SFA OS™

Temperature Monitoring and Messages

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Temperature Monitoring on SFA Hardware

Sensor Number and Location

All SFA storage controllers and disk enclosures incorporate multiple temperature sensors. The number of sensors varies with the particular equipment installed. For example:

HARDWARE FAMILY	TEMPERATURE SENSORS
Controllers	
S2A6620	5
SFA7700	6
SFA10K	9
SFA12K	19
Enclosures	
SS6000	6
SS7000	6
SS8460	9

The locations of temperature sensors in the equipment vary by hardware model. Monitored locations generally include enclosure or controller air intakes, drive bay air outlets, the air inlets to the power supplies, the interior of the power supplies, on-die sensors on high-speed I/O controller chips, and various locations on the baseboard or motherboard, including some in close proximity to processors or memory. On-board batteries are also usually monitored by a temperature sensor.

Temperature Ranges on the Hardware

There is no such thing as one normal temperature range for high-performance storage equipment. Each monitored location or component has its own temperature profile. Sensors at the air intakes to the equipment measure ambient air temperature in the room. On-die sensors measure the operating temperature of the chip. A motherboard sensor near the CPU measures air temperature near the CPU. A different temperature range will be expected and normal at each of these locations.

For example, on the S2A6620, a sensor at the chassis air inlet expects to see ambient room temperatures below 40° C (104° F). A CPU sensor in the controller on the same device would accept temperatures up to 90° C (or 194° F — the temperature of hot coffee) without throwing a warning.

Corrective Action in Hardware

The SFA hardware itself takes corrective action in response to temperature sensor information. For example, the rotation speed of the cooling fans will be adjusted if power supply temperatures are too high. And if any two sensors in the same controller or enclosure detect temperatures outside the operating range for their monitored components, the equipment will shut itself down.

> **NOTE**   ***Shutdown of the equipment is controlled by the hardware***, not by SFA OS. If a shutdown occurs, allow the affected equipment to cool down before powering it back on.

Temperature Monitoring by SFA OS

SFA OS monitors hardware temperatures in order to report status and prepare the system for a hardware shutdown in the event of an extreme temperature event. Temperature information is provided to SFA OS by SCSI Enclosure Services (SES).

Temperature Ranges and Thresholds

For each monitored location or component, SFA OS recognizes the following temperature ranges:

- ***Normal*** operating temperatures
- ***Noncritical*** temperatures that are too hot (or cold) and need correction before they get worse
- ***Critically*** hot (or cold) temperatures at which the component is expected to fail

The diagram below illustrates these temperature ranges and the thresholds between them.
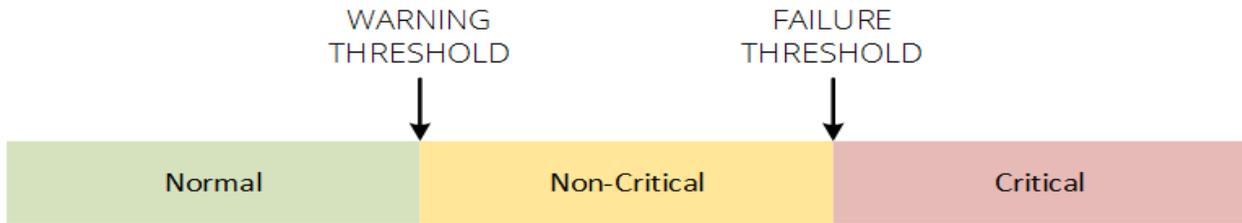
The transition between normal operating temperatures and temperatures in the excessive but noncritical range is the "warning" threshold. Temperatures that cross this threshold in either direction cause SFA OS to post a message to the event log.

The transition between noncritical and critical excessive temperatures is the "failure" threshold. Critically hot or cold temperatures are expected to cause a component to fail. Temperatures that cross this threshold in either direction cause SFA OS to post a message to the event log.

Temperature transitions and the messages they generate are shown in the table below.

