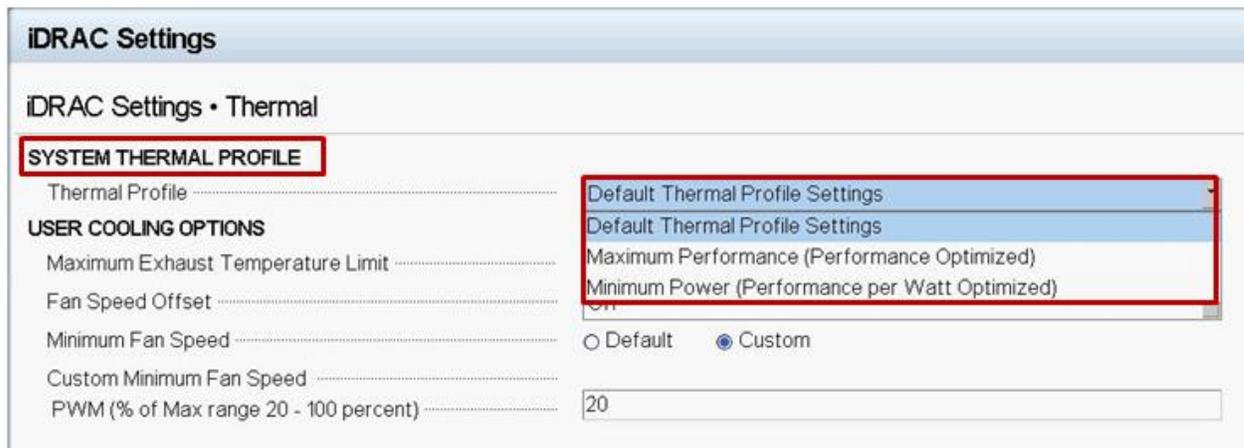


Figure 11 Setting System Thermal Profile

The System Thermal Profile provides the following options:

- Default Thermal Profile Settings:
  - Indicates that thermal algorithm uses the same System Profile setting that is defined under System BIOS Settings > System Profile Settings in System BIOS menu
  - Selecting any other option (Maximum Performance or Minimum Power) overrides thermal settings associated to System Profile setting under System BIOS Settings > System Profile
- Maximum Performance:
  - Reduced probability of memory or CPU throttling
  - Increased probability of turbo mode activation
  - Generally higher fan speeds at idle as well as stress loads
- Minimum Power:
  - Optimized for lowest system power consumption based on optimum fan power state
  - Generally lower fan speeds at idle as well as stress loads

## Customizing fan speed using iDRAC WebGUI

iDRAC WebGUI is a GUI-based web management interface you can use to customize server fan settings. You can connect to a server iDRAC WebGUI with an IP address on a remote web browser.

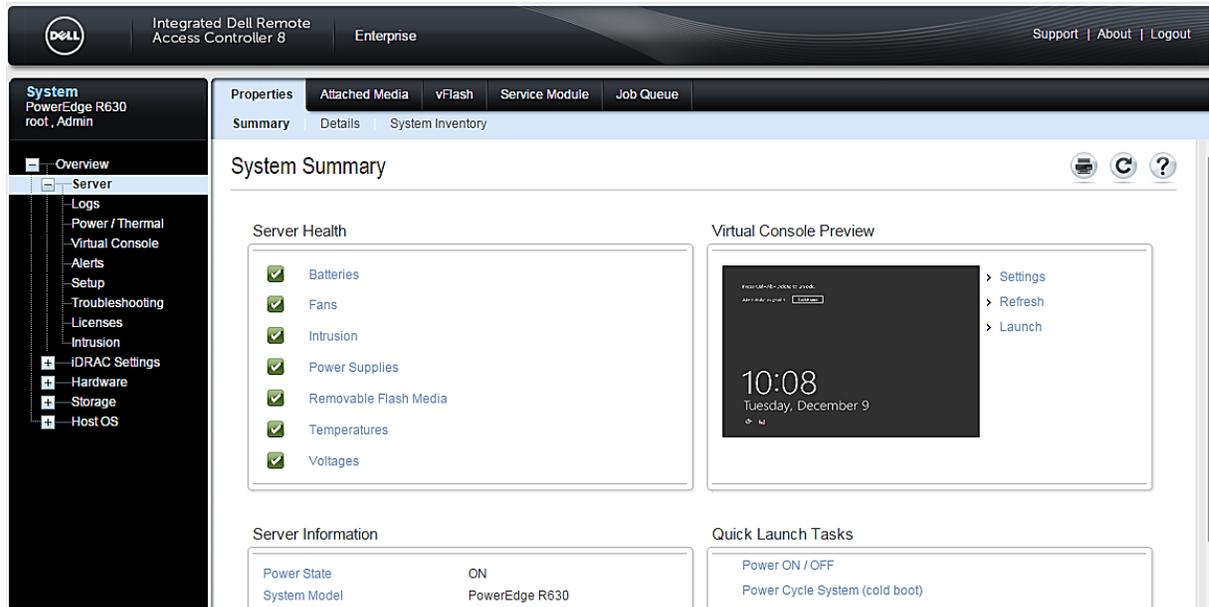


Figure 12 iDRAC WebGUI

Click Fans in Server Health or in Hardware section in the left pane to open the Fan Status page.

