

STEP BY STEP GUIDE

For visual inspection software

2 | inspect



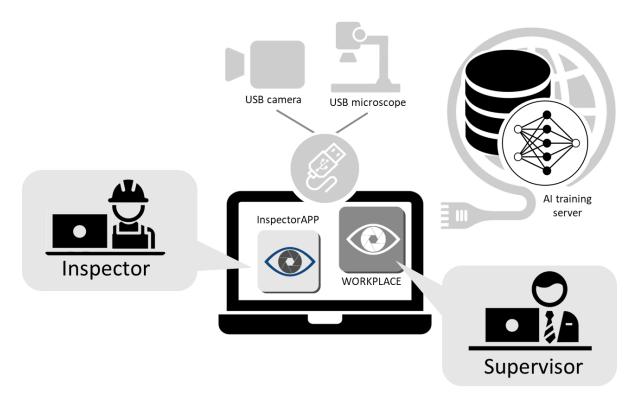
Introduction

The 2 inspect software assists the assembly worker or inspector in performing quality assurance visual inspections between individual assembly steps or at the end of manufacturing line. This is done by simply taking photos of the inspection object. Subsequently, the software extracts all inspection points and compares these images with the initial product sample. If the software detects any deviations from the desired target state in the inspection points, it frames the faulty inspection points in the result screen for visual inspection.

The key functions of the 2 inspect software are:

- Automatic extraction of all inspection points from the inspection object photo
- Comparison of the inspection points with the reference object
- Display of all faulty inspection points in the overview screen
- Automatic photo documentation of the entire visual inspection

Components of the visual inspection system



The 2|inspect inspection system requires a computer running on WINDOWS® 10 or 11 operating system, an image acquisition system (internal camera or USB camera or USB microscope) and an internet connection. The visual inspection software installed on the computer consists of two components:

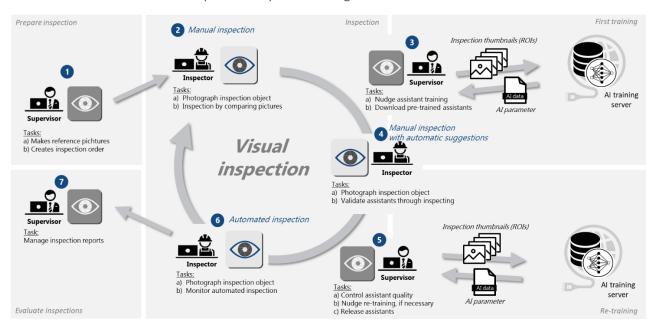


- 1. The WORKPLACE program for the supervisor. This program is used to create inspection orders and manage the test reports as well as the AI-based test assistants.
- 2. The inspectorAPP for the assembly worker or visual inspector. This is used to select predefined inspection orders and perform a step-by-step visual inspection of an inspection object.

The training of AI inspection assistants is conducted on a specialized training server, which is accessible via the internet. For training, the small images of the individual inspection points are uploaded from the workplace to the server, and after successful training, a parameter set for the trained trained inspection assistant is downloaded back to the workplace.

The inspection workflow - overview

The focus is on the visual inspection conducted by the assembly worker or inspector. This inspection can be performed manually (<u>Step 2</u>), semi-automatically (<u>Step 4</u>) or automatically (<u>Step 6</u>), with the semi-automatic and the automatic inspection requires training of AI assistants.



The visual inspection of the assembly worker or inspector is supported by the tasks of a supervisor. To do this, the supervisor performs the following steps:

Step 1: Prepare inspection

Step 3: Trigger initial assistant training

Step 5: Trigger possible re-training

Step 7: Manage inspection reports



Note: Click on the numbers in the graphic to learn more about the key software functions behind the steps.