TRANSITION	EXAMPLE MESSAGES	SES STATUS CODE
Normal → Noncritical Range	`LOG_ES_POWER_SUPPLY_`**`WARNING`** `LOG_ES_TEMPERATURE_SENSOR_`**`WARNING`**	3
Noncritical → Normal Range	`LOG_ES_POWER_SUPPLY_`**`NORMAL`** `LOG_ES_TEMPERATURE_SENSOR_`**`NORMAL`**	1
Noncritical → Critical Range	`LOG_ES_POWER_SUPPLY_`**`ERROR`** `LOG_ES_TEMPERATURE_SENSOR_`**`ERROR`**	2
Critical → Noncritical Range	`LOG_ES_POWER_SUPPLY_`**`WARNING`** `LOG_ES_TEMPERATURE_SENSOR_`**`WARNING`**	3

Noncritical Temperature Range

When SFA OS detects a sensor temperature that has crossed the warning threshhold into the nonnormal-but-noncritical range for a particular location or component, it generates a warning so the customer can take corrective action. The following events occur:

- The **Warning** temperature flag is set to **TRUE** and the relevant hardware component is reported to be **NON-CRITICAL** in the **SES Status** field of the SFA OS temperature report **(show temp *)**.

- A *warning* message is placed in the event log and an SNMP trap is generated, which may (at the customer's option) trigger an email message. Typical warning messages are:

  `LOG_ES_POWER_SUPPLY_`**`WARNING`**
  `LOG_ES_TEMPERATURE_SENSOR_`**`WARNING`**

ALERT!   When a warning message occurs, you should take corrective action to reduce the ambient air temperature near the equipment and to remove blockages from all incoming and outgoing airflows. Ensure that cables are correctly wrapped and tied away from air vents.

Critical Temperature Range

If any sensor temperature crosses the failure threshhold into the critical temperature range, ***SFA OS expects a hardware shutdown to occur at any time***. At this point, SFA OS does the following:

- The **Failure** temperature flag is set to **TRUE** and the relevant hardware component is reported to be **CRITICAL** in the **SES Status** field of the SFA OS temperature report (**show temp ***).

- An *error* message is placed in the event log, an SNMP trap is generated, and an email message is sent. Typical error messages for an imminent critical failure are:

  ```
  LOG_ES_POWER_SUPPLY_ERROR
  LOG_ES_TEMPERATURE_SENSOR_ERROR
  ```

- The **Failure** or **System Fault** LED is lit on the field-replaceable unit (FRU) containing the critically hot (or cold) component. This does *not* always indicate that a component has actually failed, but it *does* identify equipment where a component failure is imminent.

- **If the critical temperature condition occurs in a controller**, SFA OS automatically puts the cache into ***write-through mode*** and flushes the cache to disk. This may take several minutes. Write-through mode protects customer data if a component fails or the hardware shuts itself off. Temperatures must be corrected ***all the way back to the normal operating range*** before SFA OS will take the cache out of write-through mode and resume write-back caching.

NOTE	Critical temperature conditions in a drive enclosure will ***NOT*** cause SFA OS to put the cache into write-through mode.

- **If two sensors in the same enclosure or controller** report a critical temperature condition at the same time, firmware in the SEP or FPGA processor, as appropriate, will ***shut down that enclosure or controller***. The purpose of the hardware shutdown is to prevent a non-recoverable component failure or fire. For each sensor involved in triggering the shutdown, SCSI Enclosure Services posts the following message to SFA OS:

  ```
  LOG_ES_TEMPERATURE_SENSOR_EMERGENCY
  ```

Low Temperature Conditions

Electronic components have a rated minimum operating temperature as well as a rated maximum. Consequently, under-temperature conditions can trigger the same sorts of error messages and automatic corrective actions as over-temperature conditions. Details in the event log message will specify whether a reported temperature is high or low.

For example:

```
LOG_ES_TEMPERATURE_SENSOR_ERROR ES Enclosure 0x50001ff118180000
temperature sensor 3 reported error condition. SES status = 2,
T = 0 (degC), OverT = 0, UnderT = 1
```

In this and other temperature messages:

OverT = Over-temperature status, which takes the values **0** (FALSE) or **1** (TRUE)

UnderT = Under-temperature status, which takes the values **0** (FALSE) or **1** (TRUE)

In the example, then, **UnderT=1** indicates an under-temperature status of TRUE, meaning the reported temperature (**T=0 (degC)** — that is, 0°C or 32°F, the freezing temperature of water) is below the rated operating range for the component covered by the temperature sensor.