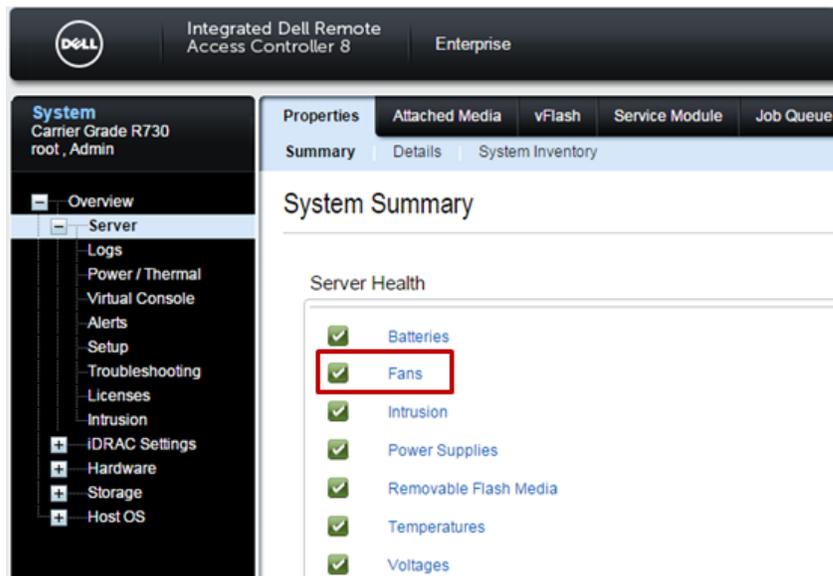


Figure 13 Accessing the Fan Status page



The Fan Status page provides a snapshot of information about the fans in your system.

**Fan Status**

| Status | Name              | PWM (% of Max) | Current Speed |         | Warning Threshold |  |
|--------|-------------------|----------------|---------------|---------|-------------------|--|
|        |                   |                | RPM           | Min     | Max               |  |
| ✓      | System Board Fan1 | N/A            | 2640 RPM      | 600 RPM | N/A               |  |
| ✓      | System Board Fan2 | N/A            | 3840 RPM      | 600 RPM | N/A               |  |
| ✓      | System Board Fan3 | N/A            | 2760 RPM      | 600 RPM | N/A               |  |
| ✓      | System Board Fan4 | N/A            | 2520 RPM      | 600 RPM | N/A               |  |
| ✓      | System Board Fan5 | N/A            | 3000 RPM      | 600 RPM | N/A               |  |
| ✓      | System Board Fan6 | N/A            | 2760 RPM      | 600 RPM | N/A               |  |

**Fan Configuration**

| Attribute                         | Value                            |
|-----------------------------------|----------------------------------|
| Thermal Profile                   | Default Thermal Profile Settings |
| Fan Speed Offset                  | Off                              |
| Minimum Fan Speed                 | Default (0% PWM)                 |
| Maximum Exhaust Temperature Limit | Default, 70 °C (158.0 °F)        |

**Fan Configuration**

| Attribute                         | Value                            |
|-----------------------------------|----------------------------------|
| Thermal Profile                   | Default Thermal Profile Settings |
| Fan Speed Offset                  | Off                              |
| Minimum Fan Speed                 | Default (0% PWM)                 |
| Maximum Exhaust Temperature Limit | Default, 70 °C (158.0 °F)        |

Figure 14 Fan Configuration information

The Fan Configuration section shows the current settings in the Value column.

To customize the fan speed settings, click Setup and use the dropdown menus to make setting changes.

**Fan Setup**

| Attribute                           | Value   |
|-------------------------------------|---|
| Thermal Profile                     | Default Thermal Profile Settings  |
| Maximum Exhaust Temperature Limit   | Default, 70 °C (158.0 °F)   |
| Fan Speed Offset                    | Off   |
| Minimum Fan Speed in PWM (% of Max) | <input checked="" type="radio"/> Default <input type="radio"/> Custom <input type="text"/> (range 0 - 100%) |

