QUASAR
Nova SMD

Product brief

v1.2

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1 Introduction

1.1 Objectives

Surface Mount Technology (SMT) has brought about a paradigm shift in high-density design, opening new horizons. However, with its widespread adoption, ensuring the quality of SMT soldering has emerged as a significant challenge. To tackle this, a range of inspection technologies, including X-Ray, optical, and thermal imaging, have been integrated to scrutinize soldering flaws. Yet, traditional human inspection methods for solderability testing and void detection suffer from drawbacks such as being time-consuming, error-prone, and inconsistent, largely influenced by the inspector's experience level.

Some existing X-Ray inspection systems rely on void detection algorithms that demand meticulous fine-tuning to adapt across different devices and production batches. In response to these challenges, 7 Sensing Software presents Quasar Nova SMD: an AI-powered optical inspection solution tailored for non-wetted areas and solder voids detection.

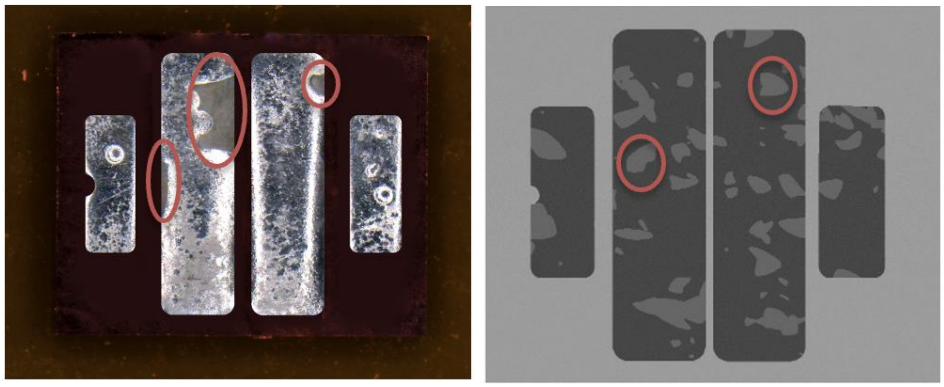


Figure 1 Example of non-wetted areas (left) and solder voids (right) in RGB and X-Ray soldering images respectively

1.2 Overview

Quasar Nova SMD revolutionizes soldering inspection for Surface Mount Devices (SMD). It excels in pixel-level solder voids and non-wetted areas detection, ensuring meticulous quality control.

Successfully deployed in automotive SMD production, Quasar Nova SMD has made manual intervention obsolete, significantly cutting down on non-quality issues and labor costs. Quasar Nova SMD offers rapid inspection, processes an image almost instantaneously and generates comprehensive technical reports compliant with JEDEC, IEC, and IPC standards.

Moreover, Quasar Nova SMD accurately analyzes images of any component seamlessly integrating with various AOI and X-Ray machines. Its intuitive graphical user interface is accessible from anywhere, catering to users of all expertise levels. Quasar Nova SMD also offers REST-API interfaces, facilitating its integration to any automated process. Additionally,

the batch-level analysis provided in the reports expedites root cause diagnosis, enhancing overall efficiency.

1.3 Product Offer description

SMD manufacturers must ensure high soldering quality for their products. Quasar Nova SMD enables accurate and easy assessment of soldering quality for SMD components using two types of soldering analysis:

- **Non-wetting analysis**

  Using images of the SMD components, Quasar Nova SMD measures solderability by automatically detecting non-wetted areas on each pad.

- **Solder void analysis**

  From X-Ray images of SMD components soldered to a PCB, Quasar Nova SMD detects all solder voids on each pad.

After detecting non-wetted areas or solder voids, Quasar Nova SMD calculates the percentage of defective areas relative to the total pad surface. This percentage is then compared to a threshold based on a user-selected standard, such as JEDEC or IPC. Each SMD component is then classified as either accepted or rejected based on this criterion.

For both non-wetting and solder void analysis, Quasar Nova SMD provides quality metrics at the pad, component, and batch levels, helping users better understand the root causes of defects.

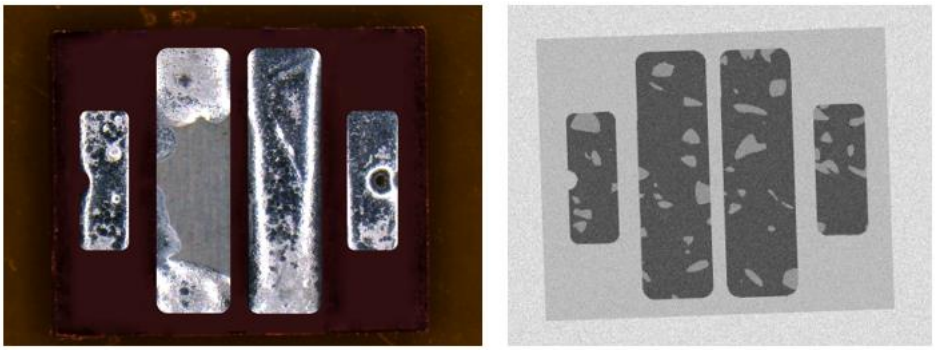


Figure 2 - example of an RGB image for non-wetted area analysis (left) and an X-Ray image for solder void analysis (right) of a SMD with four pads

1.4 Key Points

This documentation will present in detail:

- The main features and functionalities of Quasar Nova SMD
- The key technical specifications and requirements

- A user guide of the web application
- Inspection results analysis

2 Product overview

2.1 Description

Quasar Nova SMD allows users to inspect soldering quality through a web application accessible from any web browser, or via REST-API requests, from any device connected to the internet.

