IMAGING GAUGE ™ Quality Test System

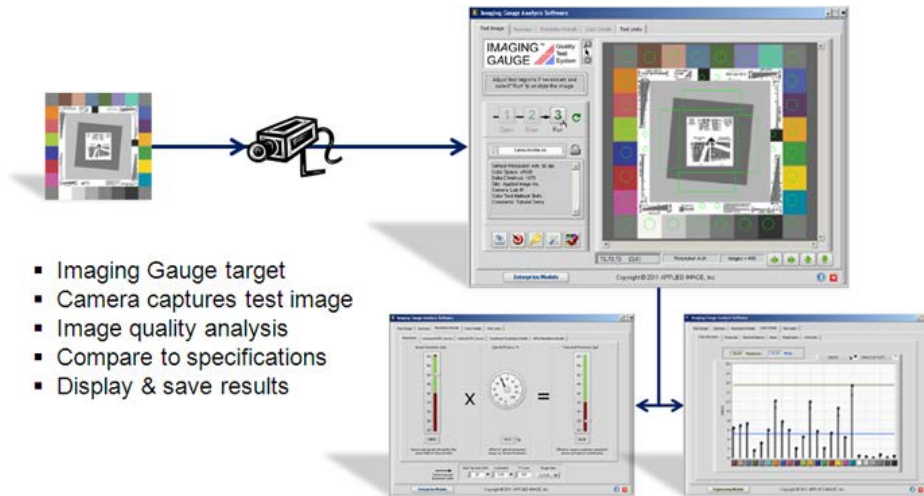# Operator's Manual for Enterprise and Engineering Editions

Table of Contents

Imaging Gauge™ System Overview

Imaging Gauge™ quality analysis software analyzes a camera's image quality (IQ) using one of the three sizes of the QA-90 precision test chart. Targets are constructed with high-resolution silver-halide paper and Munsell color patches for accuracy and durability. The software is powerful but requires no specialized knowledge to get started.

- Imaging Gauge target
- Camera captures test image
- Image quality analysis
- Compare to specifications
- Display & save results

The compiled program is easily installed on the latest Windows platforms. Image formats include: jpeg, tif, bmp, and png.
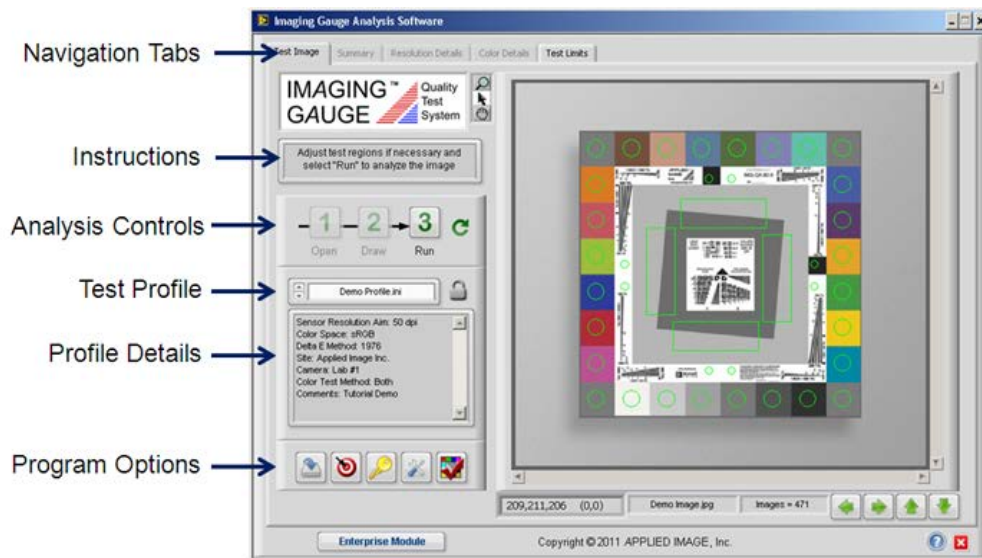
Detailed results and specification profiles can be easily accessed by advanced users. Primary Image Quality metrics include:

- ✓ Color Accuracy for standard color spaces
- ✓ Tonescale characteristic curve (OECF)
- ✓ Neutral Balance of gray color patches
- ✓ Color Channel Registration
- ✓ Lighting and Sensor Uniformity

Software Editions

Imaging Gauge™ is offered in three editions: Engineering, Enterprise, and Deployment. These provide different levels of functionality depending on the user's needs.

- **Engineering Edition**: Designed for research and engineering environments with full image analysis capability. Test specification profile creation and editing is enabled for text-based (non-encrypted) files only.
- **Enterprise Edition**: Designed for system integrators and engineers who deploy test systems to production. Includes all functionality of the Engineering Edition with additional capability to create encrypted test profiles and technical contact links for use with the Deployment Edition
- **Deployment Edition**: Designed for use by non-technical operators in field or production environments. All image tests are performed as in the other editions and summary pass/fail indicators are displayed to the end user. The ability to create or edit encrypted test profiles is disabled for this edition.   Automated technical support interface is built-in for communicating images and data to a specialist using the Enterprise Edition.


	Engineering	Enterprise	Deployment
Analyze All Image Quality Metric	✔	✔	✔
Multiple Test Profiles Available	✔	✔	✔
Display & Save Summary Results	✔	✔	✔
Display & Save Detailed Results	✔	✔	
Resolution Specification Wizard	✔	✔	
Color Accuracy Specification Wizard	✔	✔	
Read Test Profiles (Text-based)	✔	✔	
Edit Test Profiles (Text-based)	✔	✔	
Read Test Profiles (Encrypted)		✔	✔
Edit Test Profiles (Encrypted)		✔	✔
Create Technical Contact Information		✔	

Target Design & Construction

Targets have three major components: color accuracy patches, the mounting board and the resolution test feature.

Color Patches:	Mounting Board:	Resolution:
Pigment-based color patches using the gamut of the X-Rite ColorChecker® .	Lightweight, 6mm. rigid board of expanded closed-cell polyvinyl chloride (PVC)	High-resolution silver halide target includes visual and automatic analysis features

Color Patches   Mounting Board   Resolution Features
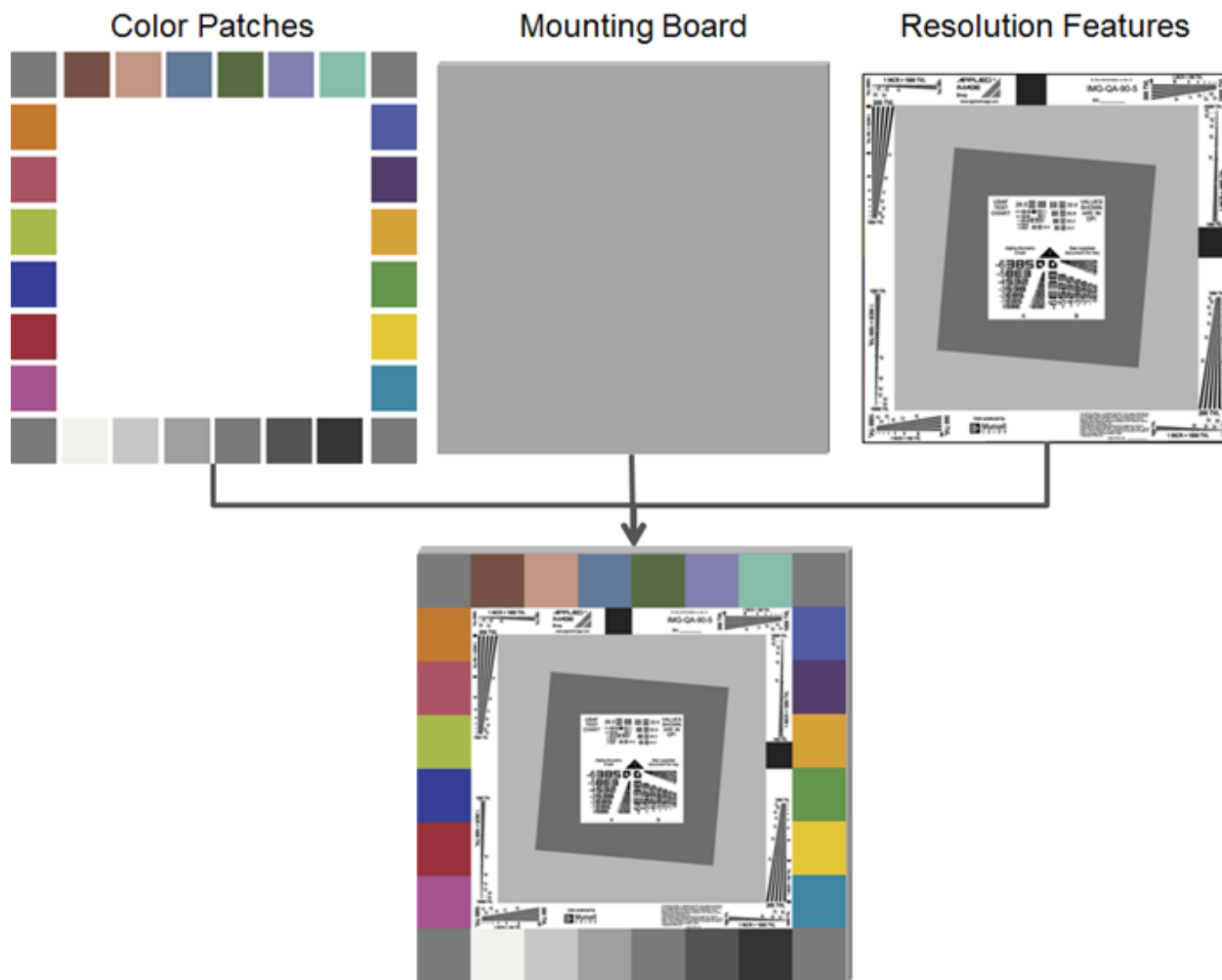
Components are 100% inspected using National Institute of Standards and Technology (NIST) traceable measurement equipment and assembled with high quality adhesives. Industrial Velcro is attached to the back of the mounting board to enable assembly onto the stand mounting brackets.

Mounting Stand

A mounting system is available to allow for accurate target positioning and adjustment. Components include a tripod, sheet-metal mounting bracket, mounting hardware, and rubber-grip handle. Mounting stands can be easily assembled and disassembled for mobility.

The mounting stands are vertically adjustable for different heights and can be rotated to accommodate cameras installed from ground-level to ceilings. Off-the-shelf hardware allows users to adapt the mounting brackets to other tripod systems, if necessary.
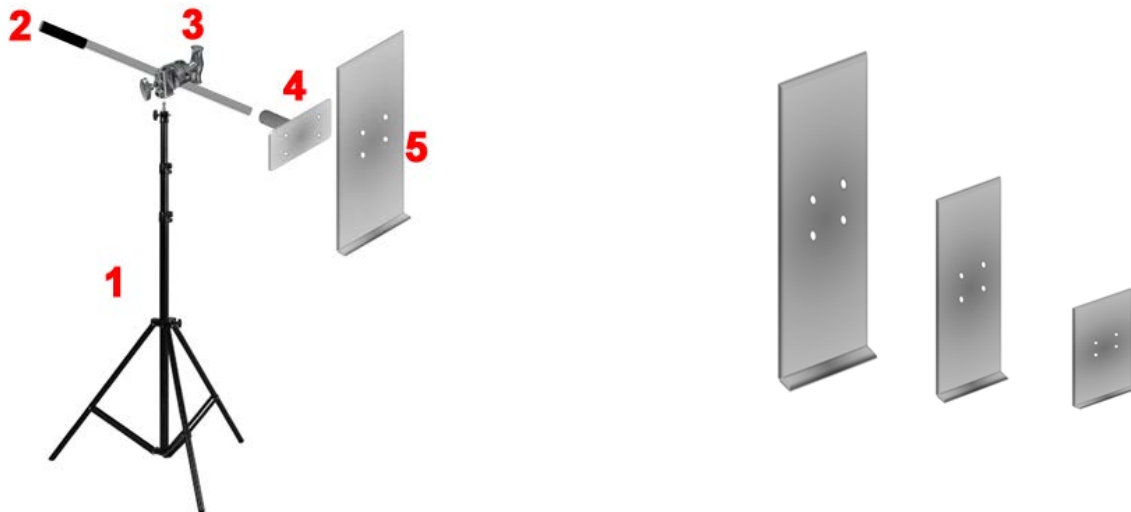
Mounting brackets are scaled for the three target sizes (1x1 ft, 2 x 2 ft, and 4 x 4 ft.)