Figure 15 Fan Setup options



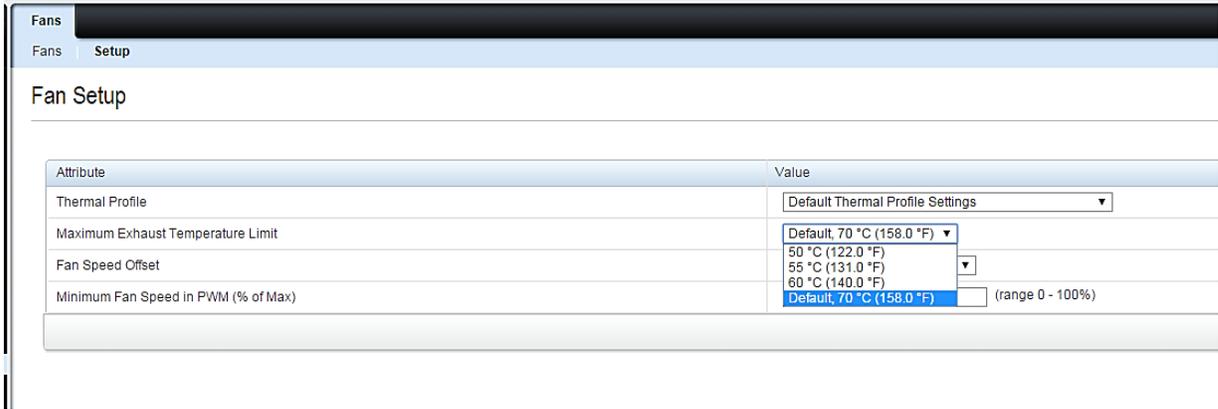


Figure 16 Setting Maximum Exhaust Temperature Limit

## Customizing fan speed using RACADM

After logging into iDRAC, run "racadm get system.thermalsettings" to display the current settings.

Example result:

```

~ # racadm get system.thermalsettings
[Key=system.Embedded.1#ThermalSettings.1]
AirExhaustTemp=70
#FanSpeedHighOffsetVal=71
#FanSpeedLowOffsetVal=24
#FanSpeedMaxOffsetVal=100
#FanSpeedMediumOffsetVal=48
FanSpeedOffset=Off
#MFSMaximumLimit=100
#MFSMinimumLimit=0
MinimumFanSpeed=255
ThermalProfile=Default Thermal Profile Settings
~ #
  
```

Command: `racadm get system.thermalsettings`

Response: The output from the command, including the list of settings and their values.

Use Table 1 as a guide for configuring these settings using the racadm system.thermalsettings command.

Table 1 RACADM SYSTEM.THERMALSETTINGS command options

| Object                | Description   | Usage                             | Example  |
|-----------------------|---|-----------------------------------|--|
| <b>AirExhaustTemp</b> | <ul style="list-style-type: none"> <li>Max Air Exhaust Temperature limit setting;</li> <li>Set Exhaust Temperature Limit to any one value (platform depended), where 0,1,2,3,4 and 255 corresponds to 40,45,50,55,60 deg C</li> </ul> | Values from 0-4 and 255 (default) | <p>To check existing setting on the system:<br/> racadm get system.thermalsettings.AirExhaustTemp<br/> It will report: AirExhaustTemp=70<br/> This means that system is set to limit air exhaust temperature to 70C.</p> <p>To set exhaust temperature limit to 60C:<br/> racadm set</p> |



| Object                         | Description   | Usage             | Example   |
|--------------------------------|---|-------------------|---|
|                                | and 70C deg C (default).  |                   | <p>system.thermalsettings.AirExhaustTemp 4<br/>Result will be "Object value modified successfully" and 60C exhaust limit is set.</p> <p>If certain AirExhaust Temperature limit is not supported by platform (e.g. 40C), then running that command:<br/>racadm set system.thermalsettings.AirExhaustTemp 0<br/>Will result in error:<br/>ERROR: RAC947: Invalid object value specified.<br/>Make sure to specify the value depending on the type of object.<br/>For more information, see RACADM help.</p> <p>To set the limit to default value:<br/>racadm set system.thermalsettings.AirExhaustTemp 255</p> |
| <b>FanSpeedHighOffsetVal</b>   | <ul style="list-style-type: none"> <li>Getting this variable will read the fan speed offset value in %PWM for High Fan Speed Offset setting.</li> <li>This value is platform dependent</li> <li>Use FanSpeedOffset to set this value using index value 1</li> </ul> | Values from 0-100 | <p>racadm get system.thermalsettings FanSpeedHighOffsetVal</p> <p>This will return a value like "66" meaning that when you use command "racadm set system.thermalsettings FanSpeedOffset 1", it will apply a fan speed offset of High (66% PWM) over baseline fan speed</p>   |
| <b>FanSpeedLowOffsetVal</b>    | <ul style="list-style-type: none"> <li>Getting this variable will read the fan speed offset value in %PWM for Low Fan Speed Offset setting.</li> <li>This value is platform dependent</li> <li>Use FanSpeedOffset to set this value using index value 0</li> </ul>  | Values from 0-100 | <p>racadm get system.thermalsettings FanSpeedLowOffsetVal</p> <p>This will return a value like "23" meaning that when you use command "racadm set system.thermalsettings FanSpeedOffset 0", it will apply a fan speed offset of Low (23% PWM) over baseline fan speed</p>   |
| <b>FanSpeedMaxOffsetVal</b>    | <ul style="list-style-type: none"> <li>Getting this variable will read the fan speed offset value in %PWM for Max Fan Speed Offset setting</li> <li>This value is platform dependent</li> <li>Use FanSpeedOffset to set this value using index value 3</li> </ul>   | Values from 0-100 | <p>racadm get system.thermalsettings FanSpeedMaxOffsetVal</p> <p>This will return a value like "100" meaning that when you use command "racadm set system.thermalsettings FanSpeedOffset 3", it will apply a fan speed offset of Max (meaning full speed, 100% PWM). In most cases, this offset will result in fan speeds going to full speed.</p>  |
| <b>FanSpeedMediumOffsetVal</b> | <ul style="list-style-type: none"> <li>Getting this variable will read the fan speed</li> </ul>   | Values from 0-100 | racadm get system.thermalsettings   |

