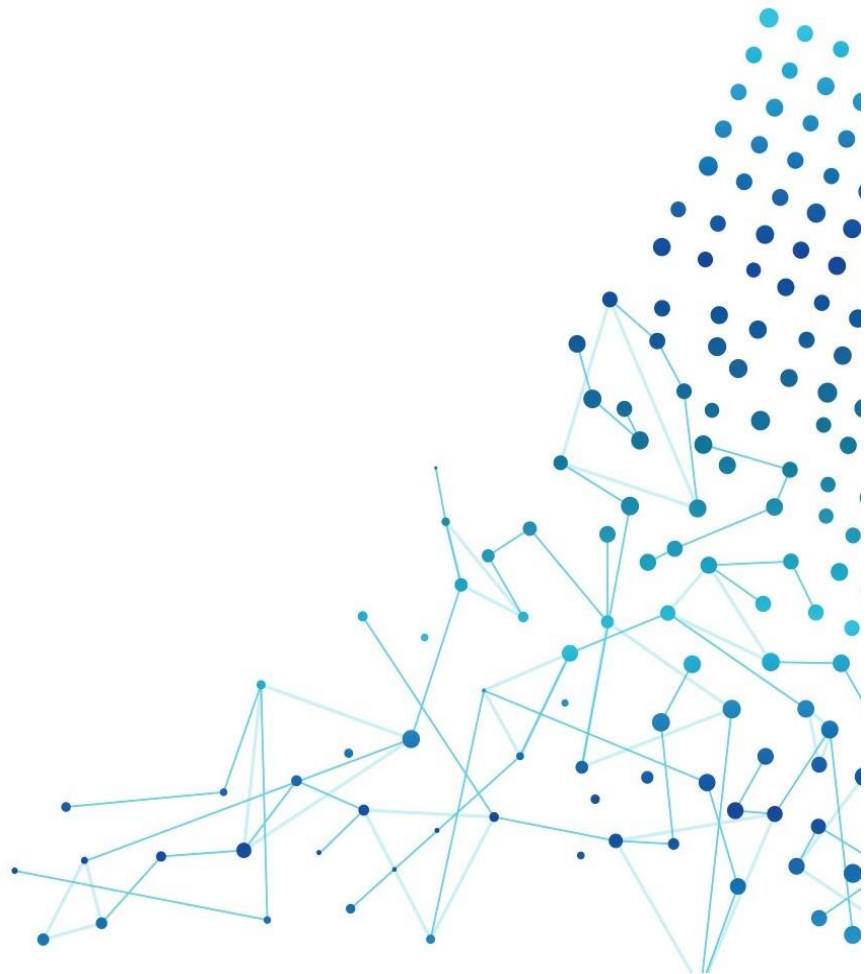# HAILO
Empowering Intelligence

Hailo Integration Tool

User Guide

Release 1.2.1
December-2021

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Table of Contents

1.   Overview

The Hailo Integration tool is supplied as part of Hailo platform package. It can be used by the user for characterization, validation or approving his system compatibility with Hailo modules or chips.

The integration tool supports several tests, with different goals, given in detail in section 4.

Note: The tool supports PCIe interface only.

2.   Changelog

Version 1.2.1 (December 2021)
- Fixed a bug in thermal test calculations
- Fixed a bug in stress test that may occur in over-temperature cases
- Fixed a bug in the report generation that may cause the last measurement to be inaccurate

Version 1.2.0 (November 2021)
- Thermal test was updated:
    - Test output now estimates the thermal resistance [W/C] of the thermal solution
    - Test report was updated to provide extended data
- Stress test was updated:
    - Test report was updated to provide extended data

Version 1.1.0 (October 2021)

- Added 2 installation modes: default and no-visualizer

Version 1.0.0 (August 2021)

- Initial release

3. Installation

3.1. System requirements

System requirements are identical to the HailoRT installation requirements.

3.2. Pre-requisites

Installed HailoRT v4.2.0 environment is mandatory.

3.3. Installation

The Integration Tool package includes a wheel – integration_tool-1.0.0-py3-none-any.whl

From the HailoRT virtual environment run the following command to install the Integration tool:

```
$ pip install integration_tool-1.0.0-py3-none-any.whl
```

or, for minimal installation:

```
$ pip install integration_tool-1.0.0-py3-none-any.whl[no-visualizer]
```

3.4. Version's compatibility

This Hailo Integration Tool matches the following:

- HailoRT v4.2.0

4. Integration Tool's Tests

4.1. General

1. The tests will run on all the Hailo boards connected. User can use the command: `$ lspci | grep Hailo` to verify which boards are currently connected.

2. Log files

   o The tool generates a report in the local folder from which the integration tool was executed.