Item	Description
1	Heavy-duty Tripod enables secure and repeatable placement of the target in field or lab environments.
2	Aluminum Target Arm with foam grip handle enables easy adjustment of the target position.
3	Grip head secures the target arm and allows rotational adjustment.
4	Target mount adapter allows quick-release of the target for easy setup in the field.
5	Brackets are available for the three target sizes. Industrial Velcro is used to attach targets to the bracket. Brackets are attached to the target mount adapter.

Program Overview

The Imaging Gauge™ program receives two (2) inputs from the operator: a test profile and a test image. The program displays and saves results of the analyzed image.
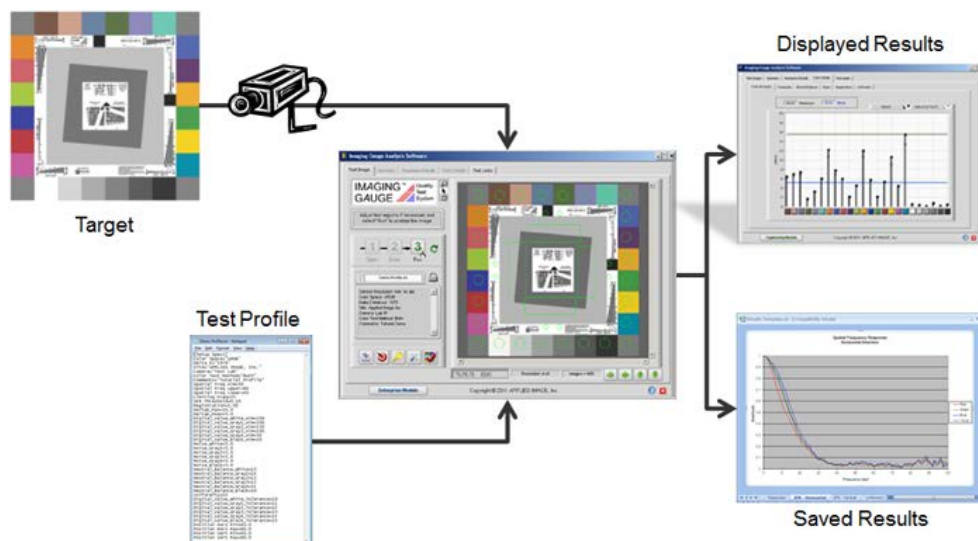
The test profile is a text file that contains all the information required to test a particular image capture system. The file contains image quality specifications, system information such as the test site name and camera information including the color profile (sRGB, Adobe RGB, etc.)
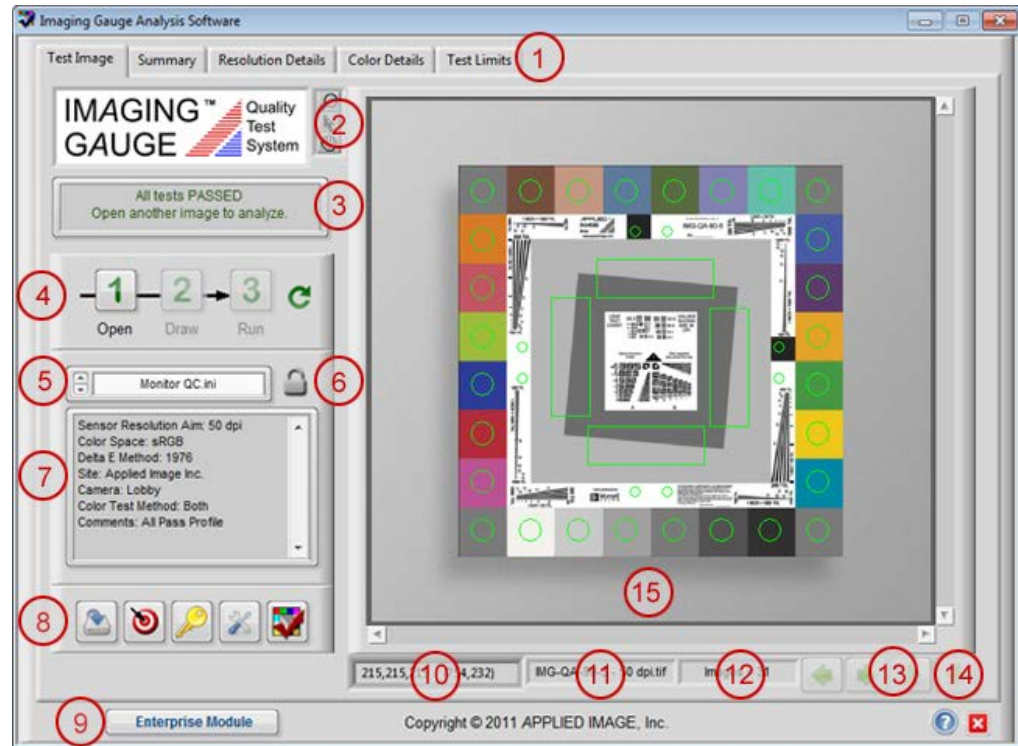
The test image is captured with the typical camera setup but with the Imaging Gauge™ test target located in the camera Field of View (FOV). Images are saved to a location for subsequent processing.

The Imaging Gauge™ program can be installed and operated in a different location from the image capture system. Images are opened and loaded individually through an image dialog window. With input from the test operator, the image is analyzed.

Test results are displayed in summary with clear pass/fail indicators. Complete detailed results are automatically exported to a tab-delimited text file for documentation and further analysis.

Main Program User Interface

The front panel of the Imaging Gauge™ program is shown below along with descriptions of each feature.

Number	Name	Description
1	**Tabs**	Navigation tabs enable users to analyze an image, view results and profiles
2	**Image Controls**	Zoom button to magnify a region of the image. Use Shift key with this button to Zoom out. Selector for moving individual Regions. Pan button to move within a magnified image. Rectangle button to draw a box around the target
3	**Operator Instructions**	Instructions are provided as guides through the analysis process. Pass / Fail indication is displayed after each image is analyzed.
4	**Analysis Process Buttons**	Opens a dialog box of images to select Draw the target region within the image Run analysis of the image with Regions of Interest (ROIs) shown Erases ROIs and resets the image

5	**Profile Drop-down Menu**	Presents all the profiles available to be used at the workstation. An import feature allows a new profile to be copied for use with the program.
6	**Default Profile Button**	Sets the current profile as the default profile loaded whenever the program is launched.
7	**Profile Description**	Display of the pertinent information for the selected profile. This allows users to identify the correct profile for use in a particular job.
8	**Program Controls**	Saves Results to File Launches the Profile Setup Wizard Launches Account Interface Launches Technical Interface (Enterprise Edition only) Launches Deployment Edition (Enterprise Edition only)
9	**Program Information**	Displays the software version and copyright information
10	**Image Information**	Displays the RGB digital values under the cursor location and location of the cursor in pixels.
11	**Image Name**	Test image currently being analyzed
12	**Image Count**	Current number of image actuations available for use.
13	**Adjustment Tools**	Adjusts all ROIs in the direction selected: up, down, left or right.
14	**Application Controls**	Launches online Help Closes the application
15	**Image**	Image window displaying the current image being analyzed

Target Test Regions
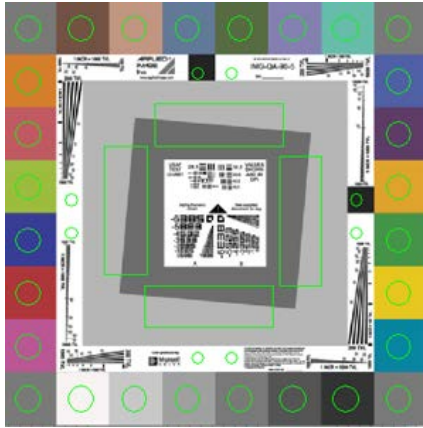
Imaging Gauge™ software selects specific regions-of-interest (ROIs) within the target to analyze. Green circles denote regions of the target that are analyzed for their color accuracy, uniformity, noise, tonescale and neutral color balance. Rectangular green ROIs denote areas that are analyzed for resolution and registration.

The program automatically places ROIs after the user selects the target in an image. An incorrect placement of the ROIs may result in inaccurate analysis. For this reason, a verification step is included in the analysis for the user to check the location of the ROIs and move them if necessary.

Circular ROIs should be located over a single color patch, without overlapping any neighboring patches. It is *not* required that these ROIs be perfectly centered on the color patches.

Eight small circular ROIs are located inside the main color patches. These are located over white or black areas and are used to decode target information such as size and color specifications.

Rectangular ROIs should be located such that each slanted edge is completely captured as shown below.
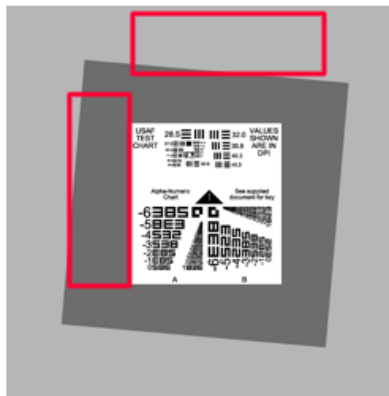
Correct ROI Placement
Black to gray transitions occur between the short ends of the rectangle.
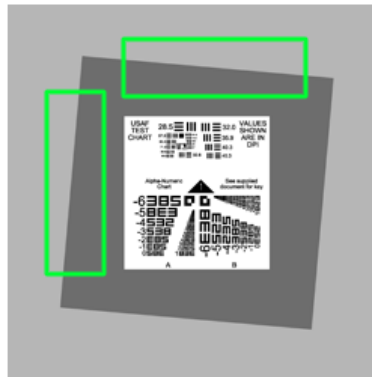
Incorrect ROI Placement

Black to gray transition occurs on long side of top rectangle.

Side rectangle includes part of the white visual target.

Target Location in a camera Field-of-View

The test target is typically located in the center of the camera Field-of-View (FOV), but is not required to be centered. Targets positioned too close to the camera may exceed the size of the FOV and targets placed too far away may not have sufficient resolution to make accurate measurements.
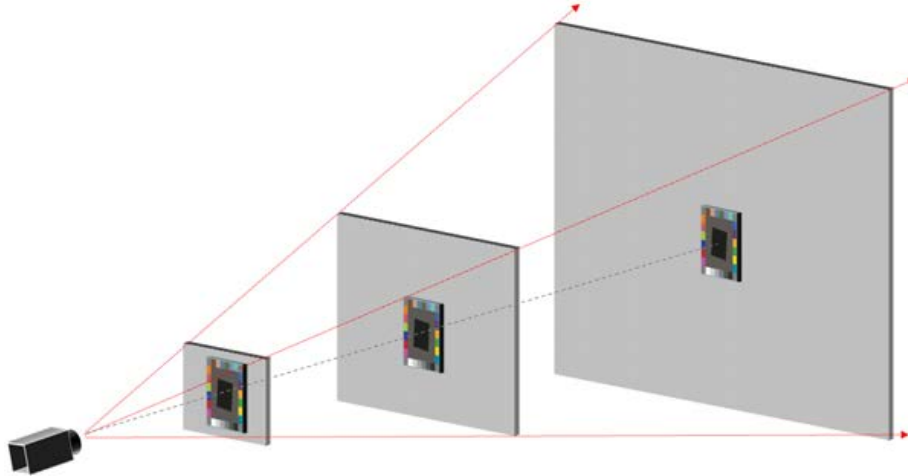

Placement of the target further from the camera results in fewer camera pixels used to define the target. This is measured as the Sensor Resolution of the camera at that distance. Depending on the Optical Efficiency of the camera, the minimum sensor resolution is typically between 1 - 5 dpi for the 2 ft. x 2 ft. target. The minimum sensor resolution can be increased 2X by using the larger target.