| Object                 | Description  | Usage   | Example  |
|------------------------|--|---|--|
|                        | <p>offset value in %PWM for Medium Fan Speed Offset setting</p> <ul style="list-style-type: none"> <li>This value is platform dependent</li> <li>Use FanSpeedOffset to set this value using index value 2</li> </ul>   |   | <p>FanSpeedMediumOffsetVal</p> <p>This will return a value (for example) "47" meaning that when you use command "racadm set system.thermalsettings.FanSpeedOffset 2", it will apply a fan speed offset of Medium (47% PWM) over baseline fan speed</p>   |
| <b>FanSpeedOffset</b>  | <ul style="list-style-type: none"> <li>Using this with "get" will report the existing Fan Speed Offset setting</li> <li>Using this with "set" will allow setting the desired fan speed offset value based.</li> <li>The index will govern what offset is applied and FanSpeed...Val variables (defined earlier) will be the values at which the offsets will be applied</li> </ul> | <p>0-Low Fan Speed, 1-High Fan Speed,2-Medium Fan Speed,3-Max Fan Speed,255-None</p>  | <p>Example with get:<br/>racadm get system.thermalsettings.FanSpeedOffset</p> <p>will report current setting.</p> <p>Example with set:<br/>racadm set system.thermalsettings.FanSpeedOffset 1</p> <p>will result in fan speed offset set to High value (as defined in "FanSpeedHighOffsetVal")</p> |
| <b>MFSMaximumLimit</b> | <ul style="list-style-type: none"> <li>Read Maximum limit for MFS</li> </ul>   | <p>Values from 1 - 100; Default – 255 (meaning None)</p>  | <p>racadm get system.thermalsettings.MFSMaximumLimit</p> <p>Will report the highest value that can be set using MinimumFanSpeed option</p>   |
| <b>MFSMinimumLimit</b> | <ul style="list-style-type: none"> <li>Read Minimum limit for MFS</li> </ul>   | <p>Values from 0 - MFSMaximumLimit ; Default – 255 (meaning None)</p>   | <p>racadm get system.thermalsettings.MFSMinimumLimit</p> <p>Will report the lowest value that can be set using MinimumFanSpeed option</p>  |
| <b>MinimumFanSpeed</b> | <ul style="list-style-type: none"> <li>Allows configuring of Minimum Fan speed that is desired for the system to operate</li> <li>It defines the baseline (floor) value for fan speed and system will allow fans to go below this defined fan speed value</li> <li>This value is %PWM value for fan speed</li> </ul>   | <p>Values from MFSMinimumLimit to MFSMaximumLimit</p> <p>When get command reports 255, it means no user configured offset applied</p> | <p>racadm set system.thermalsettings.MinimumFanSpeed 45</p> <p>Will force the system minimum speed to not go below 45% PWM (45 should be a value between what is read from MFSMinimumLimit to MFSMaximumLimit)</p>   |
| <b>ThermalProfile</b>  | <ul style="list-style-type: none"> <li>Selection for Thermal Base Algorithm</li> <li>Allows system profile to be set at desired setting for thermal behavior associated to the profile</li> </ul>  | <p>0-Auto, 1-Maximum performance, 2-Minimum Power</p>   | <p>Example using get:<br/>racadm get system.thermalsettings.ThermalProfile</p> <p>will report the current ThermalProfile setting</p>   |



| Object | Description | Usage | Example   |
|--------|-------------|-------|---|
|        |             |       | Example using set:<br>Racadm set<br>system.thermalsettings.ThermalProfile 1<br><br>Will result in Thermal Profile to be set to<br>Maximum Performance Mode. |