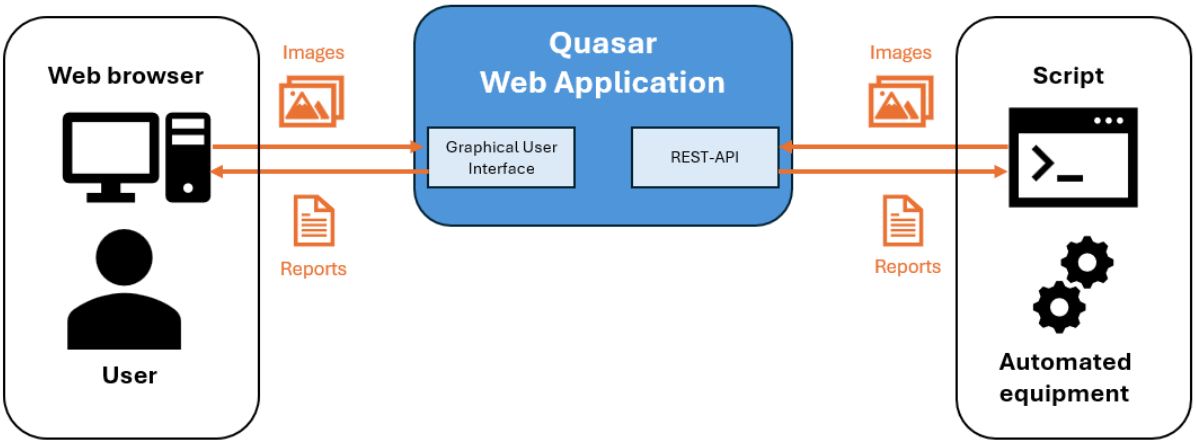


Figure 3 Illustration of soldering quality inspection report generation flow with Quasar Nova SMD

Table 1 summarizes the key features of Quasar Nova SMD.

Table 1 Key features of Quasar Nova SMD

Feature Name	Feature Description
User authentication and service access	The user shall log in via its distributed account to access to the service landing page.
Non-wetted areas analysis	Non-wetted area analysis is performed for each image in a batch uploaded by the user. The results provide several solderability quality metrics at the pad, device, and batch levels, along with their compliance to quality requirements. Once completed, the user can download both a PDF and an Excel report.
Solder voids analysis	Solder void analysis is performed for each image in a batch uploaded by the user. The results provide several solderability quality metrics at the pad, device, and batch levels, along with their compliance with quality requirements. Once completed, the user can download both a PDF and an Excel report.

2.2 Technical overview

Interface	- Graphical User Interface: web-based accessible from browsers such as Safari, Chrome, Firefox and Edge - REST-API: to access Quasar Nova SMD from automated process or equipment
Languages	English
Version	1.1.0

3 Getting started

3.1 Pre-requisite

Before running the first analysis, an administrator must provide the following information to Quasar Nova SMD:

- The name of the SMD component to be inspected
- A reference image or drawing of the SMD component
- The location of each pad on the reference image
- If necessary, one or more indications of the region of interest within the pads. This is useful, for example, when the PCB pads on which the SMD is soldered are smaller than the SMD pads.

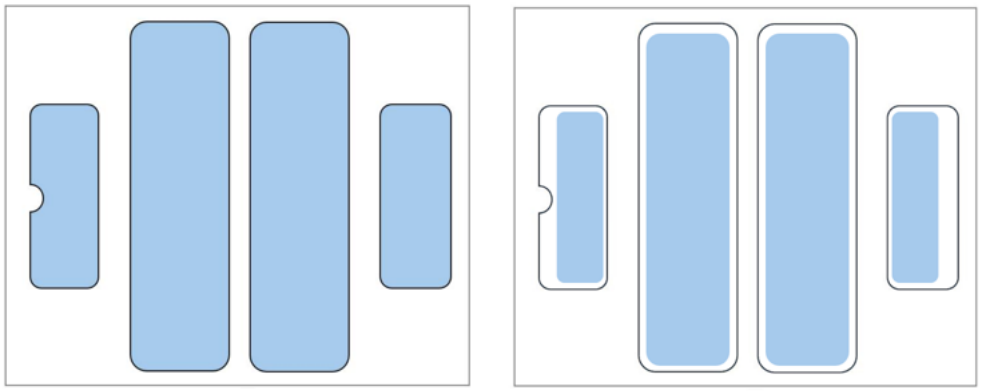


Figure 4 - Left: the whole pads are the regions of interest | Right: Sub-areas of the pads are the regions of interest

3.2 Landing page overview

3.2.1 Login

Before accessing the service, users must authenticate. Quasar Nova SMD can interact with existing SSOs or handle authentication with a login/password by itself. This section details the user authentication feature and provides instructions on how to access the service.