The chart below shows the relative size of a 2 ft. x 2 ft. target when captured with a 480 x 640 pixel camera at three different distances from the camera. The 10 dpi sample is positioned closest to the camera.
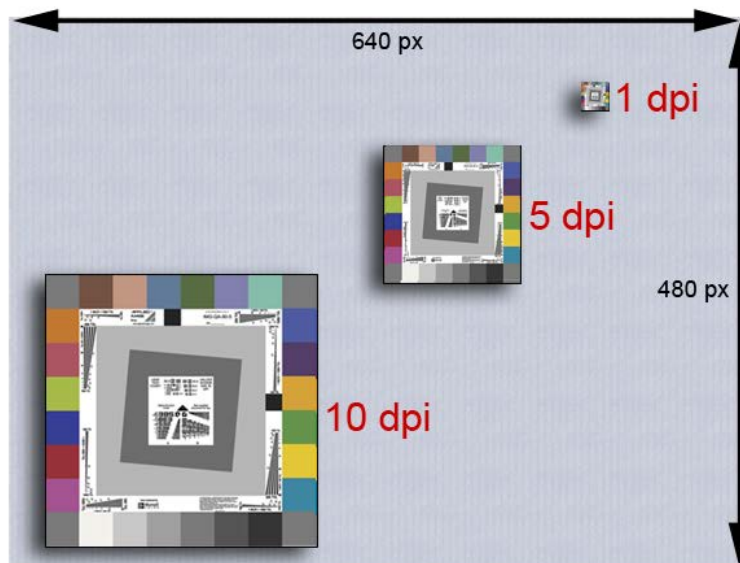
Target Alignment to the Camera Sensor

The target should be aligned parallel to the plane of the camera sensor to assure accurate placement of the test regions and to assure that the Slanted-Edge feature is captured at an angle close to 5° to the sensor plane.
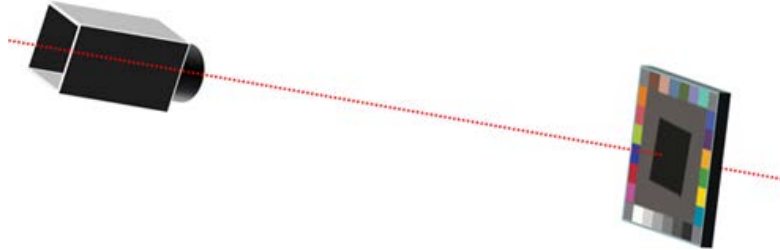

Misalignment occurs on three axes relative to the sensor plane. The alignment for all axes should be within +- 2°.

|	
Planes are parallel but rotated axially	
Horizontal Misalignment	
Vertcal Misalignment	
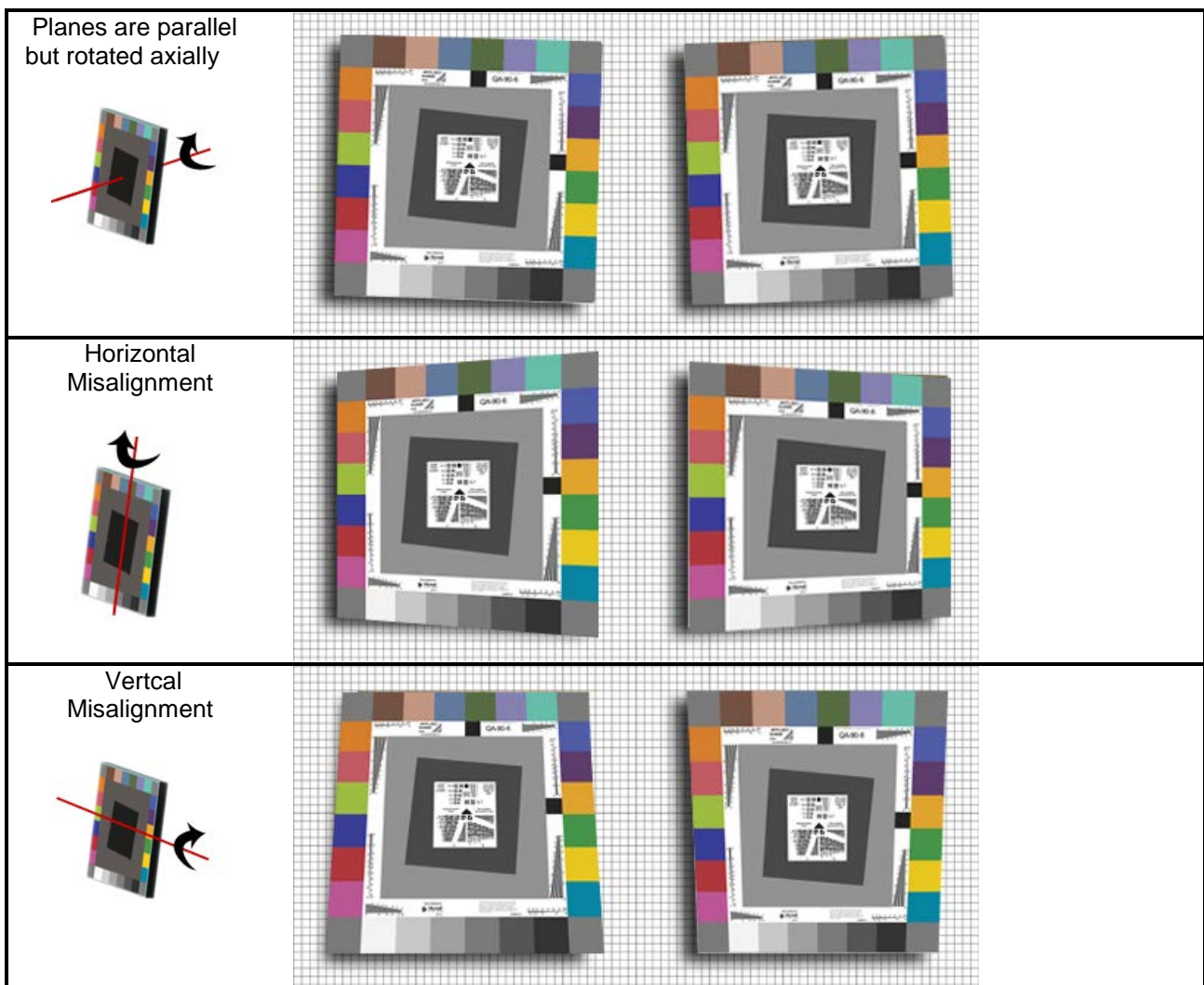
Program File Structure

The files installed to a target computer are organized to comply with the latest Windows® operating systems. Beginning with Windows® Vista, users were prevented from writing data to files located in the **Program Files*** directory. For this reason, the Imaging Gauge™ application is located in the "Program Files" directory and the write-able files are located in the **Imaging Gauge Files** directory on the root directory.

* note: the "Program Files" directory is called "Program Files (x86)" on 64-bit computers
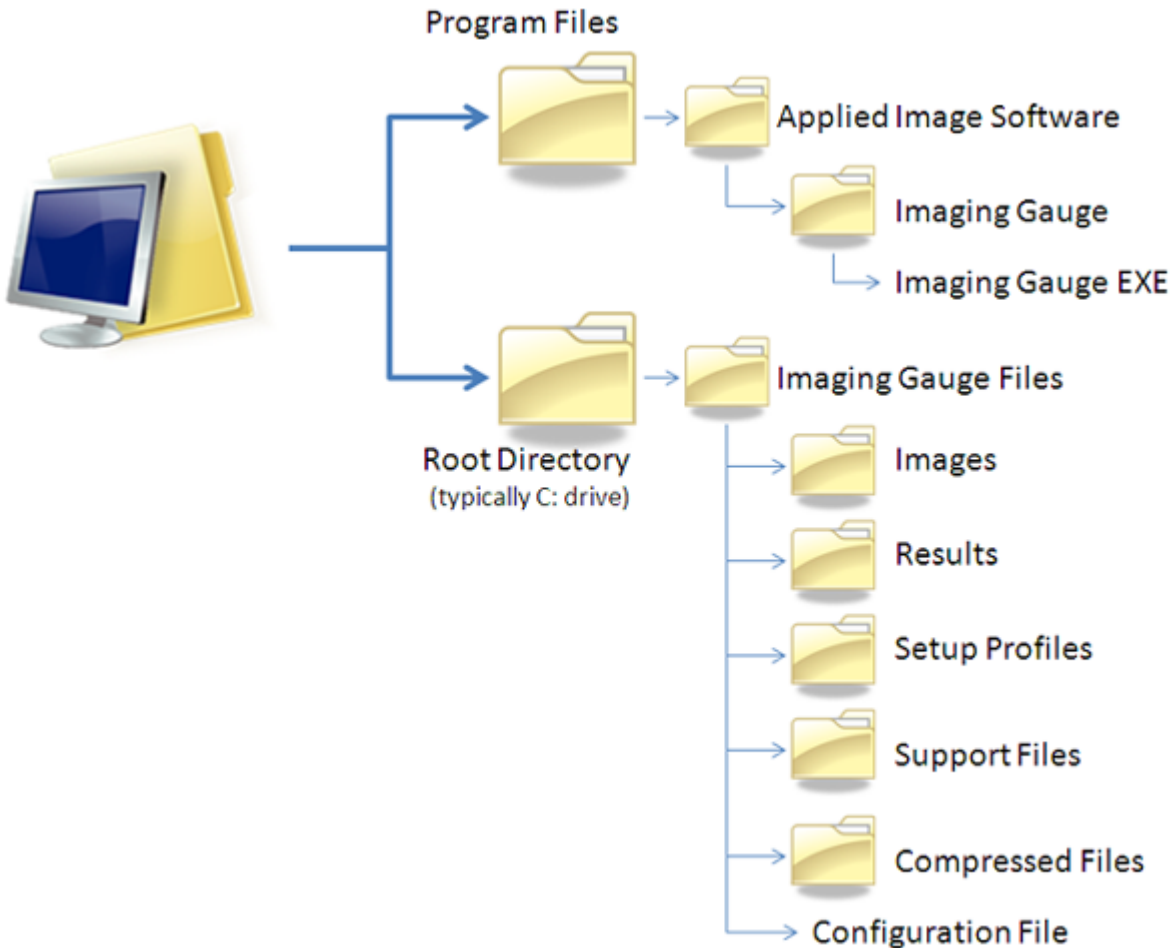
Test Specifications Profiles