Tabel of contents

Introduction	1
Components of the visual inspection system	
The inspection workflow - overview	2
Tabel of contents	3
System requirements	
Workplace computer	
Optical system	
Installation and initial commissioning of the software	
Initial commissioning	5
Step 1: Prepare inspection	6
Capture inspection perspectives of reference object	6
Creating an inspection order	
Selecting an inspection object	
Define inspection points	8
Creatin an inspection assistant for an inspection point	8
Step 2: Manual inspection	11
Step 3: Trigger initial assistant training	13
Step 4: Manuel inspection with automatic suggestions	15
Step 5: Trigger possible re-training and activate assistant	16
Step 6: Automatic inspection	16
Step 7: Evaluating inspections	18
Inspection report as a PDF	20
Overview of software menus	20
General program settings	20
Settings for the Inspection Order and Inspection	21



System requirements

Workplace computer

	minimal	optimum
Processor	Intel [©] i5	Intel [©] i7
	(or comparable performance class	(or comparable performance class
	from another manufacturer)	from another manufacturer)
RAM memory	8GB	16GB
Monitor	14" display,	Touchscreen, 15" display, min.
	min. resolution: 1400x1050px.	resolution: 1920x1080px. ("full HD").
Operating system	Windows [©] 10, 11	Windows© 10, 11
On tablet operation	Recommend Microsoft [®] surface	Recommend Microsoft [©] Surface Pro7
	Pro7 (2019) or later	(2019) or later
Web connection	LAN or WLAN	LAN or WLAN

Optical system

The optical system (microscope, macroscope, videoscope, document camera, other USB-enabled camera) must be connectable to a WINDOWS $^{\circ}$ 10 or WINDOWS $^{\circ}$ 10 operating system via USB port.

L Return to Table of Contents

Installation and initial commissioning of the software

To download the software, you can use a link or visit the homepage. Download the ZIP file with the containing software and unzip the files.

The ZIP file "2Inspect installation files" includes the following files:

- 1. README.txt (installation notes in German and English)
- 2. Dotnet-runtime-7.0.2-win64.exe
- 3. Windowsdesktop-runtime-7.0.2-win-x64.exe
- 4. InstallerBasic.msi

Start by installing the two support programs (Dotnet and Windows Desktop) from Microsoft[©] to prepare your WINDOWS system for the 2 inspect software. Run the executable programs one by one and follow



the installation instructions on the screen. Finally, launch the InstallerBasic.msi installation program to install 2 | inspect on your computer.

î Return to Table of Contents

Initial commissioning

After successful installation of the 2 inspect software, two new program icons will appear on your WINDOWS desktop: **2inspect Workplace** and **2inspect App.**

First, launch the Workplace program.

A camera window will appear, allowing you to select the desired camera for your inspection task. You can use either the internal camera of your tablet PC or connect a preferred external camera to your laptop or industrial PC via USB port.

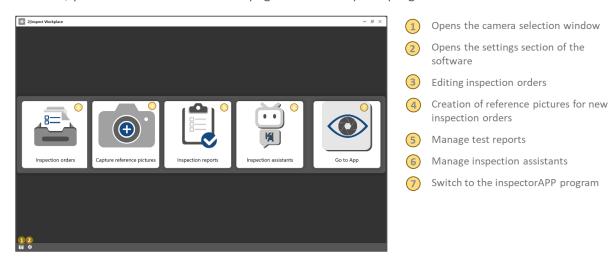
Once you confirm your camera choice, the camera window will close, and a password input window will appear. Create a password that you can use to access the Workplace program from now on.



Note: Only the Workplace program is protected by password. If you switch from the Workplace to the inspectorAPP or start the APP directly, you do NOT need a password!

Once the password has been assigned, you must enter the password for the first time to start the Workplace program.

After that, you will be taken to the main page of the Workplace program.





When you first start the Workplace program, it's best to sign up for the Al training service. To do this, click on the *Inspection Assistants* tile (6) and confirm your intention to sign up.

This action will open the *Settings* section of the Workplace program opens under the *Assistants tab* (89). Enter your company name in the *Company Name* field and assign a name for the inspection workstation, which you should enter in the *Workplace Name* field.

Click the *Register* button to open a registration form opens on the homepage, where you need to enter the *Company Name* and the *Workplace Name*. Also, enter your contact details in the form. After submitting this registration, you will gain access to the AI training service. Activation of your workstation may take up to 2 working days. You will receive a notification at the email address via the email address you provided once you are cleared for training. In the meantime, you can start creating inspection orders.

î Return to Table of Contents

Step 1: Prepare inspection

Capture inspection perspectives of reference object

To create a new inspection order, you first need to take photos of the reference object. To do this, go to the main page of the Workplace program and click on the *Capture reference pictures* tile (4). A dialog box appears, which will help you to create a new inspection order. Enter a name for the new inspection order and click *Next* (*right arrow*). This will open the window for taking inspection perspectives.