When entering the Quasar Nova SMD URL in the browser, the user will be directed to a login page if they are not authenticated.

The user must click the "Login" button, prompting a pop-up window to appear, asking them to sign in with their account. Upon successful authentication, the user will be redirected to the landing page shown in the next section.

The username will be included in all analysis reports initiated by the user.

3.2.2 Landing page

When logged in, Quasar Nova SMD displays the following page

Figure 5 - Quasar Nova SMD: landing page

3.2.3 Soldering analysis selection

Quasar Nova SMD currently supports two soldering analyses for SMDs:

- WETTING: non-wetted areas detection and analysis in RGB images
- VOIDING: solder voids detection and analysis in X-Ray images.

Users can select a use case by clicking on the desired box as shown in the Figure 5 (step 1)

3.2.4 SMD name selection

The user must select the name of the SMD to analyze among all the SMDs components provided, as shown in Figure 5 (step 2).

3.2.5 SMD reference image selection

By default, when the SMD name is selected, its reference image is displayed, with the corresponding PADs highlighted in blue, as shown in Figure 5 (step 3). In case the user is interested in measuring the void percentage compared to a sub region of the pads, the user can select different regions of interest among the ones provided, as explained in section 3.1.

3.2.6 Upload files

The user can upload a batch of images for inspection by either browsing in his folders by clicking on “Browse files” button or using drag and drop, as shown in Figure 5 (step 4).

Each of the images of the batch must contain a single component, corresponding to the selected SMD.

The accepted image formats are JPEG, PNG or TIF and the maximal size is 200MB per file.

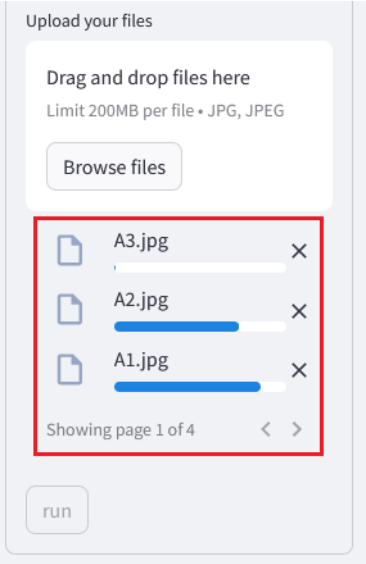


Figure 6 Example of files uploading

3.2.7 Run

Once all the images have been successfully uploaded, the user can click the "Run" button, as shown in Figure 5 (step 5), to start the inspection.

A progress bar will then display the number of images processed, as shown below:

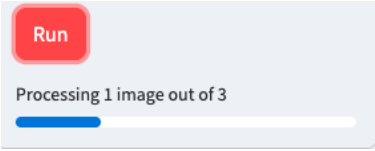


Figure 7 Illustration of progress bar when running the inspection on uploaded images

4 Results

4.1 Pad and image-level analysis

Once the image has been processed, the results are displayed in the right frame and contains:

- The image name.
- The status of the image analysis: OK or the error message.
- The original image.
- The image with the mask identifying the pads and the non-wetted/solder voids areas.
- The pad-level metrics for each pad and its compliance to the quality requirements.
- The image level metrics and its compliance to the quality requirements.

The results for each image are displayed one after the other as seen in the figure below:

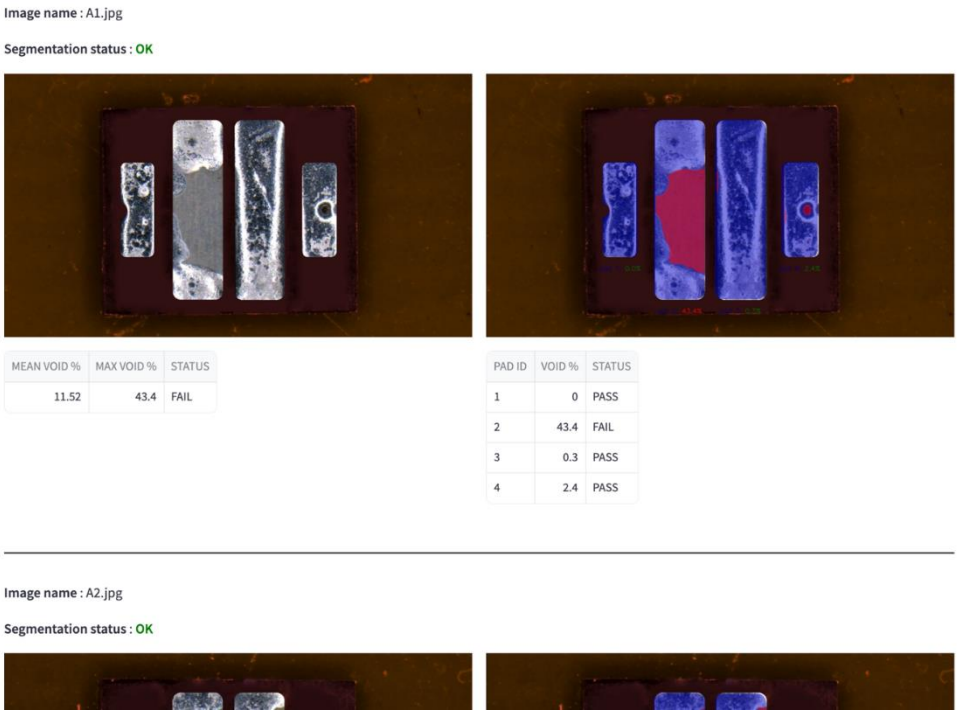


Figure 8 - Non-wetted analysis result of an image

As shown in **Error! Reference source not found.**9 and 10, each pad has:

- PAD ID: the identification number of pad in the image.
- VOID %: non-wetted areas/solder voids percentage of the pad, which equals to non-wetted area/solder void area divided by pad area.