Test specification profiles are used to define system information and test limits for each of the image quality metrics. The profile is a text-readable file that can be sent between installations to convey system requirements. The profiles available for use are populated in a drop-down menu on the front panel user interface.
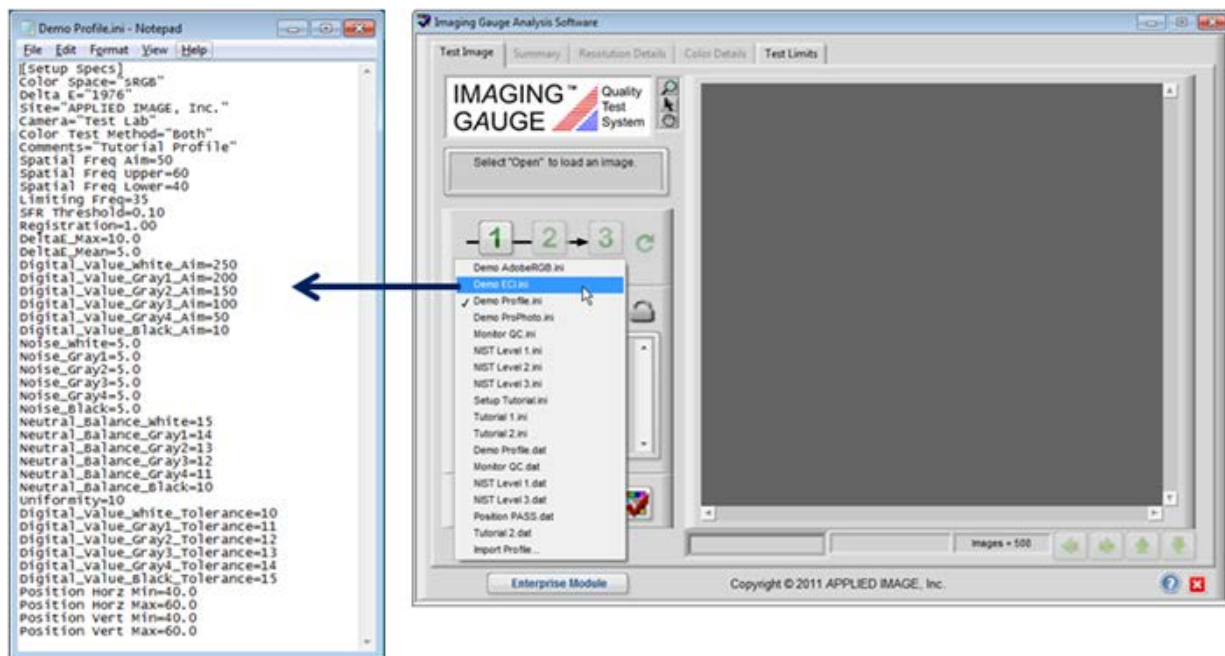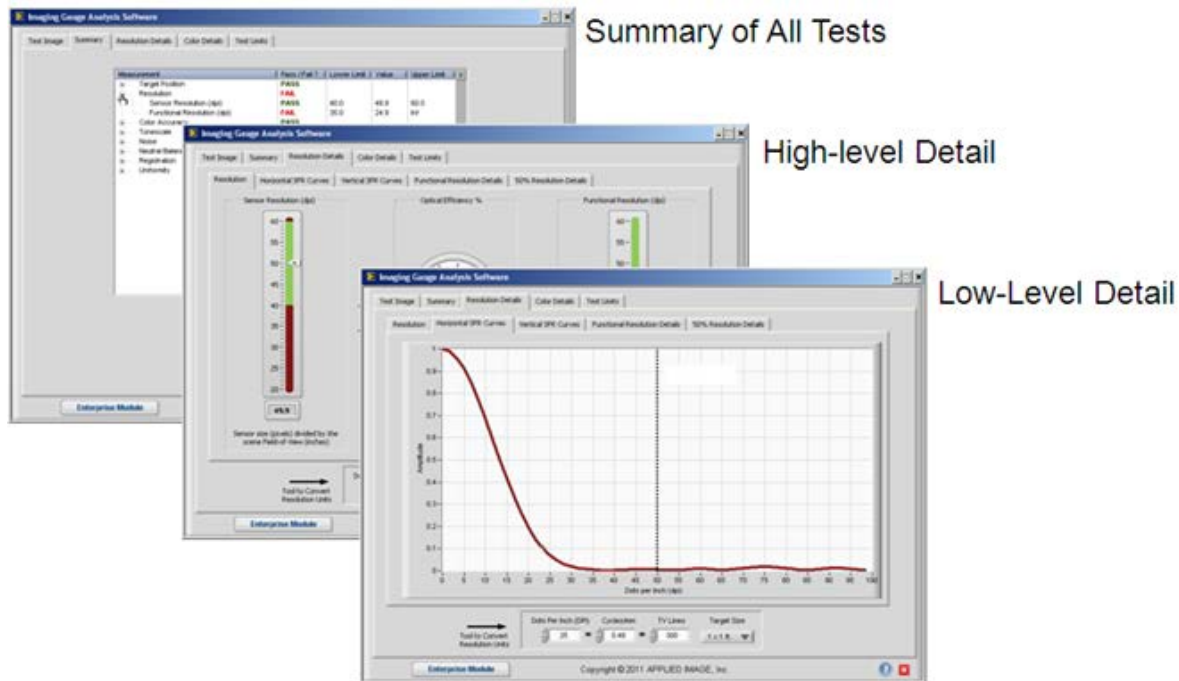

Creating and editing of profiles can occur directly by accessing the "Test Limits" tab or by using the Profile Setup Wizard.
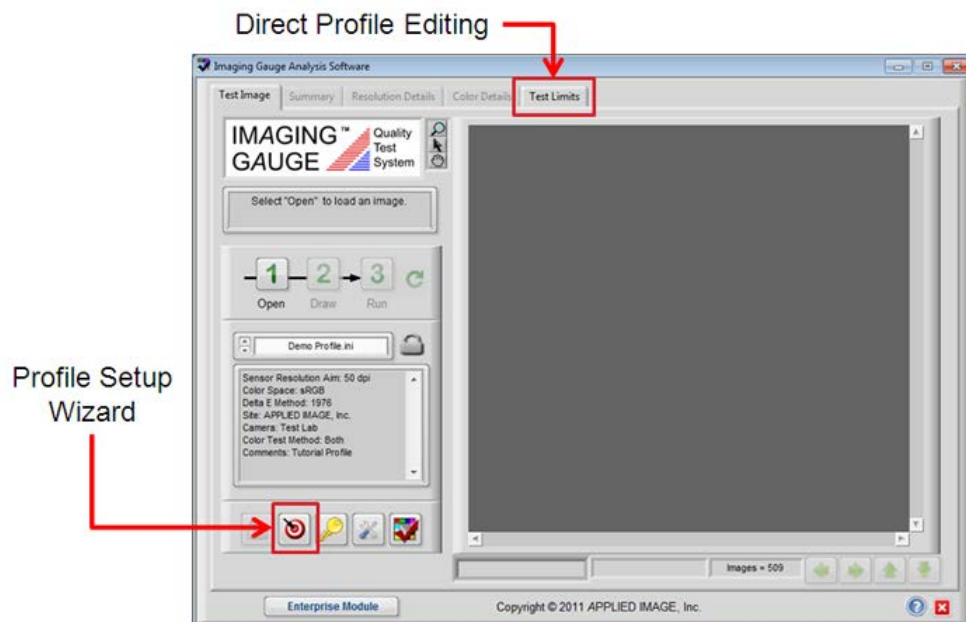
Displayed Results Summary

Results are arranged to provide a quick, accessible summary, followed by increasing levels of detail.
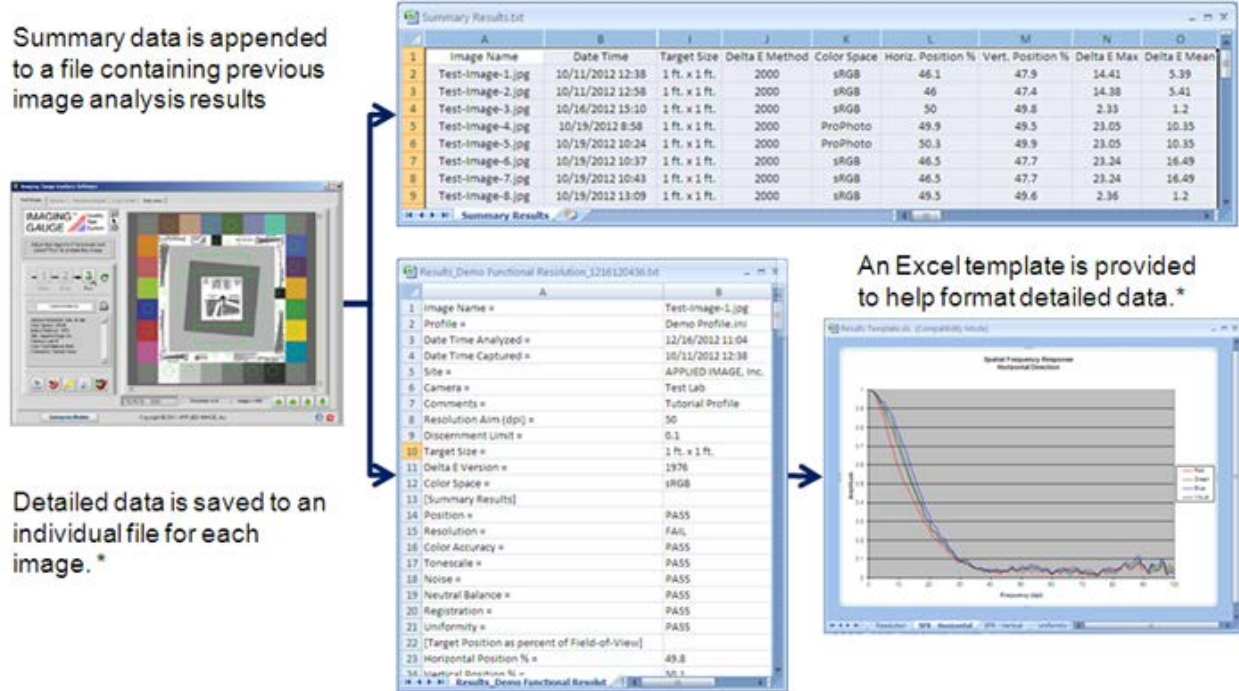

The summary tab shows all measurements made during the analysis of the image. Individual measurements are compared to limits from the active test specifications profile and a pass/fail indicator is displayed. Groups of measurements can be opened or closed using the [+] [-] toggles next to the group name. See the IQ Metrics Table to get more information on how each group is displayed.

Measurement	Pass / Fail ?	Lower Limit	Value	Upper Limit	
⊞ Target Position	PASS				
⊟ Resolution	FAIL				
Sampling Frequency (dpi)	FAIL	55.0	90.9	65.0	
Limiting Frequency (dpi)	PASS	30.0	30.0	Inf	
⊞ Color Accuracy	FAIL				
⊞ Tonescale	FAIL				
⊞ Noise	PASS				
⊞ Neutral Balance	PASS				
⊞ Registration	PASS				
⊞ Uniformity	PASS				

Exported Results Files

Imaging Gauge™ data is exported as tab-delimited, ASCII text files. The data are exported into two separate files: a comprehensive individual file for each image and an appended summary file that contains data from all images analyzed.

Summary data is appended to a file containing previous image analysis results

Detailed data is saved to an individual file for each image. *

An Excel template is provided to help format detailed data.*

* Detailed individual files are only available with the Engineering and Enterprise Editions.

Individual File - a file unique to each image containing all the data measured as part of its analysis. This can be easily printed, stored or shared electronically for a particular camera system. **Bold** items are only included in the Individual File. These contain:

- Image and system information
- Target Position data
- Digital Code Values for all 24 patches
- CIELab values for all patches
- Delta E and **Delta E (ab)** values for all 24 patches
- Noise and Neutral Balance for six neutral patches
- Uniformity
- Registration
- Resolution measurements for all colors and directions
- **Full Spatial Frequency Response (SFR) curves**

Individual results can be copied into the Microsoft Excel template located in:
C:\Imaging Gauge Files\results\Individual Results\Results Template.xls

Summary File – a master file of all analyzed images contains a subset of most relevant data. This file is best for comparing data between a number of camera systems or for a single camera system tested over a period of time. See the results tutorial for more information on generating results.

Technical Contact Interface (Enterprise Edition)

Technical contact information and methods are communicated between sites with the "Technical Contact.ini" file located in the **Imaging Gauge Files\ Support Files** folder. This file can be sent to the deployment sites and accessed using Technical Support interface.
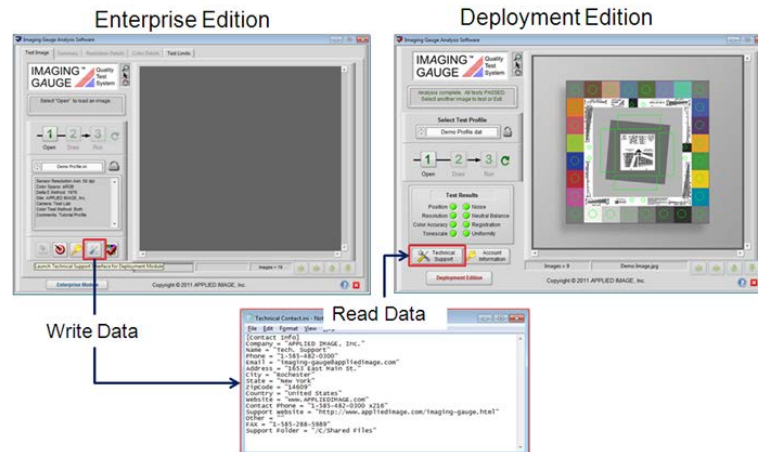
The interface launched from the Enterprise Edition includes fields for all company information and specific contact information such as telephone and e-mail. When information is entered and "Update File" is selected, the new information is written into the "Technical Contact.ini" file.
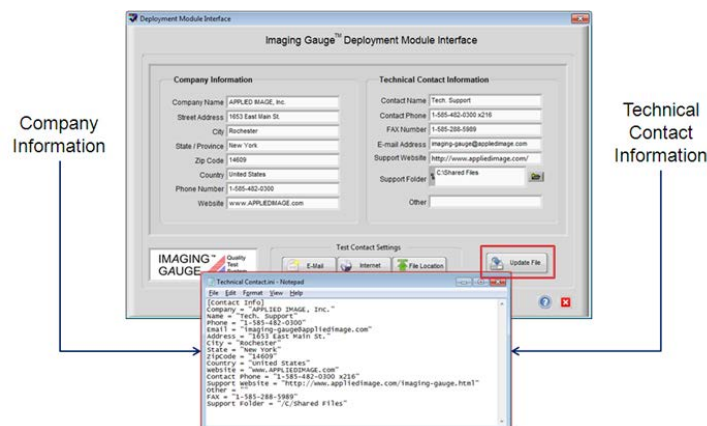

Before sending the "Technical Contact.ini" file to the deployment sites, the functionality of the information can be tested using the **Test Contact Settings** buttons as shown.