Note: If the live image from the wrong camera appears in the window, you can select a different camera by using the **Select camera** (1) button at the bottom left.



- Open the camera selection window
- Open the settings section of the software
- 8 Proceed to the next step of the workflow
- 9 Go back to the previous step of the workflow
- (10) Cancel the current workflow and return to the main window
- 11 Take a photo
- Preview photo for the current inspection
- Add an inspection perspective
- Delete the selected inspection perspective in (12)



Photograph the reference object from all perspectives where inspection points can be found. Finish and save the reference image captures by clicking on the **Next** (8) button. After confirmation with "save", you will return to the main page of the Workplace program.

î Return to Table of Contents

Creating an inspection order

After capturing the reference object, you can create the associated inspection order. To do this, click on the *Inspection orders* (3) tile on the main page of the Workplace program.

A list of available inspection orders will open. Select the inspection order you want to work on and confirm by clicking the *Next* (right arrow) button.

This will take you to the "Edit Inspection Order" workspace:



- 1 Open the camera selection window
- Open the settings section of the software
- Display the current step: Define the inspection object within the inspection perspective
- Display the "Add area to cut" tool in the toolbar
- Display the drawing tool "Draw a rectangle" in the toolbar
- 18 The red border frames the selected object area
- Click the checkmark to finish the "Define the inspection object" step

L Return to Table of Contents

Selecting an inspection object

In the first step, the inspection object is defined within the captured inspection perspective.



Note: All image areas outside the red border will be discarded during the subsequent image processing.

To do this, in the cropping tool in the tool area, select *Add area to cut* (16). After that, you can choose an appropriate drawing tool, e.g. *Draw a rectangle tool* (17), in the lower window area.

Drag the red rectangle to cut out the reference object. You can outline multiple reference objects in the image, and you can also define cutouts using the *Remove area from the template* tool.

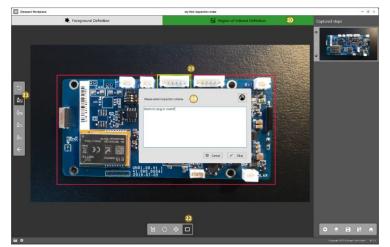


Once all inspection objects have been defined, finish the inspection *object definition* step by clicking the *checkmark* (19) and switch to the *Inspection point definition* area.

î Return to Table of Contents

Define inspection points

To define inspection points in the image, select *Add inspection point* (21) in the tool area on the left. To visually outline an inspection point, you can choose one of the drawing tools below, such as *Drawing a rectangle* (22).



- Display the current step: Inspection point definition
- 21 Display the "Add inspection point" tool in the
- Display the drawing tool "Draw a rectangle" in the toolbar
- 23 The yellow border frames the selected inspection point
- 24 Dialog box for inspection point definition
- Define Al inspection assistants (Default: turned off)

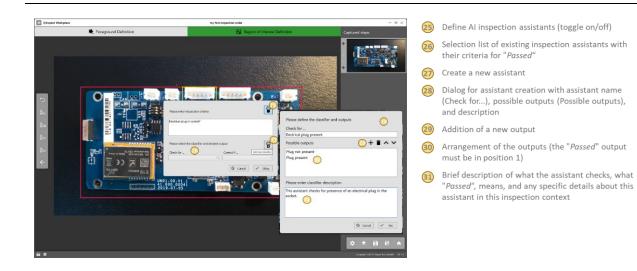
Now, outline the point to be inspected. After completing the outline process, the *Define inspection point* dialog (24) will open. Here, enter the inspection criterion that the inspector should later check at this point. By clicking *Okay*, the inspection criterion is saved for this inspection point.

L Return to Table of Contents

Creatin an inspection assistant for an inspection point

To enable later automatic inspection with an AI assistant, an assistant must be created for this inspection point.



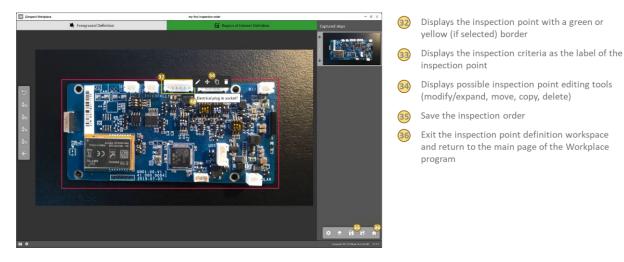


To do this, click on the *Define AI Inspection Assistant* (25) button. The dialog expands to include the *Assistant* section. Here, you can select an existing assistant for the inspection point or crate a *new assistant* (27) by opening another dialog for *assistant creation* (28). Each assistant requires a unique name, a list of possible *inspection scenarios* (30), and optionally, a *supplementary description* (31).