Locating Hot or Cold Components

In order to correct an over-temperature or under-temperature condition, you must locate the component that is reporting the problem. The following SFA OS commands can help you do that.

SHOW TEMPERATURE *

The **show temp *** CLUI command requests a temperature status report for all sensors in the storage system. This is the first place to look to identify an SFA temperature problem. For example:

```
*********************************
*      Temperature Sensor(s)      *
*********************************
                        |  Over Temp   |  Indicators  |
Idx|Encl|Pos|Temp(C)|Present|Warning|Failure|Failure|Locate|Location|SES Status
----------------------------------------------------------------------------
1    0    1    43       TRUE    FALSE   FALSE   OFF     OFF         SCH OK
2    0    2    50       TRUE    FALSE   FALSE   OFF     OFF         CPU OK
3    0    3    73       TRUE    FALSE   FALSE   OFF     OFF         MCH OK
4    0    4    48       TRUE    FALSE   FALSE   OFF     OFF     Ambient OK
5    0    5    40       TRUE    FALSE   FALSE   OFF     OFF     Battery OK
1    1    1    39       TRUE    FALSE   FALSE   OFF     OFF   PSU 1    OK
2    1    2    38       TRUE    FALSE   FALSE   OFF     OFF   PSU 2    OK
3    1    3    31       TRUE    FALSE   FALSE   OFF     OFF   BB F RHT OK
4    1    4    34       TRUE    FALSE   FALSE   OFF     OFF   BB F LFT OK
5    1    5    36       TRUE    FALSE   FALSE   OFF     OFF   BB R RHT OK
6    1    6    38       TRUE    FALSE   FALSE   OFF     OFF   BB R LFT OK
1    2    1    64       TRUE    TRUE    TRUE    ON      OFF         SCH CRITICAL
2    2    2    50       TRUE    FALSE   FALSE   OFF     OFF         CPU OK
3    2    3    75       TRUE    FALSE   FALSE   OFF     OFF         MCH OK
4    2    4    45       TRUE    FALSE   FALSE   OFF     OFF     Ambient OK
5    2    5    41       TRUE    FALSE   FALSE   OFF     OFF     Battery OK
1    3    1    43       TRUE    FALSE   FALSE   OFF     OFF   PSU 1    OK
2    3    2    40       TRUE    FALSE   FALSE   OFF     OFF   PSU 2    OK
3    3    3    34       TRUE    FALSE   FALSE   OFF     OFF   BB F RHT OK
4    3    4    32       TRUE    FALSE   FALSE   OFF     OFF   BB F LFT OK
5    3    5    41       TRUE    FALSE   FALSE   OFF     OFF   BB R RHT OK
6    3    6    39       TRUE    FALSE   FALSE   OFF     OFF   BB R LFT OK

Total Temperature Sensors: 20
```

Idx .... Sensor index. Use with **Encl** in **show temp all** command.
Encl.................................... Enclosure index. Use in **show enc *** command or with **Idx** in **show temp all**
Pos...................................... Sensor position within enclosure or canister.
Temp (C)........................... Current temperature reading for the sensor in degrees Celsius/centigrade.
Present.............................. Sensor is present or not installed in this position.

Over Temp Warning...... Set to `TRUE` if sensor is in either the noncritical or critical temperature range.

Over Temp Failure .... Set to `TRUE` only if sensor is in the critical temperature range.

Failure Indicator............ Set to `ON` if the **Failure** LED for the FRU containing this component is lit.

Locate Indicator .... Set to `ON` if the **Locate** LED for the FRU containing this component is lit.

Location........................... Description of sensor location within the controller or enclosure.

SES Status......................... Text version of SES status code for sensor: `OK, NONCRITICAL, CRITICAL`

In the example output from the `show temp *` command above, one temperature sensor is showing a status of `CRITICAL` in the **SES Status** field, meaning it is sensing a temperature in the critical range above the hot failure threshold or below the cold failure threshold. The affected sensor is identified as the `SCH` sensor, located at sensor index 1 (**Idx**) and position 1 (**Pos**) in the controller canister assigned enclosure index 2 (**Encl**). (One way to tell that enclosure index 2 refers to a controller rather than a disk enclosure is the fact that the `CPU` sensor also shares this **Encl** index.)