- STATUS: For non-wetting analysis, if the VOID% is higher than **5%** (the threshold can be customized), then the PAD status is FAIL, otherwise PASS. For voiding (solder voids), if the VOID% is higher than **25%** (the threshold can be customized), then the PAD status is FAIL.

At image level, three metrics are defined:

- Mean void %: average non-wetted areas/solder voids percentage in the image, which equals to the overall void area in the image divided by all pads' area
- Max void %: the maximum non-wetted areas/solder voids percentage of all pads
- Status: if all pads pass, then the image status is PASS, otherwise its status is FAIL

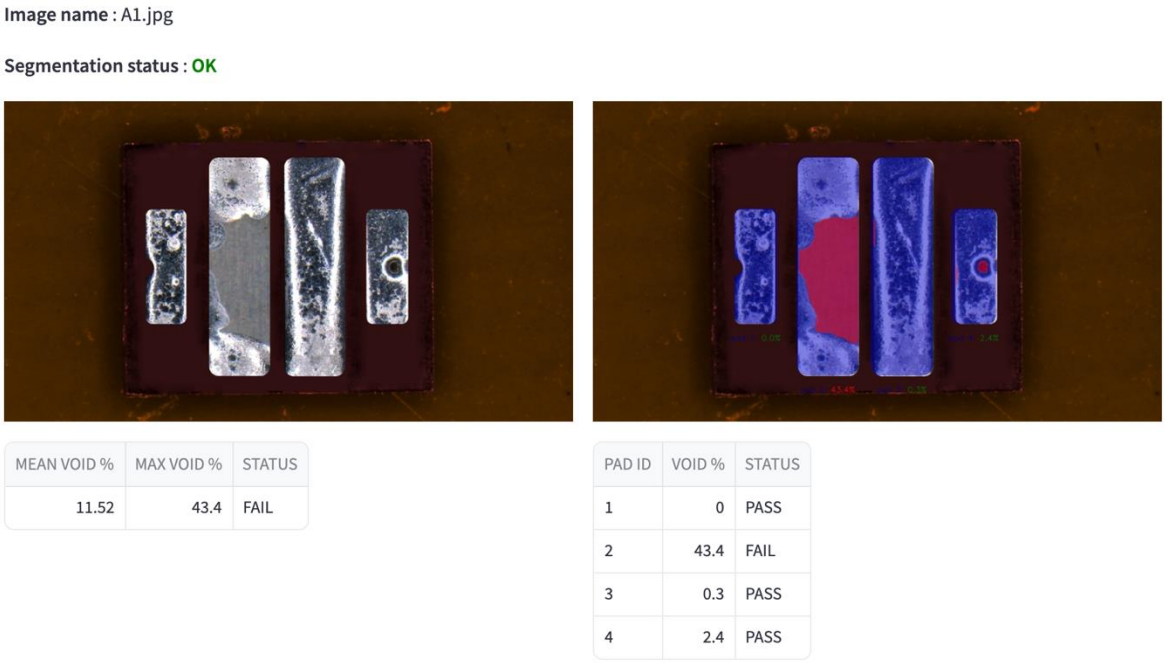


Figure 9 - Illustration of image-level and pad-level metrics definition for non-wetted areas analysis

MEAN VOID %	MAX VOID %	STATUS
10.77	12.8	PASS

PAD ID	VOID %	STATUS
1	7.8	PASS
2	11.9	PASS
3	10.6	PASS
4	12.8	PASS

Figure 10 - Illustration of image-level and pad-level metrics definition for voiding areas analysis

4.2 Results edition

In few cases, Quasar Nova SMD may miss a small solder void or non-wetted area. If this occurs, the web application allows the user to manually edit the results by drawing the solder void directly on the image, which quickly regenerates the metrics and the report.

This feature is accessible by clicking "Edit the results" just below the result image.