   Report file name: "Hailo_integration_tool_report_<date>_<hour>"

   o In case of a failure, the list of errors can also be viewed in the integration_tool.log file or the hailort.log file.
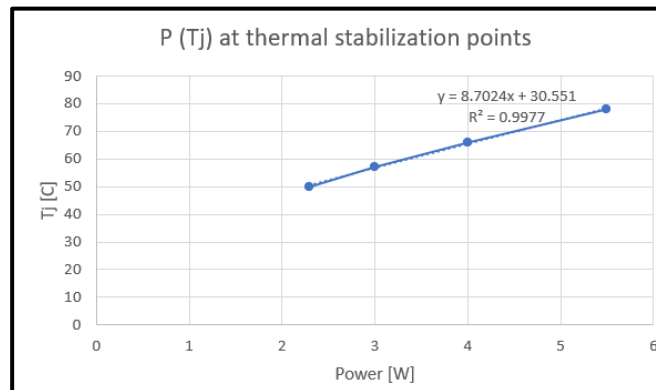
4.2. Thermal test

4.2.1. Overview

3. Goal: map the thermal operating envelope of a Hailo-8 device or a Hailo module, for a given heat dissipation solution and ambient temperature, and provide feedback for customers so they can adjust the thermal design as needed.

4. Input: The user inputs the required upper bound of the power consumption range

5. Output:

   o The tool confirms that the user's thermal solution is sufficient for the given maximal required power consumption and ambient temperature, or otherwise exits with an error.

   o The tool estimates the thermal resistance [C/ W].

   o Based on the estimated thermal resistance [C/W], the tool indicates, per power consumption:

      ▪ In which ambient temperature the thermal throttling is expected to be enabled.

      ▪ In case the thermal throttling feature is disabled, in which ambient temperature the temperature AMR is expected to be exceeded.

- o All measurements are logged into the "hailo_int_tool_thermal_test_<device>_<date>_<hour>" file which is located in the local folder from which the integration tool was executed.

6. Method:

- o The tool uses four pre-complied networks, for an 'ascending order power consumption sweep'.

- o Per pre-complied network, thermal stabilization is confirmed if the temperature maintains stable 'dtemp' for 'dsamples' consecutive temperature sensor readouts polls.

- o After the four networks have thermal stabilized, the tool calculates the linear regression of the Power(Tj) function to estimate the test's ambient temperature and the thermal resistance [C/W]:

  - ▪ Thermal resistance – slope of the P(Tj) function

  - ▪ Ambient temperature – bias of the P(Tj) function

  - ▪ Example:

P (Tj) at thermal stabilization points

$y = 8.7024x + 30.551$
$R^2 = 0.9977$

Tj [C] (y-axis: 0 to 90)
Power [W] (x-axis: 0 to 6)

- o For neural network with average power of 1W to 'maxpower', the tool calculates the maximal ambient temperature for which:

  - ▪ Temperature throttling mechanism will not yet be enabled (full performance)

  - ▪ Temperature AMR will not be exceeded, if the temperature throttling mechanism is disabled.

  The calculation is done with the following steps:

  - ▪ Tool reads the temperature monitoring thresholds:

    - • Orange TH: Exceeding this temperature TH will enable the temperature throttling mechanism.

- Red TH: Indicating the temperature AMR, exceeding this temperature TH will cause shut down on the input data stream

  - Denoting the thermal resistance as θ, the tool uses the following equation $Tj[C] = Ta[C] + P[W] * θ\ [C/W]$ accordingly:

    - $maxTaBeforeAMR = Red_{TH} - P_i * θ$

    - $maxTaBeforeThrottling = Orange_{TH} - P_i * θ$

7. Pass criteria - the tool will exit with error code if:

   o The inference is stopped due to an overcurrent event. (if applicable).

   o The inference is stopped due to an overheat event.

   o The R-squared of the Power(Tj) linear regression is too low - can imply on instable thermal solution or ambient temperature

4.2.2.   Test execution

Command line: `$ hailo-int thermal [--show] [--dsample] [--dtemp] [--maxpower]`

8. Parameters:

Parameter name	Description	Notes
maxpower	- Optional flag. - non-integer parameter, in Watts unit, indicating the required upper bound of the tested power consumption range - Default value = 7.0 W	
show	- Optional flag. - In case used, the tool will show the results graph of the temperature vs power after completion. - Default value = False	

dsample	• Optional flag. • Indicating the required number of consecutives stable temperature sensor readout pollings. • Default value = 15	
dtemp	• Optional flag. • Indicating the temperature stability criteria. • Default value = 0.3 [C]	Thermal stabilization is confirmed if the temperature maintains stable 'dtemp' for 'dsamples' consecutive temperature sensor readouts pollings