Notice that other sensors report significantly higher temperatures than the SCH sensor does without generating even a warning, let alone a critical error condition. This is common. Remember that each location and component monitored by a sensor has a different temperature profile.

SHOW ENCLOSURE *

To determine whether a sensor is located in a controller shelf or canister, the head disk enclosure, or an expansion disk enclosure, cross-reference the **Encl** value in the `show temp *` report against the **Idx** value in the output of the `show enc *` CLUI command. For example:

```
*************************
*     Enclosure(s)     *
*************************

Idx|Pos|Type      |Logical ID        |Vendor ID|  Product ID|Revision|FW Version|Responsive
------------------------------------------------------------------------------------------
  0  NA CONTROLLER 0x0015b2a193980000    DDN      S2A6620   PE01    1.5.6.0    TRUE
  1   1 DISK       0x5000000000890000    DDN      S2A6620   0109    C03.001    TRUE
  2  NA CONTROLLER 0x0015b2a134580000    DDN      S2A6620   PE01    1.5.6.0    TRUE
  3   2 DISK       0x50001ff117b80000    DDN      SA4601    0109    C03.001    TRUE

Total Enclosures: 4
```

In the `show temp *` report, the `CRITICAL` sensor was shown to reside at enclosure index 2 (**Encl**). This value maps to enclosure index 2 in the **Idx** field of the `show enc *` report above. Here we see that enclosure index 2 identifies the equipment **Type** as `CONTROLLER`, and the **Product ID** is `S2A6620`. These two pieces of information locate the the `CRITICAL` sensor in one of the controller canisters of an S2A6620 head enclosure. Since we only have one such enclosure, this is sufficient information to physically locate the hardware.

If the sensor had been located at enclosure index 1 or 3 in the `show temp *` report above, we could identify the enclosure position as either 1 or 2 from the **Pos** field of the `show enc *` report. The equipment **Type** would tell us we're looking for a `DISK` enclosure, and the **Product ID** would tell us whether that disk enclosure was a head enclosure (`S2A6620`) or an expansion enclosure (`SA4601`). Again we have enough information to locate the hardware and take corrective action.

The following table lists the values that can appear in the **Type** field and **Product ID** field of the **show enc *** report and identifies the corresponding DDN equipment.

PRODUCT ID	EQUIPMENT TYPE	DESCRIPTION
S2A6620	Controller	S2A6620 controller canister (1 of 2 in same enclosure)
S2A6620	Disk	S2A6620 head disk enclosure
SA4601	Disk	SS6000 expansion disk enclosure
SFA10000	Controller	SFA10K controller shelf
SFA12000	Controller	SFA12K controller shelf
SFA14K	Controller	SFA14K controller canister (1 of 2 in same enclosure)
SFA7700	Controller	SFA7700 controller canister (1 of 2 in same enclosure)
SFA7700X	Controller	SFA7700X controller canister (1 of 2 in same enclosure)
SS14000	Disk	SFA14K head disk enclosure
SS7000	Disk	SFA7700 head disk enclosure if **FW Version** is *nnnn-nnn* SS7000 expansion disk enclosure if **FW Version** is *nn.nn.nn*
SS8460	Disk	SS8460 expansion disk enclosure
SS8462	Disk	SS8462 expansion disk enclosure

LOCATE ENCLOSURE *<index>*

If the enclosure position is **NA** in the **show enc *** report or otherwise unclear, use the **locate enc <idx>** command to turn on a blue beacon LED to help you find it. The beacon LED appears on the front panel of disk enclosures and controller shelves, and on the front panel of controller canisters at the rear of S2A6620 and SFA7700 head enclosures.

The locate beacon is usually needed to identify the particular controller canister within a head enclosure that is reporting a temperature warning or error. If a canister needs to be replaced due to an over-temperature condition that caused a component to fail, it is necessary to know whether the affected canister is located on right or left side of the enclosure.

To do this, enter the following CLUI command:

```
locate enc <enc-idx>
```

where

<enc-idx>   is the **Encl** value in **show temp *** or the **Idx** value in **show enc ***

Corrective Action for Temperature Issues

Once an over-temperature or under-temperature component has been located, it's time to take the following corrective actions.

- ***Ensure there is 3 feet of unobstructed clearance*** at the front and rear of the rack containing the enclosure or controller reporting excessively high (or low) temperatures.