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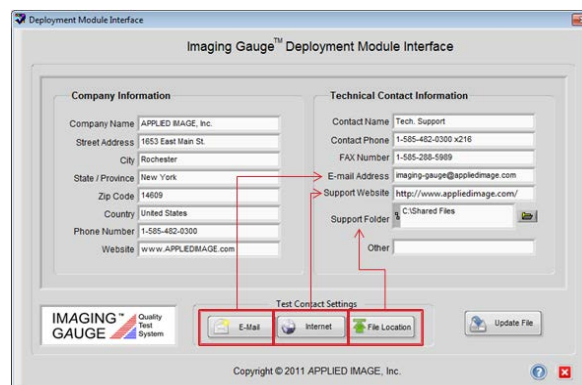
Technical Support Interface (Deployment Edition)

The technical support interface is designed to enable users of the Deployment Edition to easily bundle and send all necessary information associated with a failed image to a support group that is running the Enterprise Edition. These files include the test image, test results, test profile, and information about the problem, including contact information.

After the information is bundled into a compressed file, the file can be sent automatically to the contact's e-mail address, it can be uploaded to a support website or copied to a folder location. As a separate file it can also be copied manually to another media type and delivered manually to another workstation. A schematic of the process is shown below:
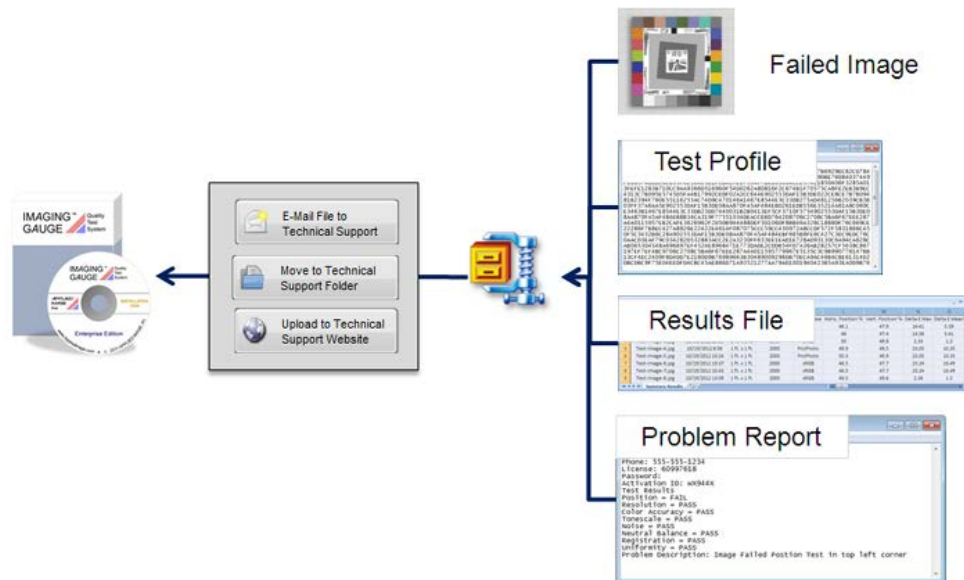
Features of the Deployment Edition interface are shown below and on the following page::

Number	Name	Description
1	Company Information	Name and information of the company that provides technical support to the Deployment Edition customer.
2	Technical Contact Information	Contact information of the individual at the company that supplies technical support to the user of the Deployment Edition.
3	End User Information	Name, e-mail, phone and problem description of the Deployment Edition end user. This is used to communicate the problem corrective action.
4	Create File Button	Creates a compressed file that includes the latest image analyzed, the current specification profile, the summary results file, and the information provided by the end user in "End User Information".
5	View File Button	Opens the compressed file.
6	File Contents Window	Displays the names of the contents of the compressed file.
7	E-Mail to Technical Support Button	Opens the default e-mail application and enters the technical contact e-mail address as a recipient. Also fills in the subject field. File must be attached manually.
8	Upload to Technical Support Website Button	Opens thee web-page specified in the "support website" field. This website should be set up by the company providing technical support with functionality to upload the compressed file.
9	Move to Technical Support Folder Button	Copies the compressed file to the location specified in the "Support Folder" field. This can be a mapped server location or another share point available to the user's workstation.
10	Help and Stop Buttons	Opens the online support file. Stop button closes the Technical Support window and returns the user to the main program.
11	Import Contact Info Button	Opens a dialog box to allow a new contact information file to be copied to the "Imaging Gauge Files/Support Files" folder for use with Imaging Gauge™.
12	Save Contact Info Button	Saves the Company Information and Technical Contact Information to the "Technical Contact.ini" file located in the "Imaging Gauge Files/Support Files" folder,

Account Management Interface
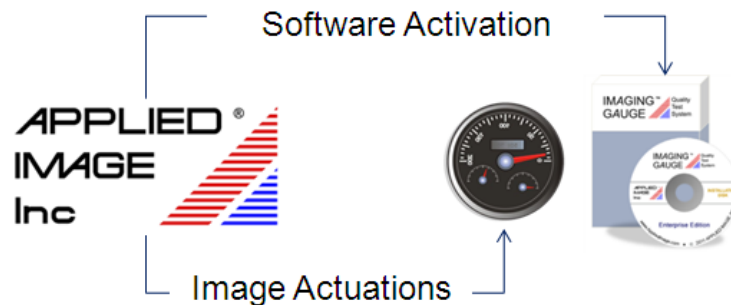
Imaging Gauge™ software has two conditions required for an installation to operate: license activation and sufficient number of image actuations. Both are managed through an interface that communicates with the *A*PPLIED IM*A*GE servers to validate the installation.

Software:
- Software is copy-protected
- Software can be used on one workstation at a time
- Each software edition (Enterprise, Engineering & Deployment) is licensed independently

Image Actuations:
- A supply of image "actuations" is required for the software to operate
- The supply is decremented by one each time an image is analyzed
- Additional blocks (250, 500 & 1000) of image actuations are added using activation keys

The account management interface enables easy access to the encrypted license files for each of the software editions.
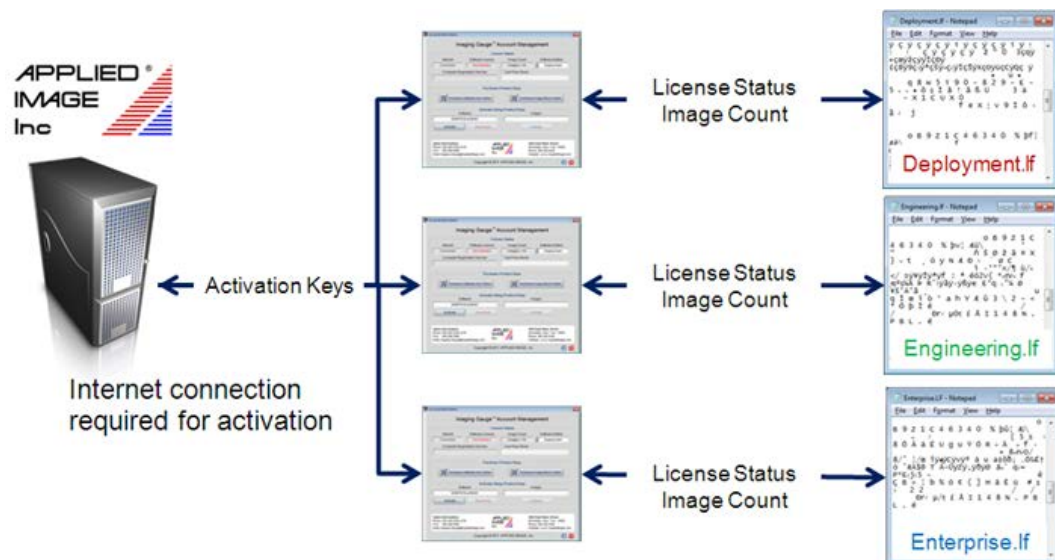
Features of the Account Management interface are shown below.

Number	Name	Description
1	Internet Connection Status	Displays the connection status of the workstation. Connection is required to activate, de-activate the workstation and add images
2	Software License Status	Displays "Activated" or "Not Activated" status .
3	Image Count	Displays current number of image actuations available to analyze images.
4	Software Edition	Selection of software edition (Deployment, Engineering or Enterprise) for which the information and actions are associated.
5	Computer Registration Number	This number is automatically created and assigned when software activation is run. The number is used in the de-activation process.
6	Proxy Server	Field to allow the use of a proxy server for communicating with the activation servers, if necessary.
7	Purchase Software Keys Online	Opens the web store section of the Applied Image website for purchasing a software key. One key is required per workstation. Each edition requires a separate software key.
8	Purchase Image Keys Online	Opens the web store section of the Applied Image website for purchasing a image activation keys. Images can be applied to any of the three software editions.
9	Software	Location to enter the software key.
10	Image	Location to enter the image activation key
11	Activate Software Key	Communicates with server to ensure a valid key is entered. Activates software license if key is valid.
12	De-Activate Software	Communicates with server to allow the current software key to be used on another workstation. Shuts down current version of Imaging Gauge™ if deactivated successfully.
13	Activate Image Key	Communicates with server to ensure a valid key is entered. Adds image actuations to the image count if key is valid.
14	Navigation Buttons	Opens online help. Stop button closes the window and returns to the main program.

Activating a Workstation

Software activation requires the 14-digit activation key that was shipped with the installation CD or sent online. An internet connection is required to activate the software and a field is available if a proxy server is used.   To activate the software, enter the software activation key in the field labeled "Software" and select the **Activate** Button.

If activation is successful, the Software License status will display **Fully Activated** and a Computer Registration Number will be assigned. The **Deactivate** software and **Activate** images buttons will be enabled. Image actuations cannot be added to the workstation unless the software is activated.

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Adding Image Actuations

Activating Image Keys to add actuations requires the 14-digit activation key that was shipped with the installation CD or sent online. An internet connection is required to add image actuations and a field is available if a proxy server is used. To add a block of image actuations, enter the image activation key in the field labeled "Images" and select the **Activate** Button.

If activation is successful, the Image Count will be increased by the number of actuations associated with the activation key (250, 500 or 1000). The example below added 500 image actuations.

De-Activating a Workstation

Software de-activation requires internet connection and a field is available if a proxy server is used. To de-activate the software, select the **Deactivate** button.

If de-activation is successful, the Software License status will display **Not Activated.** The **Activate** software button will be enabled. The software activation key can then be used to activate another workstation. The Imaging Gauge™ program will automatically close after the interface window is closed.

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Specification Profile File Types

Imaging Gauge™ employs an encrypted version of the setup profile in addition to the normal text-readable file. Both can be opened in text editors such as Notepad, but the encrypted file must be accessed by the Enterprise Edition to view or edit the contents. The encrypted file is designed to ensure that specifications cannot be altered in field or production installations without authorization.
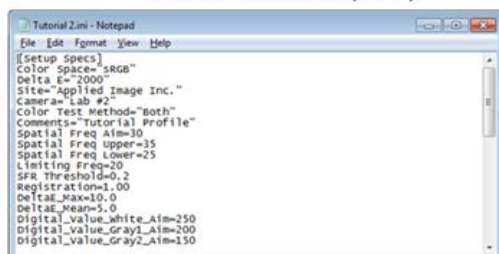
ASCII-Text File (*.ini)   Encrypted File (*.dat)

Both file types are located in the "**Imaging Gauge Files/Setup Profiles**" folder. ASCII-text files con only be edited by the Engineering and Enterprise Editions.