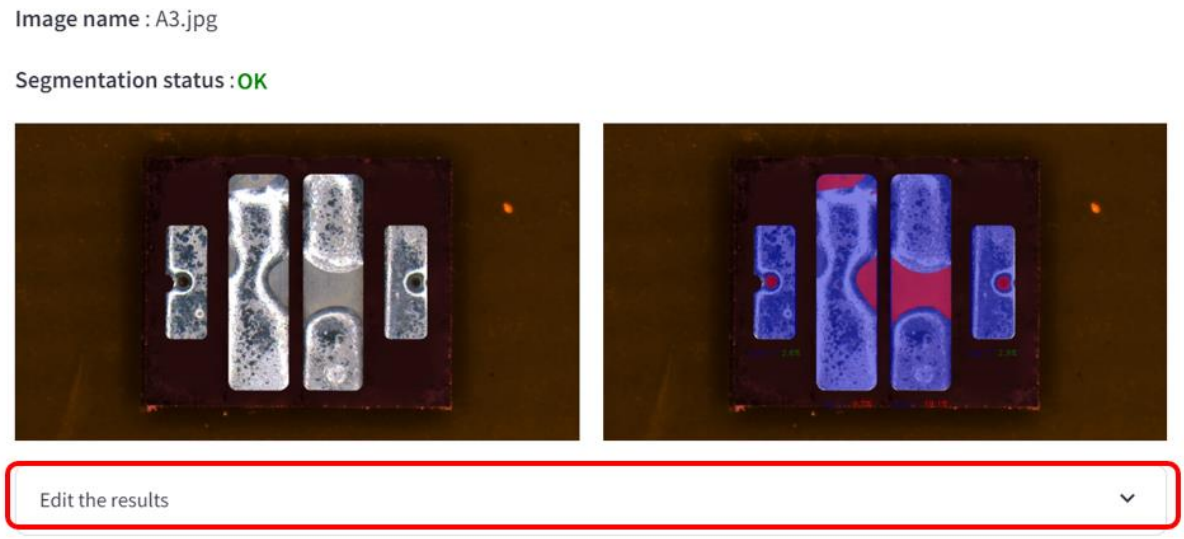


Figure 11 - Edit the results

Once clicked, it is possible to add, modify or delete any pad, non-wetted area or void with few clicks, as shown below. Once the user has finished his correction, clicking on “Update” results in updating the result image, the metrics as well as the reports.

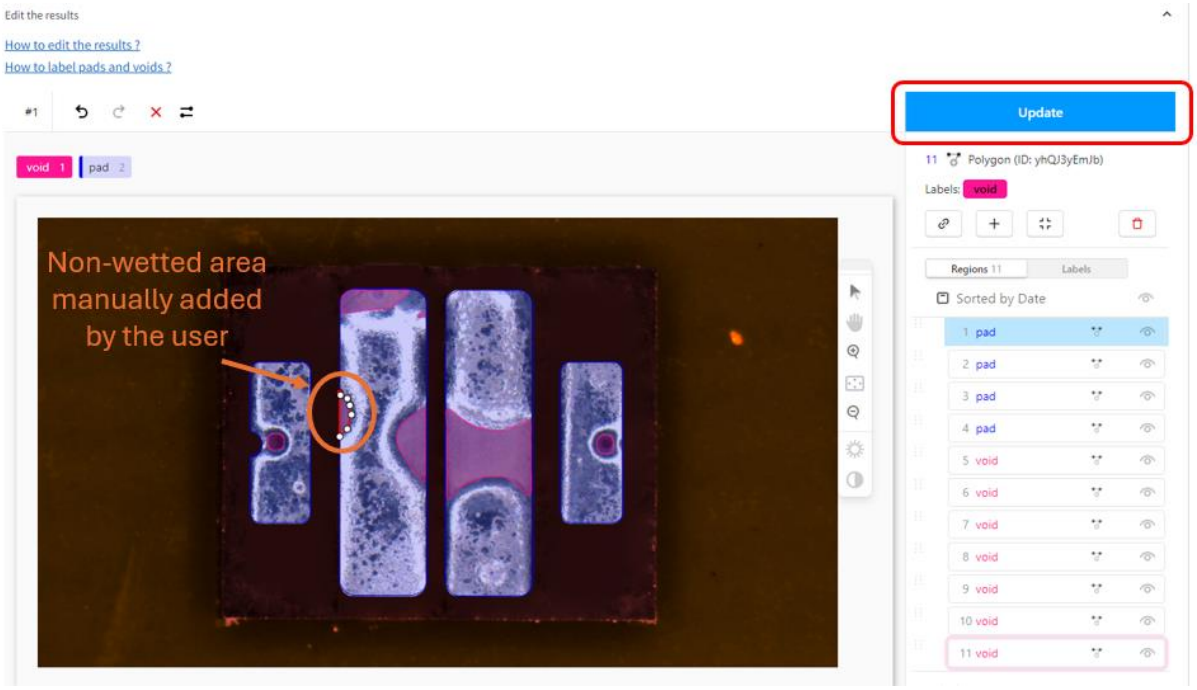


Figure 12 - Example of results edition for a missing non-wetted area

4.3 Batch-level analysis

Once all the images of a batch had been analyzed, Quasar Nova SMD computes batch-level metrics and a heatmap showing the occurrence of non-wetting or solder void in the device.