Note: Multiple inspection scenarios can be defined for each assistant. For example, you can define 3 different failures scenarios or 8 different cable colors.

Confirm the correct and complete entry by selecting **Yes** and the right configuration of the inspection point with **Okay**. Then return to the overview screen for the inspection object.



Draw all points to be inspected (ROIs) on the photo. Inspection points can still be edited, moved, copied, and deleted after they have been created. The drawn inspection points can also overlap in the image.



Once all inspection points are defined and positioned, *save the inspection order* (35) and *return to the main page* (36) of the Workplace program.



Note: When saving, you can overwrite the current name of the inspection order or assign a new name. The second option becomes important if you want to create additional inspection orders with different inspection points based on the captured perspective images.

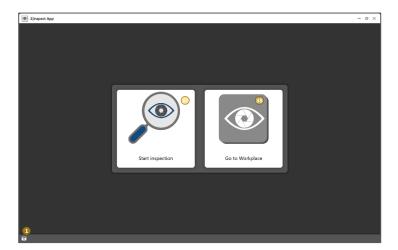
<u>L Return to Table of Contents</u>



Step 2: Manual inspection

To conduct an inspection, the inspector opens the **2inspectAPP** program.

In the app's start window, there are two tiles: Start Inspection (37) and Go to Workplace (38).



- 1 Opens the camera selection window
- 37) Starts a new inspection
- Switches to the Workplace program for the inspection planner (password-protected)



Note: The Go to Workplace function is password-protected.

After clicking on the *Start inspection* (37) tile, the selection window for finding an inspection order will open. Choose the correct inspection order from the list and confirm by clicking the *Next* (right arrow) button.



- Preview of the inspection object with the defined inspection points
- Metadata for the inspection report:
 Inspector (based on the user's WINDOWS
 login name)
- Metadata for the inspection report: Serial number or production order number
- Next button, starts the inspection



The selected inspection order appears. To create a new inspection report from the inspection order, the name of the logged-in *inspector* (40) is pre-entered. Additionally, a *serial or production order number* (41) must be insert. The actual inspection is initiated by clicking the *Next* button (42).



- 43 Semitransparent optical template with inspection points (ROIs)
- Capture or Next button for evaluation of the inspection
- 45) Cancel the inspection process

In the inspection window, you can see the live camera feed. Above the live feed is a semi-transparent *optical template* (43) with the inspection points outlined in yellow. Align the live feed of the inspection object with the optical template and *take a picture* (44). By repeatedly pressing the *Next* button (44), you will enter the comparison view of the inspection.



- 46 Inspection criteria for comparing the test object with the reference
- 47 Inspection point with visual comparison of the test object to the reference
- 48 Evaluation of the inspection point as "ok"
- (49) Evaluation of the inspection point as "not ok"
- Next button appears when all inspection points in the comparison list have been evaluated

Evaluate each individual inspection point in the list by *visually comparing the images* (47) with the *inspection criteria* (46) as *Passed* (48) or *Defect* (49). Once all inspection points have been assessed, the *Next* button (50) will appear.



Note: The gold-yellow highlighted column of the inspection table contains the inspection point images of the reference inspection object for comparison.

The Next button takes you to the final result screen of the visual inspection.





- Result image of the visual inspection
- Marking of the inspection points as "ok" or "not ok"
- Return to the evaluation table of the inspection points
- Final confirmation of the result and completion of the inspection

The *result screen* (51) displays all inspection points with their *inspection result* (52). At this point, the inspector can *review the inspection one last time* (53) or consciously and finally *complete* it (54).