	Deployment	Engineering	Enterprise
File Type	Encrypted	ASCII-Text	ASCI-Text & Encrypted
Extension	.dat	.ini	.ini & .dat
Edit-able	NO	YES	YES

The diagram below shows a typical folder of profiles. The colored rectangles indicate which profiles are accessible by the different editions. Note that the Enterprise edition has access to all profiles.
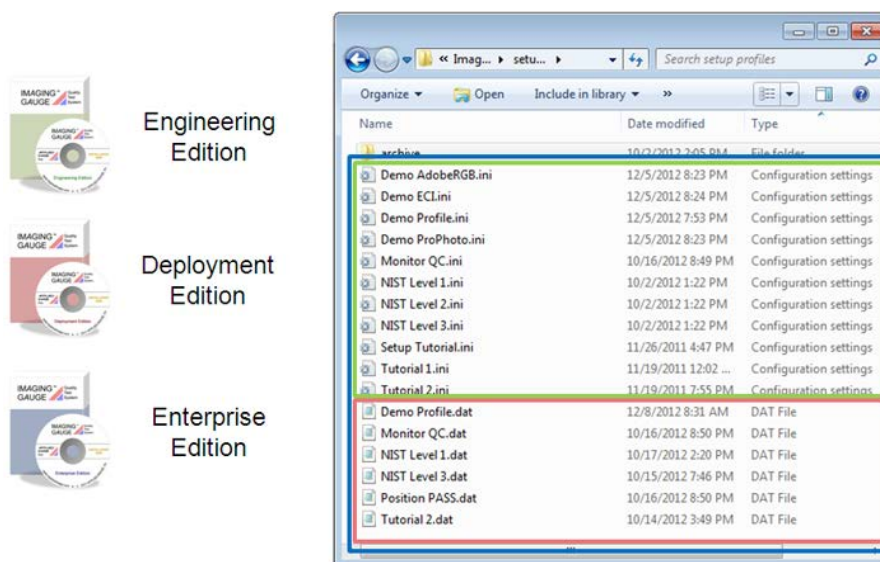
Default Specifications Profile

Contents of the default specifications file are loaded automatically when the program is started. The name of the default file is stored in the **configuration.ini** file located in the **Imaging Gauge Files** directory.

Default profiles are loaded when Imaging Gauge™ is first started
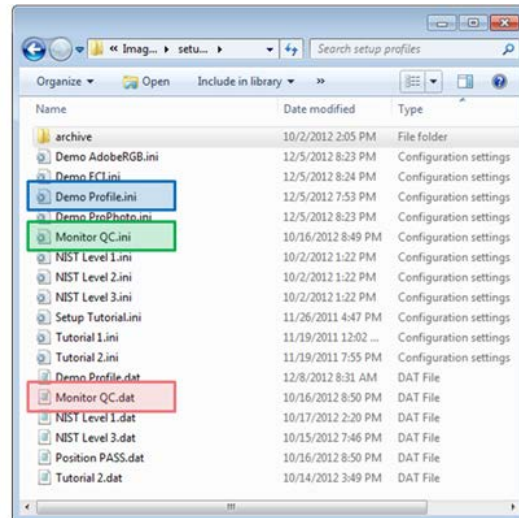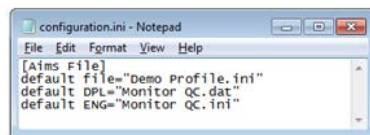
The default profile name can be changed by selecting buttons in two locations. From the front panel, select the lock button to save the currently selected profile as the default.
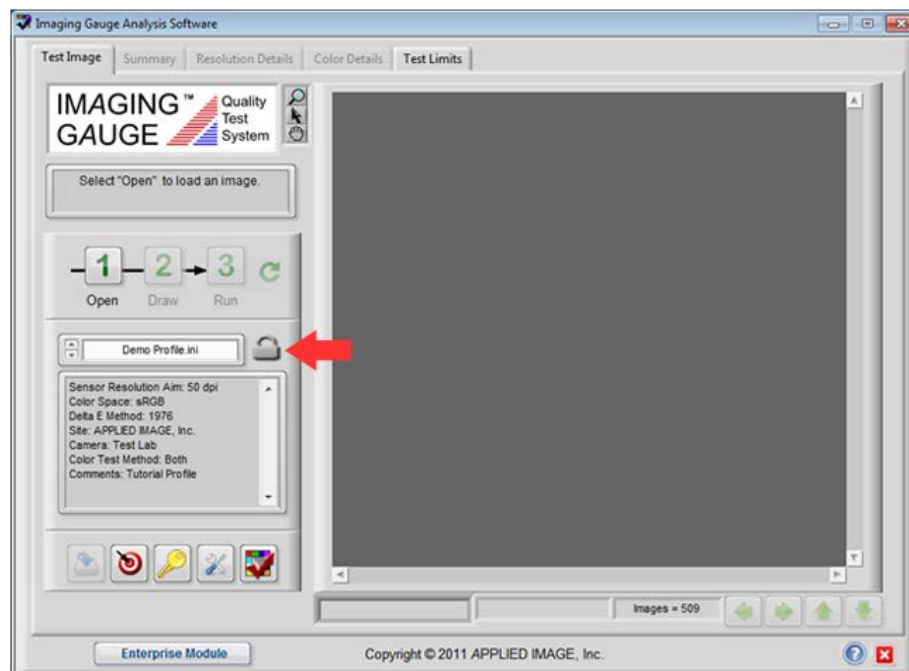
From the **Test Limits** interface, select **Save As Default** **Save as Default** to save the profile listed in **Active Profile Name** as the default.
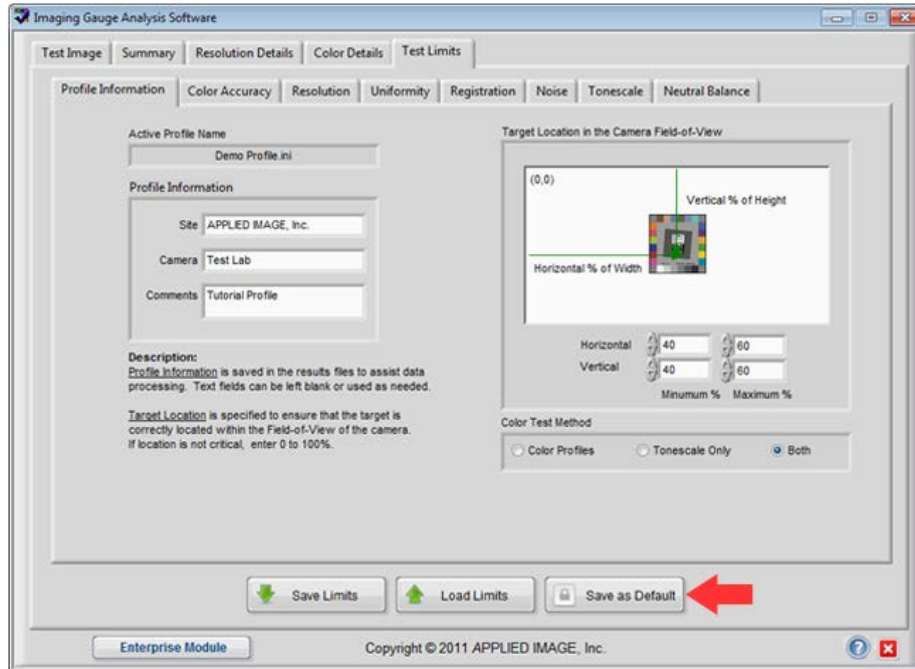
The profile will be loaded each time the software is opened until a new profile is set as default.

Direct Specification Profile Editing

Profiles can be viewed or edited directly be selecting the **Test Limits** tab. A new file can be created by saving the new profile with a different filename.
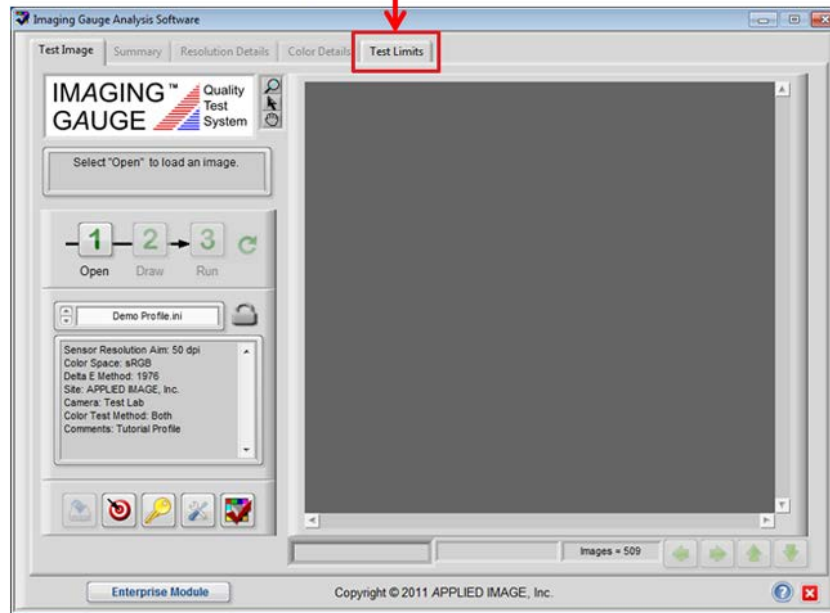
The **Test Limits** front panel has the following features. Individual tabs for each are also displayed below.
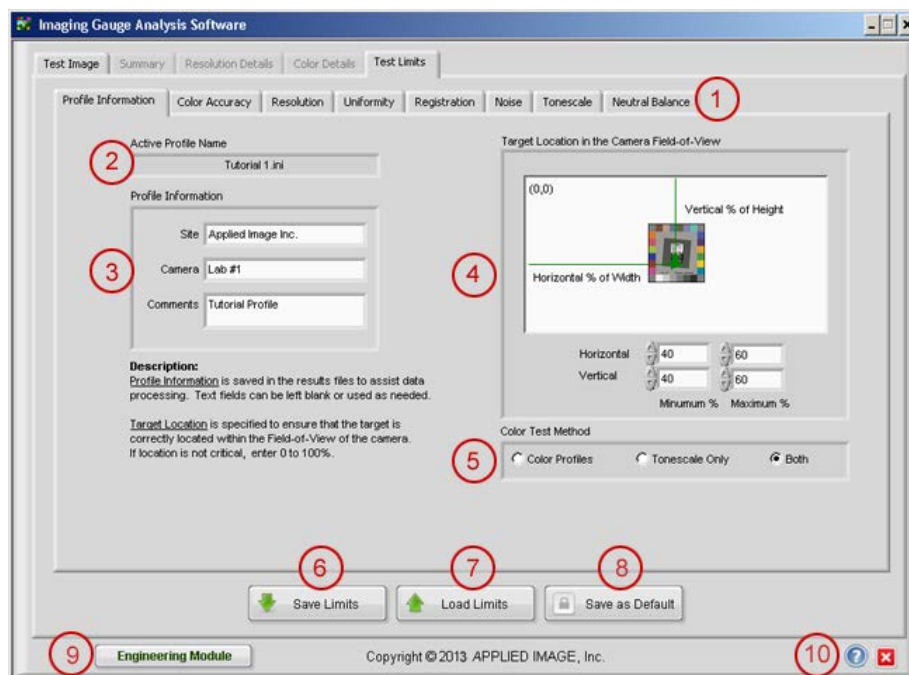
Feature Number	Feature Name	Feature Description
1	Metric Tabs	Selections to allow specification limits to be entered for each metric
2	Active Profile Name	The name of the currently loaded profile
3	Profile Information	Site, camera and comments fields
4	Metric Specifications	Provides a brief description of the metric to specify. The front panel shows the position metric. The other metrics are shown on subsequent tabs.
5	Color Test Method	Allows the selection of a color test method for the profile
6	Save Limits	Allows a new file to be created.
7	Load Limits	Loads an existing test specification profile to view or edit.
8	Save as Default	Sets the profile listed in Active Profile Name as the default test profile
9	Edition	Displays the software version and copyright information
10	Program Controls	Launches the Online Help Returns to the Main Program without saving the profile.

Quick Setup Wizard

The purpose of the Quick Start-Up Guide is to create test profiles by providing examples of color accuracy and resolution with known performance levels. This allows users to examine images similar to those expected from their system to determine acceptability limits.