- **Remove blockages** all from all incoming and outgoing airflows. Ensure that cables are correctly wrapped and tied away from air vents.

- **Adjust the ambient air temperature setting for the equipment room,** and verify that the air temperature at all equipment air intakes falls inside the normal operating temperature range for the equipment. (As a rule of thumb, aim for temperatures between 5°-32° C or 40°-90° F.) In addition, you may need to adjust the direction of air conditioning vent louvres or increase the size or number of air conditioning vents in the equipment room to ensure adequate air flow across all installed equipment. If the problem persists, it may be necessary to have an HVAC professional rebalance the air conditioning system throughout the data center.

- **Perform a graceful shutdown, power off the equipment, and allow it to cool** if temperatures enter the critical over-temperature range on the CPU sensor or on any two or more other sensors. Then power up the system normally. If the issue recurs, contact DDN Support.

- **If you see or smell smoke, perform a graceful shutdown and power off the equipment**. Then contact DDN Support.

- **Do not use portable air conditioning equipment to inject cold air directly into the equipment**. This can cause extreme temperature differentials within the device and may lead to uneven metal shrinkage and expansion, material cracking, electrical disconnects, or electrical shorts. In addition, under-temperature errors may arise that cause the equipment to abruptly shut down.

Under-Temperature Events

Under-temperature events are far less common than over-temperature events, but they do occur. They can usually be addressed using the foregoing methods in conjunction with increased room air temperature settings.

Invalid Temperature Error Messages

Unexpected or nonsensical temperature error messages can occur with some regularity on certain SFA platforms if obsolete component firmware is installed on the BMC/FPGA processors, SEP processor, the power supply units (PSU), or if SFA OS itself is at version 2.3.1.3 or earlier. Invalid messages can be identified by any of the following features:

- Reported temperature is impossible
- Message is self-contradictory
- SES status code is 7

For example:

```
382570 2015-07-14 11:15:45:4647550 G=61 S=2 T=1 RP=0 VP=00
LOG_ES_TEMPERATURE_SENSOR_ERROR ES Enclosure 0x1ff0a09c90000 temperature
sensor 4 reported error condition. SES status = 7, T = -20 (degC), OverT = 0,
UnderT = 0.
```

This is an *error* message, indicating that the reported temperature is either above the hot failure threshold or below the cold failure threshold. This is consistent with a reported temperature well below freezing (-20° C or -4° F). But if you observe the equipment and it is not cold to the touch, this message is probably spurious.

Also notice that this *same* message states that `UnderT=0`, meaning the under-temperature flag is set to FALSE. This is inconsistent with a temperature below freezing, which makes the message meaningless. ***Self-contradicting messages of this kind should be reported to DDN Support as a bug***.

Finally, this *same* message reports `SES status=7` for the temperature sensor. A SES status code of 7 indicates that the temperature sensor is installed and has no known problems, but it has not been turned on or enabled by the temperature monitoring firmware. In other words, ***it can't report a temperature*** because it needs to be turned on. No temperature reading can be accurate with this SES status.

SES status codes that appear in temperature messages, together with their meanings, are listed in the table below. These can be helpful in sorting spurious messages from those that require action.

SES STATUS CODE	MEANING IN TEMPERATURE MESSAGES
0	Unsupported, status detection is not implemented for this sensor
1	OK, no warnings or errors, temperature is in normal operating range
2	CRITICAL condition has been detected, temperature is in component failure range
3	NONCRITICAL condition has been detected, temperature is past warning threshold
4	Unrecoverable condition has been detected
5	Sensor is not installed
6	Unknown, sensor has failed or status is not available
7	Sensor is installed with no known errors, but is not turned on or enabled

Contacting DDN Technical Support

Please contact DDN Technical Support at any time if you have questions or require assistance. Support can be reached by phone, by email, or on the web as listed below.

Web
DDN Community Support Portal   https://community.ddn.com/login
Portal Assistance   webportal.support@ddn.com

Telephone
DDN Support Worldwide Directory   http://www.ddn.com/support/contact-support

Email
Support Email   support@ddn.com

Bulletins

Support Bulletins   http://www.ddn.com/support/technical-support-bulletins

End-of-Life Notices   http://www.ddn.com/support/end-of-life-notices

Bulletin Subscription Requests   support-tsb@ddn.com