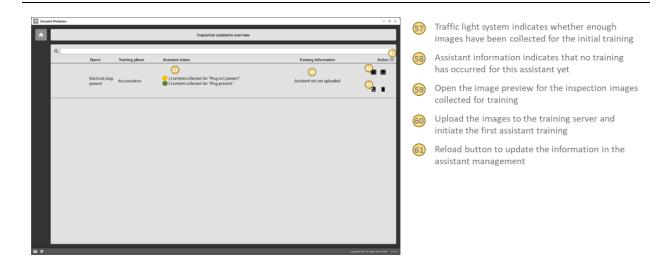
- Cancel the inspection process
- 53 Step back to the result overview
- Save the inspection and return to the main display window of the APP program
 - Save the current inspection and continue with a new inspection

î Return to Table of Contents

Step 3: Trigger initial assistant training

Once some inspections have been completed, and thus, some inspection images have been collected, the supervisor can initiate the initial training for the AI inspection assistants. To do this, from the start window of the Workplace program, they go through the *Inspection assistants* (6) tile to the management area for the AI inspection assistants.





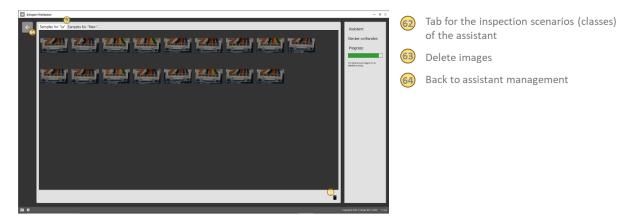
A *traffic light system* (37) indicates whether enough images have been collected for the first training of an inspection assistant.



Note: The traffic light will show red if there are less than 11 images available. For 11-15 images, it will show yellow, and for more than 15 images, it will show a green light.

Assistant training can start when all classes (inspection scenarios) show at least a yellow status.

The *Image Preview* (59) button allows the supervisor to review the existing collection of inspection images that will be sent to the server for training.



In the image preview, the images collected for each inspection scenario (class) are displayed. The individual classes can be opened via the *Samples tabs* (62). If the supervisor realizes that some images are incorrectly assigned, they can redistribute them to the appropriate tab by "dragging and dropping". Completely wrong or unusable images can be deleted by picking up the image to be deleted and moving



it to the *trash can* (63). When all inspection images are correctly assigned, you can return to the previous assistant management view by using the *Back button* (64).

From the assistant management, you can start assistant training by clicking the *Training button* (60).



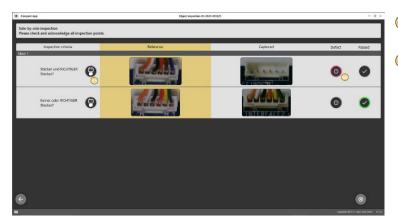
Note: Depending on the number of transferred classes and images per class, the transmission and training process can take between 10 and 35 minutes. After successful training, the server will send a message to the Workplace program that a new assistant can be downloaded.

A successfully downloaded assistant is recognized by the presence of a preview image of the assistant in the assistant management view. In the information column *Training phase*, there is a switch that is preset to *validate*. In this status, the software marks its inspection suggestions in the comparison table.

L Return to Table of Contents

Step 4: Manuel inspection with automatic suggestions

When an AI inspection assistant is in the *validate* status after the initial training, it marks its inspection suggestions in the comparison table. The process of inspecting with automatic suggestions is fundamentally similar to the procedure for manual inspection. The only difference is seen in the comparison table after capturing the inspection object.





Suggestions from the AI assistant in "validate" status

When an assistant is in the *validate* status, it marks its inspection suggestions with a *colored circle* (66) around what it considers the correct inspection result. The human inspector can choose to accept or override these suggestions.



Note: Images with differing inspection results between the human and the machine are saved for potential future re-training of the assistant.

L Return to Table of Contents



Step 5: Trigger possible re-training and activate assistant

At regular intervals, the inspection planner should check the *assistant management* (6) in the Workplace program and review the current training status of the inspection assistants.



- Open the image preview for the inspection images collected for training
- Uploads the images to the training server and initiates the assistant training
- 67) Thumbnail image of the inspection assistant
- 68 Assistant status
- 69 Download fully trained assistant into the 2 | inspect software
- Switch to activate automatic inspection by the inspection assistant

In the *Assistant status* (68) column, the supervisor can see how many times the assistant has been in use and whether there are new images available for retraining the assistant.

If new images are available, the supervisor can view these images through the *preview* (59) and initiate *retraining of the assistant* (60). After successful training, the software informs the supervisor that fully trained assistants are ready for download. Upon *downloading* (69) the assistant, the status of the assistant in the *Training phase information* column can be set to *valid* (70). In this setting, automatic assistant inspection is activated.