Sample images are displayed for five (5) application scenarios (Digital Archiving, Printed Media, Identification Photos, License Plates, and Vehicles). For each application, a range of samples is displayed with varying quality levels. This allows a visual limit sample to be translated into a quantifiable test limit for both color accuracy and resolution.
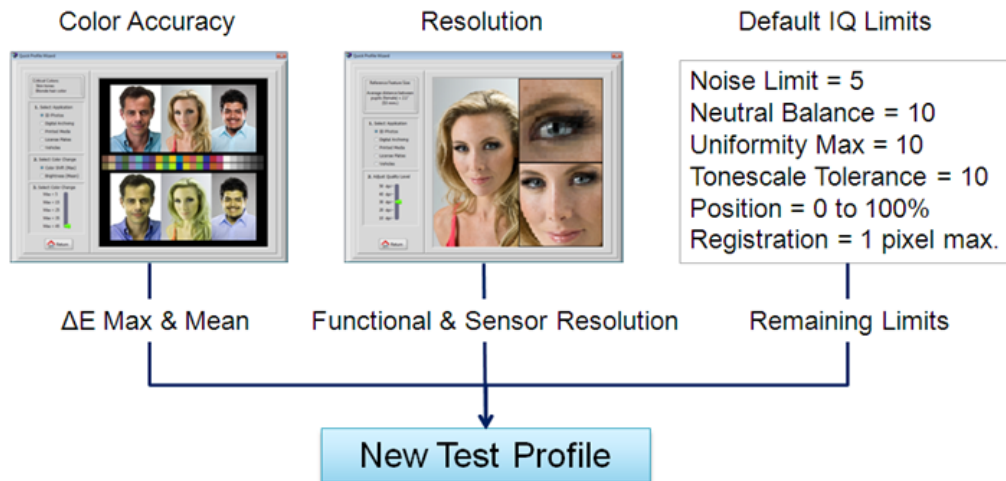
The **Start-Up Guide** can be launched from the main program interface by selecting: . The front panel of the **Start-Up Guide** includes the following features:

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Feature Number	Feature Name	Feature Description
1	System Information Description	Text box describing the three fields available to identify the new profile
2	Review Samples for Resolution	Launches the resolution sample set for review
3	Resolution Aim Value	Displays the resolution limit based on the selection from the resolution sample set
4	Review Samples for Color accuracy	Launches the color accuracy sample set for review
5	Delta E Maximum and Mean Limit Values	Displays the limit values that were selected as part of the review of color accuracy samples
6	Save New Profile Button	Opens a dialog box to name the new profile and returns to the main program. The new profile becomes the active profile for the main program.
7	Color Space Selections	Displays the currently available color space profiles.
8	Program Controls	Launches the Online Help Returns to the Main Program without saving the profile.

Color Test Method

Imaging Gauge™ allows three methods for specifying color depending on the configuration of the imaging system and its requirements. These were implemented to maximize the use of Imaging Gauge™ into as many test scenarios as possible.

The "Tonescale Only" option was developed for situations where the captured images are not saved with one of the four standard color spaces. Using only "Color Profiles" treats the neutral patches as any other color patch. Choosing "Both" allows the tonescale specifications to be limited more specifically than is possible with the Delta E metric

To edit the Color Test Method, select the Profile Information tab inside the Test Limits tab. Select the button as shown.
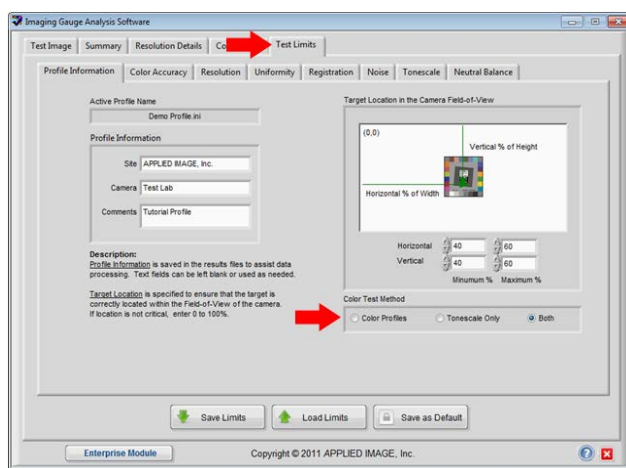
The following table shows which metrics apply to each selection. When using the Quick Setup Wizard, both color profiles and tonescale are assessed.

	Color Profiles	Tonescale Only	Both
Maximum Delta E	✔		✔
Mean Delta E	✔		✔
Tonescale		✔	✔
Neutral Balance		✔	✔

Color Profiles: This test method transforms the camera RGB values to CIELab using the Color Space selected (sRGB, Adobe RGB, ProPhoto or ECI), calculates Delta E to determine color accuracy and compares the mean and maximum Delta E values against their specifications. Neutral patches are not evaluated against tonescale or neutral balance aims although the measurements are displayed and recorded.

Tonescale Only: This method is used when the imaging system does not use one of the standard color spaces or uses a custom aim for the tonescale (neutral patch) curve. Digital code values and neutral color balance of the six (6) neutral patches are compared with specifications for each patch. The eighteen (18) color patches are not used to measure color performance.

Both: The tonescale values and neutral balance of the six (6) neutral patches are evaluated along with the Delta E values of all twenty-four (24) patches. This selection is used to hold the neutral patches to a tighter tolerance than the color patches. The Quick Setup Wizard automatically uses both Color Profiles and Tonescale limit.

Evaluating Resolution Samples

Resolution samples are displayed by **Application** and **Quality Level**. Applications are chosen to provide a range of resolution requirements: from high resolution digital archiving to low resolution vehicles. Within each of these applications, a finer range of resolution quality levels are presented to demonstrate the level of visual detail corresponding to each quality level.
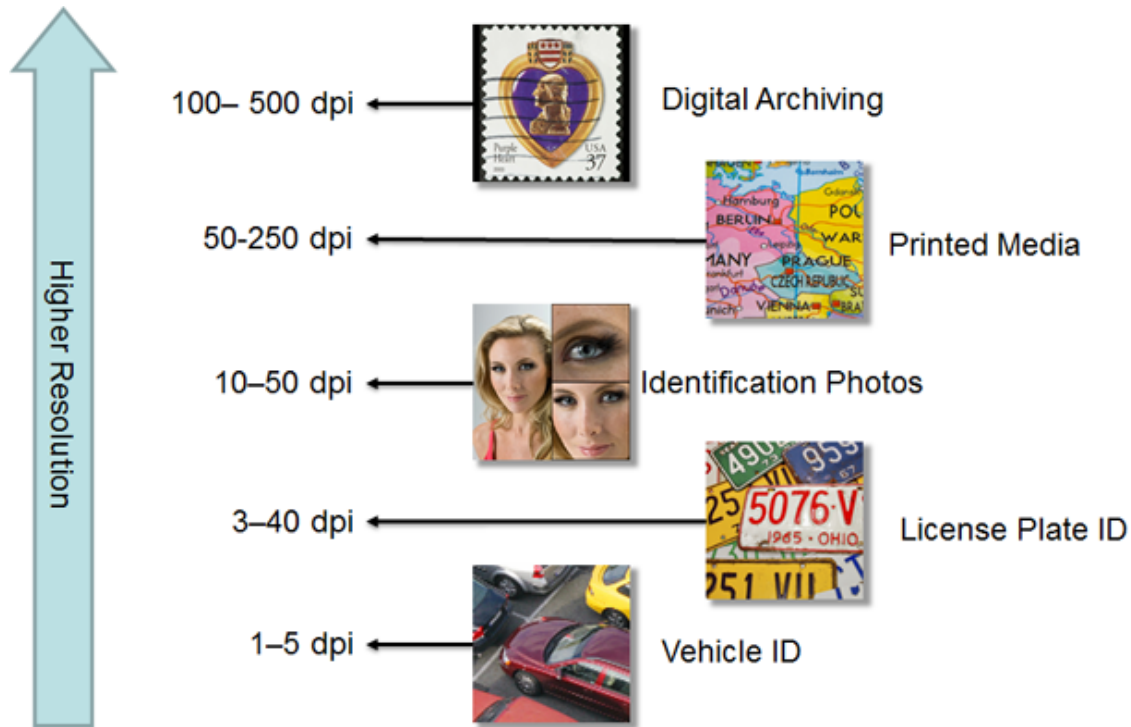
The **Reference Feature Size** indicates the real-world dimension from which the resolution (in dots per inch) is derived. In the case below, the reference feature size is the average distance between pupils (2.1 inches for females). The number of pixels between the model's pupils, therefore, ranges from 21 pixels for the 10 dpi resolution to 105 pixels for the 50 dpi resolution. Note that the images are re-sized to the same screen size to fit into the same display window.

The following table shows all the Applications and Quality Levels used in the Start-Up Guide. The Reference Feature within an application provides the physical reference measurement for each application.

Application	Reference Feature	Quality Level	Pixels to define Reference Feature
Digital Archiving	Stamp Height = 1" (25.4 mm)	100 dpi	100 pixels
		200 dpi	200 pixels
		300 dpi	300 pixels
		400 dpi	400 pixels
		500 dpi	500 pixels
Printed Media	Text Size 12 pt. font = 0.17" (4.2 mm)	50 dpi	9 pixels
		100 dpi	17 pixels
		150 dpi	26 pixels
		200 dpi	34 pixels
		250 dpi	43 pixels
Identification Photos	Average between pupils (female) = 2.1"	10 dpi	21 pixels
		20 dpi	42 pixels
		30 dpi	63 pixels
		40 dpi	84 pixels
		50 dpi	105 pixels
License Plates (US)	Letter Height = 2.75" (70 mm)	3 dpi	8 pixels
		5 dpi	14 pixels
		10 dpi	28 pixels
		20 dpi	55 pixels
		40 dpi	110 pixels
Vehicles	Tire Size= 20" (508 mm)	1 dpi	20 pixels
		2 dpi	40 pixels
		3 dpi	60 pixels
		4 dpi	80 pixels
		5 dpi	100 pixels

The resolution user interface panel is shown below with descriptions for each feature:

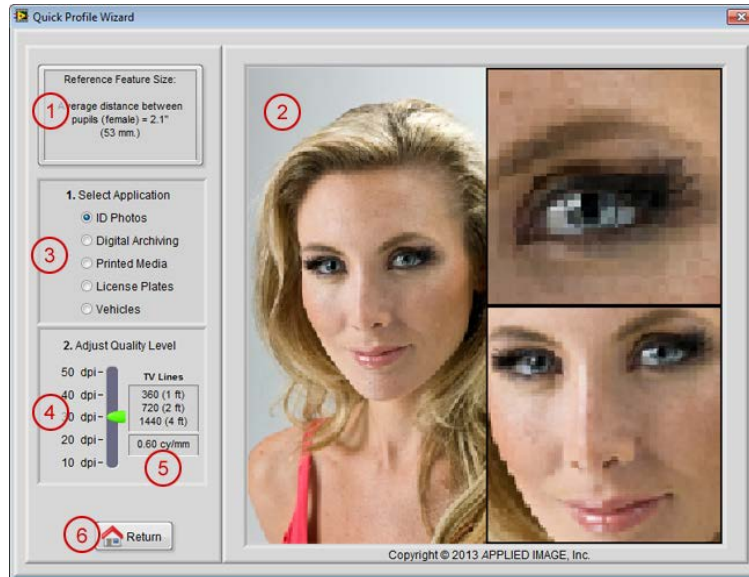| Feature Number	Feature Name	Feature Description
1	Reference Feature	The reference feature size indicates the real-world dimension from which the resolution (in dots per inch) is derived
2	Sample Image	Image corresponding to the Application and Quality Level selected.
3	Application	User applications that represent possible scene types
4	Quality Level	Range of resolution values within an application
5	Units Conversion	Conversion of dots per inch (dpi) values to TV Lines and cycles per mm. for each quality level
6	Return	Records the quality level and returns to the front panel

The resolution level is set when the Return button [Return] is selected.