4.3.1 Batch-level metrics

The batch level metrics are defined as following:

- **TotalMaxVoiding[%]**: the maximum non-wetted areas/solder voids percentage of all pads in the batch
- **AvgeVoiding all devices [%]**: average non-wetted areas/solder voids percentage of all pads in the batch, which is calculated as the division of total non-wetted/solder voids area over total pad area
- **Failed devices [%]**: failed image number divided by number of images in the batch
- **Failed devices [%]**: failed pad number divided by number of pads in the batch

4.3.2 Heatmap

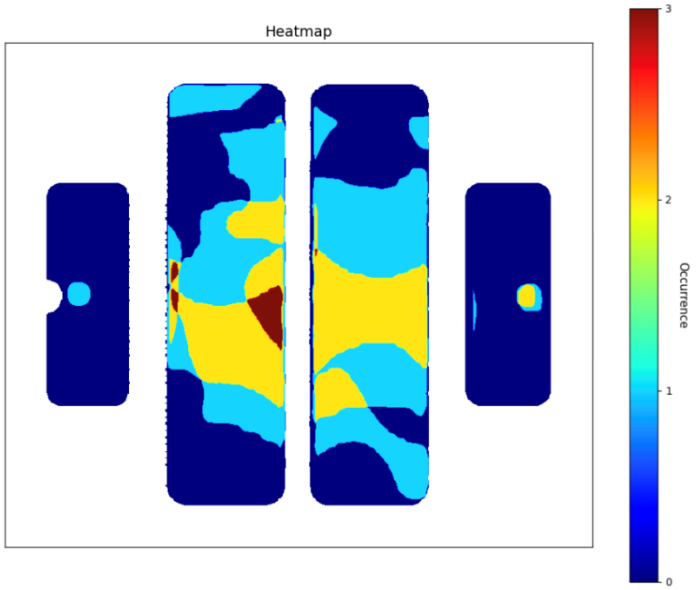


Figure 13 – Example of non-wetted areas heatmap

Figure 13 shows an example of non-wetted areas heatmap. It is built by counting the occurrence of each pixel of a non-wetted area in a pad in all the images of the batch.

Such a heatmap is also obtained when running the solder void analysis.

4.3.3 Analysis summary

A compliancy status of the batch is provided.

The metrics are encapsulated into a summary table containing additional information:

- The date of inspection
- The device name if filled by the user
- The username
- The device type
- The number of images
- The number of pads for the device type
- The threshold applied on the max acceptable non-wetted area/solder voids area ratio for each pad (5% by default for non-wetting, 25% for solder voids analysis)
- Quasar Nova SMD version

	Overview
Date	2024-06-05
User	Unknown
Device	KW2 HIL532.TK
Number of devices	3
Number of pads	4
TotalMaxVoiding [%]	14.6
AvgeVoiding all devices [%]	4.72
Failed devices [%]	100.0
Failed pads [%]	41.67
Thresholds [%]	5 5 5 5
QUASAR release version	v1.0.0

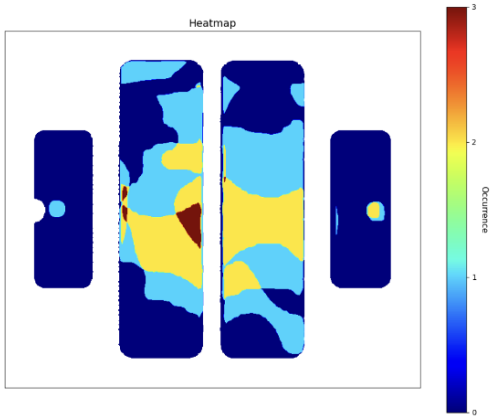
Figure 14 – Example of analysis summary

4.4 Graphical and statistical reports

Below the analysis summary, a link allows downloading an Excel and a PDF report as shown in the figure below.

Batch segmentation status : OK

	Overview
Date	2024-06-08
User	Unknown
Device	device_01
Number of devices	5
Number of pads	4
TotalMaxVoiding [%]	52.2
AvgeVoiding all devices [%]	13.74
Failed devices [%]	100.0
Failed pads [%]	35.0
Thresholds [%]	5 5 5 5
QUASAR release version	v1.0.0