L Return to Table of Contents

Step 6: Automatic inspection

Once all the inspection assistants required for an inspection order have been activated (set to *valid*), the software takes over the inspection of all individual inspection points. In this state, the inspectorAPP program immediately displays the result image of the inspection with the evaluation of each inspection point after *capturing* (44) the inspection object (44).





- Final confirmation of the result and completion of the inspection
- Display of the inspection result and who conducted the inspection (human or machine)
- 72) Detail view of the inspection point
- 73 Overwrite the inspection result
 - Close the detail view

The result screen displays all the inspection results and indicates the responsible inspector (human or machine). By clicking on each inspection point, the corresponding *detail view* (72) opens. In this display, the visual comparison for the inspection, the used inspection assistant, and the inspection result are presented. If there has been a misjudgment of the inspection point, the human inspector can override the inspection result by clicking *Change* (73). The *Back* (74) button concludes the detail view.

If the human inspector is satisfied with the overall inspection result, it confirms and conclude the inspection by clicking the green *checkmark* (54).



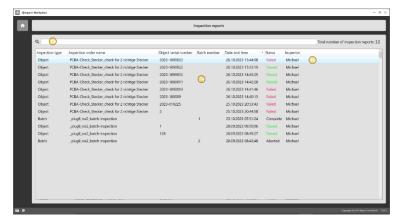
Note: An inspection assistant that has been trained with many example images and possibly retrained multiple times will become so reliable over time that it can provide accurate inspection results independently. However, the human inspector retains quality responsibility. By clicking the green **checkmark** (54), the human inspector officially approves the inspection.

î Return to Table of Contents



Step 7: Evaluating inspections

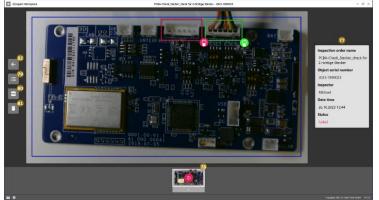
If the supervisor wants to trace individual inspections, he can view the automatically generated reports for the inspections.



- 1 Inspection report list
- 75 Search field to enter a text or number range to be found in the list
- 76 Selectable inspection report

The supervisor can access the inspection report list through the *Inspection reports* (5) tile in the Workplace program. The list displays all generated inspection reports, including the certain type of inspection (object = single object inspection or batch = multiple inspections), the underlying inspection order, the serial or batch number, the inspection time, the inspection status, and the responsible inspector.

By entering a search term into the **search bar** (75), the result list can be filtered accordingly. Clicking on the selected **inspection report** (76) opens the stored report documentation.



- Overview of the inspection result including metadata from the inspection report list
- Display of the summarized inspection result of the inspection perspective
- Result display of individual inspection points
- Generate inspection report as PDF
- Delete inspection report
- 82 Exit display and return to the inspection report list

The inspection report documentation includes the result summary along with *metadata* (77) for the inspection. If there are multiple inspection perspectives, they are displayed in the preview bar at the



bottom with their final *inspection result* (78). By clicking on the preview image, the corresponding perspective is displayed.

Using the *Display individual inspection point results* (79) button, the supervisor can access a sub-view that displays all individual inspection results.



The individual inspection results allow the supervisor to trace what the inspector and the assistant have decided. In the *Final decision* (83) information column, the supervisor can see who (human or machine) made the final decision with which result. If a *comment* (84) was added to an nOK rated inspection point, it can be opened by clicking the *exclamation mark* (84).

The current result display can be exited using the *Back* (85) button.

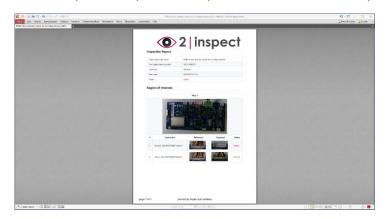
L Return to Table of Contents



Inspection report as a PDF

Each inspection report can be written as a PDF and saved. To do this, the supervisor clicks on *Generate PDF* (80). This will open the PDF viewing program available on the computer, where the inspection report is displayed as a PDF.

The PDF inspection report can be printed and/or saved at any location in the available file directory.





Note: The text header of the inspection report can be customized through the menu **General Program Settings > PDF**.

In the overview display of the inspection report, the current test report can be deleted using the *trash can* (81) button.