The resolution level corresponds to the aim **Sensor Resolution** of the camera. Upper and lower limits for the sensor resolution are calculated by adding and subtracting 10%. The lower limit for **Functional Resolution** is determined by assuming an 80% Optical Efficiency (reducing the sensor resolution by 20%)

For example, if the quality level selected is 50 dpi, the following resolution limits are assigned:
Sensor Resolution Aim = 50 dpi
Sensor Resolution Minimum = 50 - (50 x 10%) = 45 dpi
Sensor Resolution Maximum = 50 + (50 x 10%) = 55 dpi
Functional Resolution Minimum = 50 x 80% = 40 dpi

Note that these values can all be edited directly after using the Quick Start-Up Guide by going to the Test Limits tab from the front panel of the main program.

Evaluating Color Accuracy Samples

Modifications to the colors in sample images were made using a photo-editing program. Identical color processing was performed on the original image and a master target with sRGB color patches. To affect the Maximum Delta E, a hue shift was performed. To affect the Mean Delta E, overall image brightness was changed.

The sample images represent *only one of many* color changes that affect the color accuracy of an image. These samples are designed to show the visual magnitude of the of a camera's color accuracy performance. Actual limits should be set by inspecting images from the actual application to determine acceptability.

The Color Accuracy panel of the Start-Up Guide has the following features:
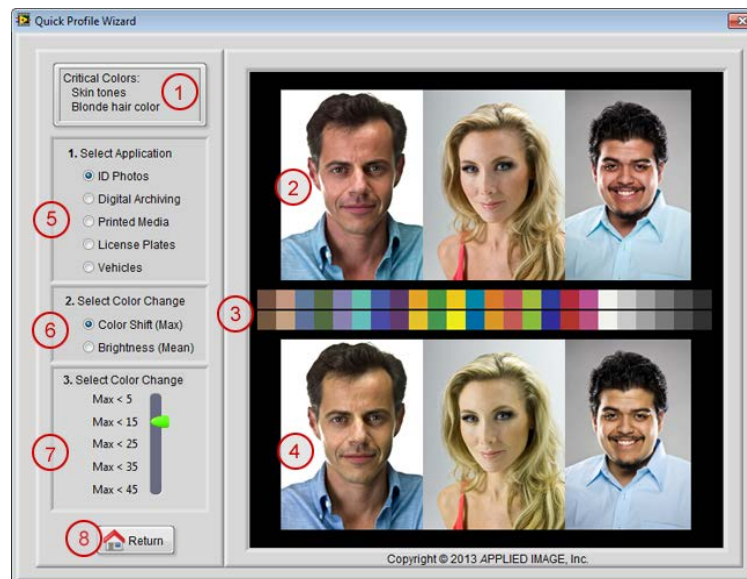

| Feature Number	Feature Name	Feature Description
1	Critical Colors	Color features in the images that indicate the most change when the Quality Level is modified.
2	Original Image	Image assumed to be correctly captured. This is the baseline image
3	Color Patch Reference	sRGB representation of the Imaging Gauge™ color patches to indicate how these colors are affected by the image modifications
4	Altered Image	Image produced by modifications to affect color accuracy
5	Application	User applications that represent possible scene types
6	Color Change Type	Selection to allow the maximum Delta E to be set using color hue shift modifications or to the Mean Delta E limit to be set by adjusting brightness
7	Color Change	Control to adjust quality levels for each application
8	Return	Sets the current limits and returns to the main panel

Maximum allowable Delta E Limit: The same five applications used for establishing resolution settings are also used to establish color accuracy limits. The Quality Levels for Maximum Delta E are identical for each application, however. These are 5, 15, 25, 35 and 45. The different applications allow the impact of these levels on different subject colors such as flesh tones, memory colors and saturated colors. This limit applies the accuracy of any *single* color. The samples below show the effect of Maximum Delta E at a 45 level.
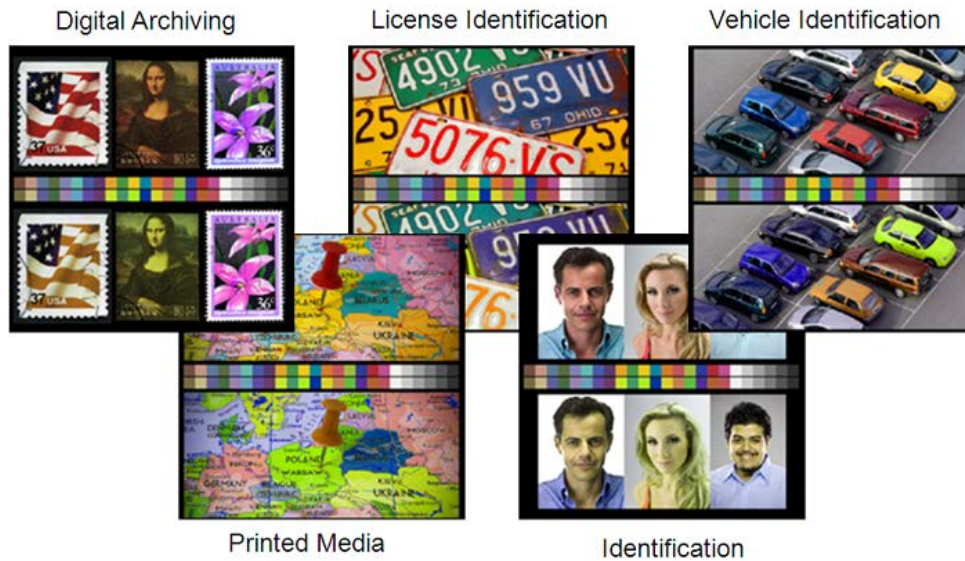

The chart below shows an image that resulted in a maximum Delta E (for the cyan patch) of 24.76. Note that the grayscale patches have a very low Delta E, indicating that the overall brightness and contrast of the image was correct.
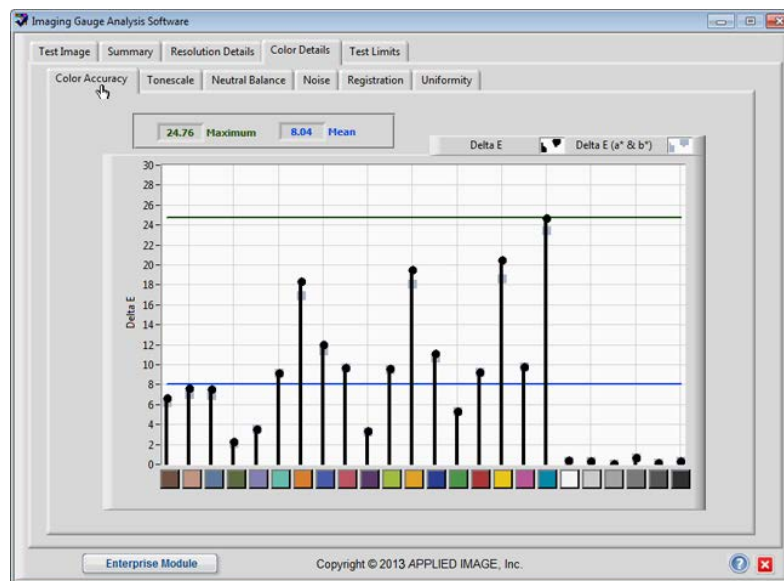
Maximum allowable Mean Delta E Limit: To affect all colors in an image, the brightness was increased to produce five quality levels for the Mean Delta E limit: 3, 6, 9, 12, and 15. The samples below show the mean of 15 for all applications.
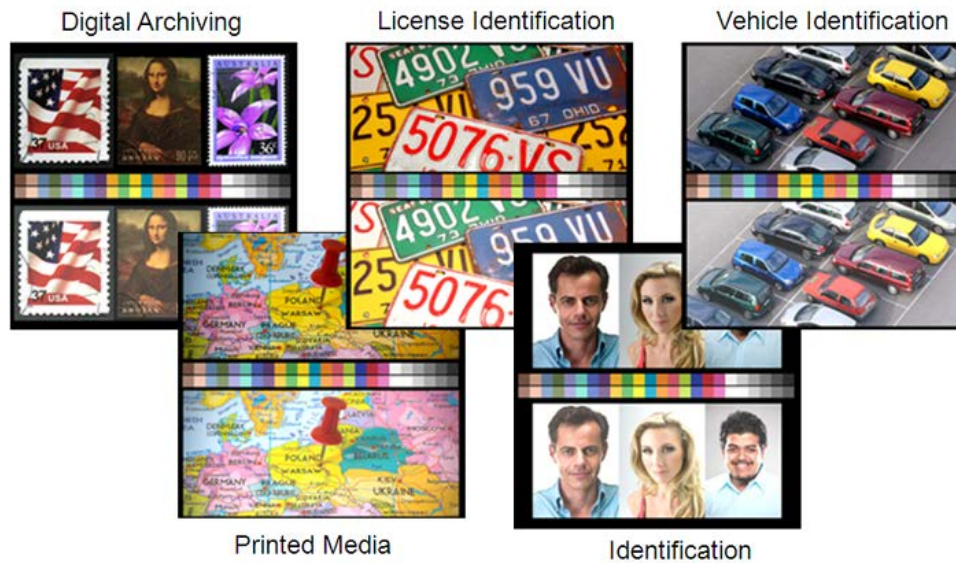
The chart below shows an image with an average Delta E of 11.32. Note that all colors (including grayscale patches) have significant Delta E values although none of them are as high as the previous sample.
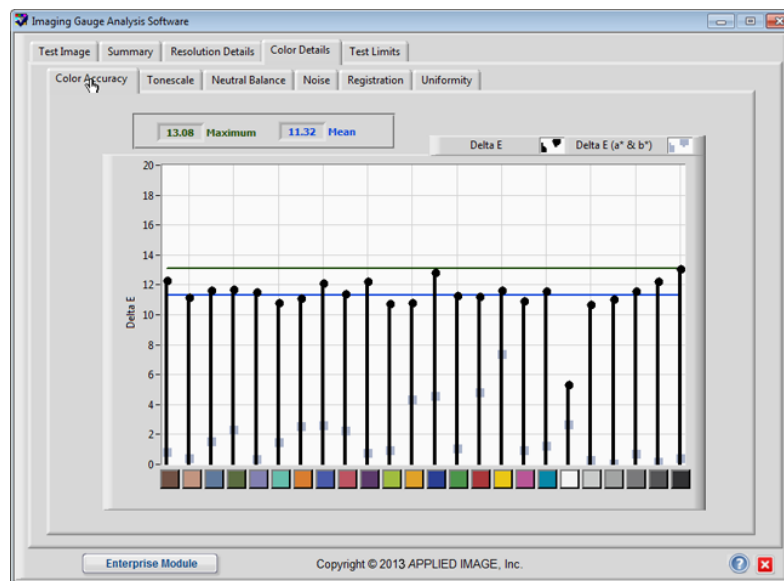
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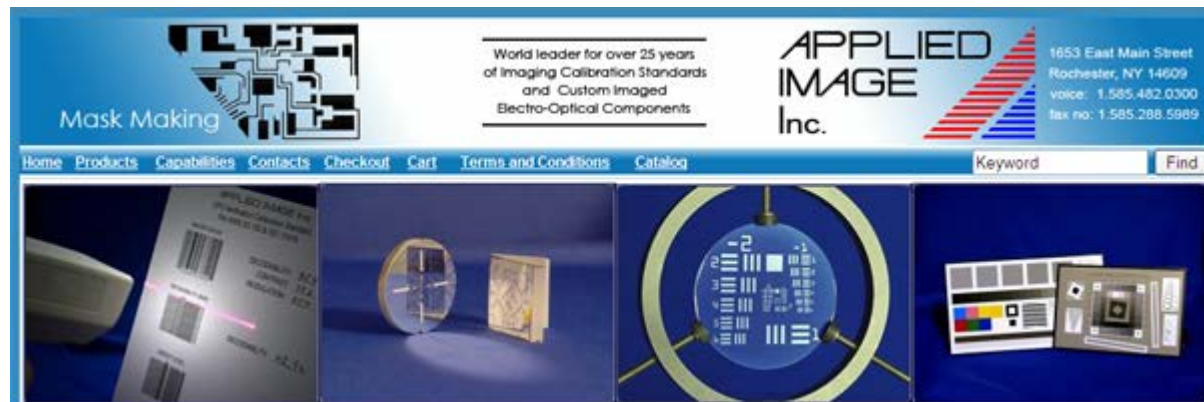
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