Download Excel file

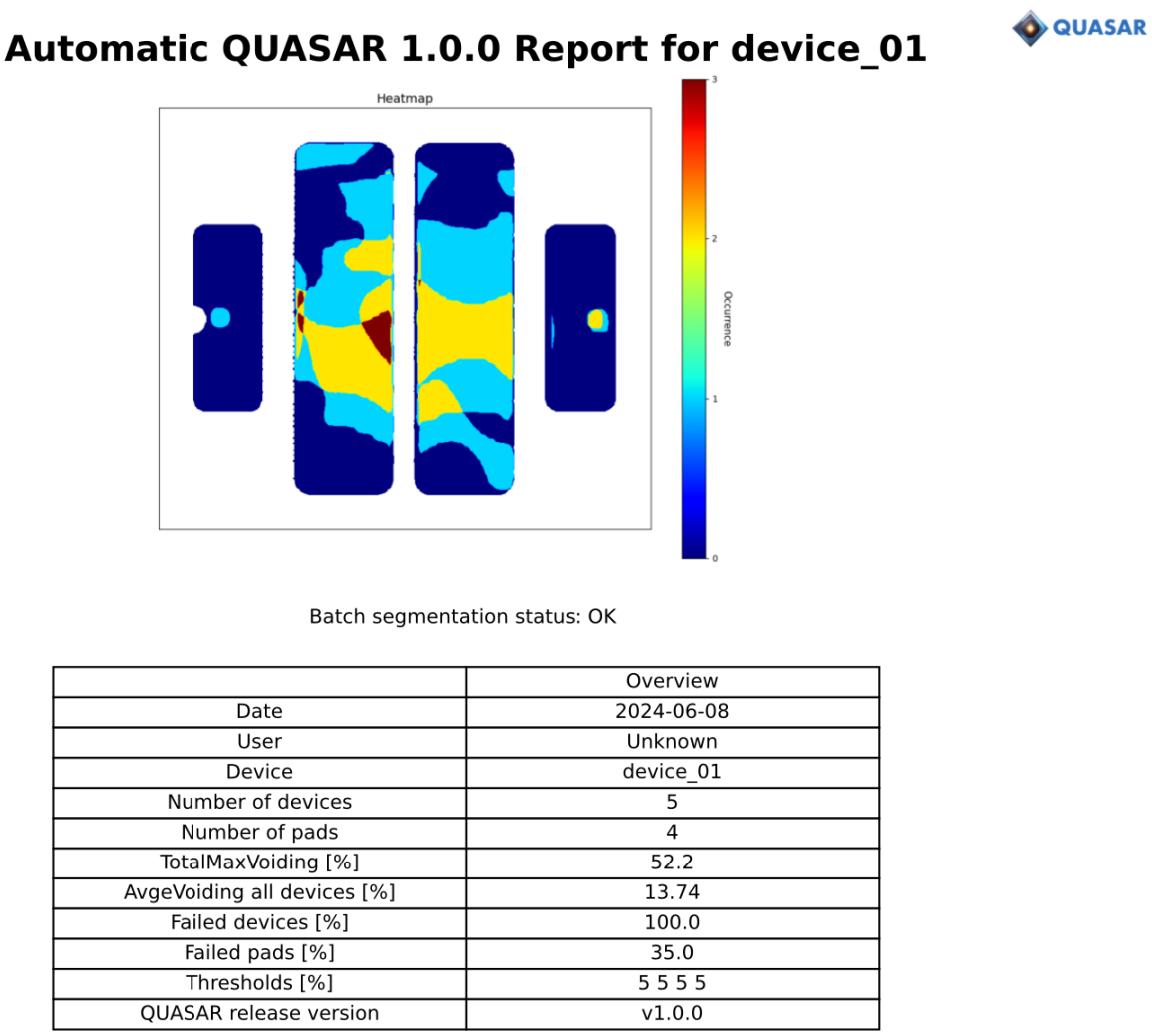
Download PDF file

Figure 15 - Reports download links

4.4.1 PDF report description

The PDF contains the following information:

- Batch level analysis: a heatmap explained in section 4.3.2 and an analysis summary shown in section 4.3.3 are summarized in the cover page of the report.
- Image level analysis: a dedicated page for each image in the batch is generated and it contains an original image, an image with segmentation masks, an image-level table and a pad-level table.

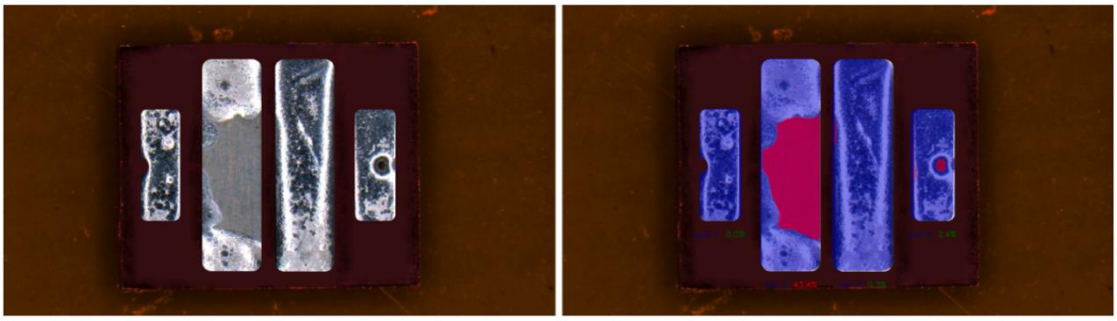


	Overview
Date	2024-06-08
User	Unknown
Device	device_01
Number of devices	5
Number of pads	4
TotalMaxVoiding [%]	52.2
AvgeVoiding all devices [%]	13.74
Failed devices [%]	100.0
Failed pads [%]	35.0
Thresholds [%]	5 5 5 5
QUASAR release version	v1.0.0

Figure 16 - Example of cover page of the PDF report

	DeviceID	MEAN VOID %	MAX VOID %	STATUS
A1.jpg	1	11.52	43.4	FAIL

Segmentation status: OK



	DeviceId	PAD ID	VOID %	STATUS
A1.jpg_d1_p1	1	1	0.0	PASS
A1.jpg_d1_p2	1	2	43.4	FAIL
A1.jpg_d1_p3	1	3	0.3	PASS
A1.jpg_d1_p4	1	4	2.4	PASS

Figure 17 - Example of image-level page in the PDF report

4.4.2 Excel report description

The excel file consists of 4 tables:

- **Overview**: table of analysis summary explained in

	Overview
Date	2024-06-05
User	Unknown
Device	device1
Number of devices	3
Number of pads	4
TotalMaxVoiding [%]	14.6
AvgeVoiding all devices [%]	4.72
Failed devices [%]	100.0
Failed pads [%]	41.67
Thresholds [%]	5 5 5 5
QUASAR release version	v1.0.0