<u>L</u> Return to Table of Contents

Overview of software menus

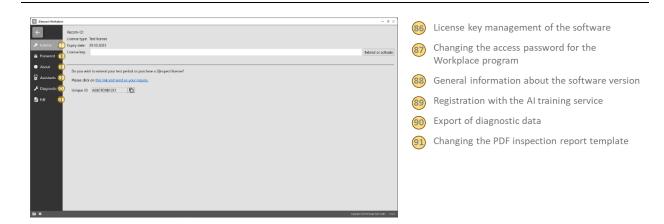
The 2 inspect visual inspection software has 2 menu areas:

- 1. General settings of the program
- 2. Settings related to an inspection order and its inspection sequence

General program settings

The general program settings in the Workplace program can be accessed through the *Software Settings* (2) button.





In the program settings section, you can manage the program and make various adjustments. Under the *License* (86) tab, you can find the Unique ID required for the assignment of a license key. In the *License key* field, you can enter a valid license key and activate it. Under the *Password* (87) tab, you can change the access password to the Workplace program that was assigned during the initial software setup. The *About* (88) tab contains information about the software version, and the *Assistants* (89) tab is used to register the workplace with the AI training server. Under the *Diagnostic* (90) tab, you have the option to export diagnostic data for troubleshooting. The *Pdf* (91) tab allows you to customize the PDF inspection report template.

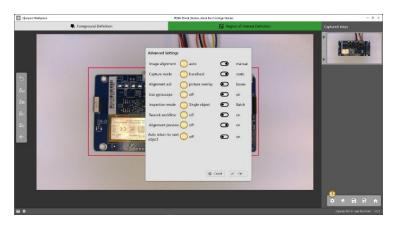
Settings for the Inspection Order and Inspection

Another menu provides settings for inspection. All settings made at this point pertain exclusively to the specific inspection order.



Note: Settings made in the inspection order menu apply exclusively to the currently selected inspection order!





- 92 Opens the inspection order settings
- (3) Alignment of the checkpoint images in the inspection perspective: auto = on; manual = off
- Borders of the checkpoint images: static = according to the drawn outline; handheld = slightly larger than the drawn outline
- Alignment aid for positioning the digital image template on the test object: boxes = only checkpoint markings visible; picture overlay = semi-transparent image of the reference object visible
- Optical alignment aid for rotation and tilt, usable, when the inspection software is used on a tablet PC
- Selection of the type of inspection: Single-object inspection; Batch inspection.
- 98) Enable or disable rework process
- 69 Display of a preview image after each shot to check if the inspection perspective was correctly captured
- Software behavior after completing a single-object inspection): off = At the end, return to the main screen; on = Input screen for the next test object.

The Inspection Order Settings (92) button opens the Advanced Settings menu. Under Image Alignment (93), you can set whether inspection point images should be realigned within the overview image after capture or not. The auto option is recommended for hand-held shots, such as those taken with a tablet PC. The Capture mode (94) option works in the same direction. For hand-held shots, it is recommended to use the *handheld* setting, where the individual inspection point images are always slightly larger than they were originally drawn when setting up the order. In the *Alignment aid* (95) section, the supervisor can determine whether to use the reference object as a semi-transparent template (= picture overlay) or only the outlines (= boxes) of the individual inspection points for capturing the inspection perspective. When using the software on a tablet PC, the *Use ayroscope* (96) option allows you to decide whether a graphical alignment aid for tablet rotation and tilt should be displayed in the image. The 2 inspect software supports two different *Inspection modes* (97): single-object inspection (= *Single* object) and batch inspection (= Batch). In batch inspection, individual inspection point photos are not saved. Instead, after completing the inspection, a quality report with a defect rate is provided. In singleobject inspection, on the other hand, all individual inspection point photos are always saved and listed in the inspection report. For the single-object inspection scenario, you can decide whether a rework workflow (98) is desired in case of defects or not. The Alignment preview (99) is providing an additional view that displays the perspective just captured. This intermediate step allows for a visual assessment of the perspective in terms of whether it was properly framed and in focus. If the inspector detects an issue, they can re-capture immediately. This function is recommended for inspection orders with a large number of inspection perspectives. It helps avoid poorly captured perspectives unnecessarily interrupting the later image comparison process. The Autoreturn to next object (00) function is used in the single-object inspection scenario. Here, you can determine whether, after the last inspection, the input screen for the next object immediately appears or if the software returns to the start screen of the inspectorAPP.

î Return to Table of Contents