9. Console logs

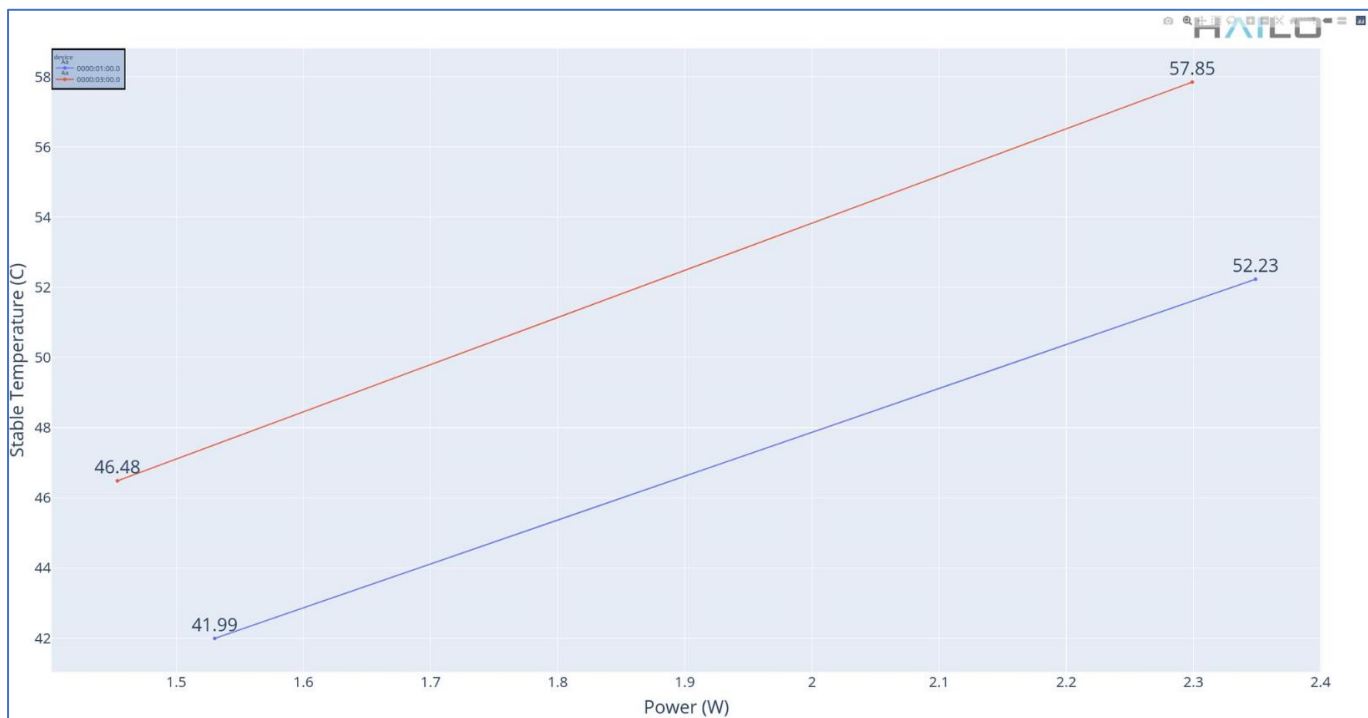During the test execution, the tool will indicate the current running network, temperature and power measurements:

10. Graph output

In case the --show flag was set, the tool will output the graph of stabilized temperature per consumed power:

4.3. Stress test

4.3.1. Overview

- It is suggested to run the stress test after the thermal solution was validated by executing the thermal test (see section 4.2).

- Goal: The tool confirms the system's capability to run the model for a long duration, without exceeding thermal\current limit or run-time errors.

- Input: The user input the NN to run during the stress test and the required duration of the test run [minutes].

- Output:

  o The tool outputs a pass\fail message, indicating if the Hailo-8 has noticed any error during the stress test.

  o All measurements are logged into the "hailo_int_tool_stress_test_<device>_<date>_<hour>" file which is located in the local folder from which the integration tool was executed.

- Method: The tool runs the chosen NN for <duration> minutes.

- Pass criteria: The test completed running for the required duration without any errors.

4.3.2. Test execution

- Command line:

```
$ hailo-int stress [--testedhef] [--duration]
```

- Parameters:

Parameter name	Description	Notes
testedhef	- Optional flag - Indicating the NN to be executed during the stress test. The user can choose the HEFs used in the thermal tool or provide a path to his own HEF file. - Thermal test's HEFs: "1.hef" "28.hef" "48.hef" "57.hef" - Default value: "57.hef"	
Duration	- Optional flag - indicating the required duration of the stress test [minutes] - Default value: 1440 [24 h]	

- Console logs

> During the test execution, the tool will indicate the current temperature and power measurements.

```
15:11:54 :: running stress test
15:12:06 :: <0000:03:00.0>: Temperature: [sensor #0: 27.30 (C), sensor #1: 26.90 (C), average: 27.10 (C)]. Power: 0.95 (W)

15:11:54 :: running stress test
15:12:28 :: stress test passed
+----+---------+-------+---------------+-----------------------------------------+---------+-----------------------+
|    | status  |  fps  | device        | device_type                             | Power (W) | Stable Temperature (C) |
+----+---------+-------+---------------+-----------------------------------------+---------+-----------------------+
| 0  |       0 | 41.26 | 0000:03:00.0  | HAILO-8 AI ACCELERATOR M.2 M KEY MODULE |    0.95 |                  27.58 |
+----+---------+-------+---------------+-----------------------------------------+---------+-----------------------+
```