Figure 18 - Example of Summary table

- **FullData**: a table contains detailed information of each pad (row) with following columns
    - UniqueName: A unique name to identify a row, which is made up of OriginalName_DeviceNumber_PadNumber
    - OriginalName: original image name without extension
    - DeviceNumber: device number in the batch
    - PadNumber: pad number in the image
    - SolderJointArea_pixels: soldering area (in pixel) of the pad
    - VoidingArea_pixels: non-wetted/solder voids area (in pixel) of the pad
    - VoidingRatio [%]: non-wetted/solder voids ratio of the pad, which is VoidingArea_pixels divided by SolderJointArea_pixels times 100 (in percentage)
    - BiggestVoid_pixels: biggest non-wetted/solder voids area in pixel in the pad
    - NumberOfVoids: number of non-wetted areas/solder voids in the pad
    - MeansizeOfVoids_pixels: average non-wetted areas/solder voids area in pixel, which is VoidingArea_pixels divided by NumberOfVoids
    - Status: if the pad passes quality check. For non-wetting analysis, when VoidingRatio > 5%, the status is FAIL, otherwise FAIL. For solder voids analysis, when VoidingRatio > 25%, the status is FAIL, otherwise FAIL.

A	B	C	D	E	F	G	H	I	J	K
UniqueName	OriginalName	DeviceNumber	PadNumber	SolderJointArea_pixels	VoidingArea_pixels	VoidingRatio [%]	BiggestVoid_pixels	NumberOfVoids	MeansizeOfVoids_pixels	Status
Bild 001.jpg_1_1	Bild 001.jpg	1	1	56745	5047	8.894175698	2491	2	2523.5	FAIL
Bild 001.jpg_1_2	Bild 001.jpg	1	2	66277	0	0	0	0	0	PASS
Bild 001.jpg_1_3	Bild 001.jpg	1	3	68342	2272	3.32445641	2159	2	1136	PASS
Bild 001.jpg_1_4	Bild 001.jpg	1	4	58462	1040	1.778933324	1040	1	1040	PASS
Bild 002.jpg_2_1	Bild 002.jpg	2	1	56489	0	0	0	0	0	PASS
Bild 002.jpg_2_2	Bild 002.jpg	2	2	65008	3819	5.87466158	1486	4	954.75	FAIL
Bild 002.jpg_2_3	Bild 002.jpg	2	3	67988	5991	8.81184915	5991	1	5991	FAIL
Bild 002.jpg_2_4	Bild 002.jpg	2	4	58924	0	0	0	0	0	PASS
Bild 003.jpg_3_1	Bild 003.jpg	3	1	56653	0	0	0	0	0	PASS
Bild 003.jpg_3_2	Bild 003.jpg	3	2	65579	7726	11.78121045	4450	6	1287.666667	FAIL
Bild 003.jpg_3_3	Bild 003.jpg	3	3	66569	0	0	0	0	0	PASS
Bild 003.jpg_3_4	Bild 003.jpg	3	4	58248	8516	14.62024447	7162	2	4258	FAIL

Figure 19 - Example of FullData table

- **DeviceSummary**: summary of a device (image), where each row represents an image, and it has following columns
    - OriginalName: original image name without extension
    - DeviceNumber: device number in the batch
    - Avge Voiding Ratio [%]: average non-wetted area/solder voids ratio in the image, which is total non-wetted/solder voids (overlapped with pads) area divided by total pad area in the image in percentage.
    - MaxVoidingPercent: maximum non-wetted area/solder voids percentage of all pads in the image
    - Status: if all pads in the image pass, the status is PASS, otherwise FAIL
    - Segmentation status: segmentation status of the image

OriginalName	DeviceNumber	Avge Voiding Ratio [%]	MaxVoidingPercent	Status	Segmentation status
Bild 001.jpg	1	3.48	8.7	FAIL	OK
Bild 002.jpg	2	3.68	9	FAIL	OK
Bild 003.jpg	3	6.6	14.6	FAIL	OK

Figure 20 - Example of DeviceSummary table

- **PadSummary:** summary of a pad in all images of the batch, where each row represents a pad, and it has following columns
  - Pad: pad ID
  - VoidingArea pixels: sum of non-wetted area/solder voids area of THIS Pad in all images
  - Summe von SolderJointArea_pixels: sum of soldering area of THIS Pad in all images
  - Avge Voiding Ratio [%]: average non-wetted area/solder voids ratio in percentage, which is VoidingArea pixels divided by Summe von SolderJointArea_pixels and times 100
  - MaxVoiding Percent: maximum non-wetted area/solder voids percentage of THIS pad in all the images.

Pad	VoidingArea pixels	Summe von SolderJointArea_pixels	Avge Voiding Ratio [%]	MaxVoiding Percent
1	5047	169887	2.970798236	8.894175698
2	11545	196864	5.864454649	11.78121045
3	8263	202899	4.072469554	8.81184915
4	9556	175634	5.44085997	14.62024447
Total	34411	745284	4.617166074	14.62024447

Figure 21 - Example of PadSummary table