

# Implementing Pass/Fail in Imatest IT

## Imatest IT Pass/Fail operation

### Introduction

Imatest IT can return pass/fail results for industrial inspection. Although Pass/fail is primarily intended for IT/DLL, it works with IT/EXE and with GUI-based versions of Imatest (except for Studio), where it is primarily used for testing. *The details shown here are not final.*

### Quick summary:

- The pass/fail settings— minima, maxima, or limits— are stored in an ini file with the usual ini file format. [section] corresponds to the module.

### [section]

**parameter = value; Comments start with a semicolon.**

- The pass/fail ini file must be created and maintained by the customer (for now, at least) using a text editor.
- The full path name to the pass/fail ini file, which may be stored in a protected area, is entered in the [api] section of the main ini file with a statement of the form,

### [api]

**passFail = fullPathName.**

- Information about the Unit Under Test (UUT) must be passed to Imatest in the same JSON object (string) used to pass image array properties to Imatest DLL modules.
- The UUT part number, serial number, pass/fail settings, results value, and pass/fail results (1 or 0) are returned to the calling program in a JSON object. XML may be added on customer request.

### Pass/Fail settings file

Pass/Fail settings— minimum or maximum values for individual measurements— are stored in an ini file that is separate from the main ini settings file so it can be protected from tampering, if needed. It can be in a protected folder that requires administrator access to write.

It will have standard ini file format with sections corresponding to sections in imatest.ini. Here is an example:

[sfrplus]

MTF50P\_ratio\_min = .5

MTF50P\_CP\_weighted\_mean\_min = .13

Rotation\_degrees\_max = 1

FOV\_degrees\_diagonal\_min = 62

Convergence\_angle\_max = 5

Secondary\_readout\_1\_center\_mean\_min = .2

Secondary\_readout\_1\_outer\_mean\_min = .2

Secondary\_readout\_2\_center\_mean\_min = .2

Secondary\_readout\_2\_outer\_mean\_min = .2

[blemish]

Dead\_pixels\_max = 10

Hot\_pixels\_max = 10

Optical\_center\_offset\_max = 50

Relative\_illumination\_worst\_corner\_pct\_min = 40

Uniformity\_RoverG\_corners\_pct\_max = 10

Uniformity\_BoverG\_corners\_pct\_max = 10

Blemish\_size\_pixels = 20 50

Blemish\_maximum\_count = 2 1

An example from above: MTF50P\_ratio\_min = .5 sets the minimum acceptable value for (minimum MTF50P)/(maximum MTF50P) (taken over all the selected regions) to 0.5.

The customer must create and update this file to meet his needs. Additional measurements will be added on request.

**Table 1. Measurements for Pass/Fail**

<b>[sfrplus]</b> Related documents: <a href="#">Using SFRplus Part 2</a>   <a href="#">SFRplus INI file reference</a>	
Variable with typical parameter	Description
MTF50P_ratio_min = .5	The minimum ratio of the minimum to maximum MTF50P (spatial frequency where contrast falls to half its peak value). A low value indicates poor lens quality or possibly significant lens tilt.
MTF50P_CP_weighted_mean_min = .13	The weighted mean MTF50P in Cycles/Pixel.
Rotation_degrees_max = 1	Image rotation in degrees, measured from the

	top and bottom distortion bars. The absolute value is used for Pass/Fail.
FOV_degrees_diagonal_min = 62	The diagonal Field of View in degrees
Convergence_angle_max = 5	The maximum allowable convergence angle (both Horizontal and Vertical are measured). A measure of keystone distortion.
Secondary_readout_1_center_mean_min = .2	The minimum value of Secondary readout 1 in the center region (up to 30% of the center-to-corner distance). <b>Secondary readouts are described in <a href="#">Here</a>. Secondary readout ini file settings are listed in the <a href="#">Imatest INI file reference</a>.</b>
Secondary_readout_1_outer_mean_min = .2	The minimum value of Secondary readout 1 in the outer region (over 30% of the center-to-corner distance; note other regions are part-way, 30-75% and corner, >75%).
Secondary_readout_2_center_mean_min = .2	The minimum value of Secondary readout 2 in the center region (up to 30% of the center-to-corner distance).
Secondary_readout_2_outer_mean_min = .2	The minimum value of Secondary readout 1 in the outer region (over 30% of the center-to-corner distance)
All_Edge_IDs_detected = 1	Test for properly detected top and bottom bars (present with no significant gaps).
Mirrored_chart = 1	Test for mirrored (Left-Right) image (fails mirror images) if entered and the chart contains a grayscale step chart below the center square and stepchart = 1 in the <a href="#">[sfrplus]</a> section of the main ini file.
Bayer_decode = 1	Test for correct Bayer pattern decoding (fails if incorrect) if entered and the chart contains color patches above the center square and colorchart = 1 in the <a href="#">[sfrplus]</a> section of the main ini file.
Color_expected_detected = 1	A color pattern is expected when colorchart = 1

	<p>in the <a href="#">[sfrplus]</a> section of the main ini file. If the color pattern is not present, this test will fail. This could indicate bad chart positioning or simply that the color pattern is not present in the test chart.</p>
Stepchart_expected_detected = 1	<p>A grayscale stepchart is expected when stepchart = 1 in the <a href="#">[sfrplus]</a> section of the main ini file. If the stepchart is not present, this test will fail. This could indicate bad chart positioning or simply that the grayscale stepchart is not present in the test chart (a rare occurrence because it's in most standard charts, except for the chrome-on-glass chart).</p>
passfail_ini_file_date = (manually entered date)	<p>Optional indicator of pass/fail date. Another result appears in the output: passfail_ini_time_size, which contains the time the file was modified and the size in bytes.</p>
<p><b>[blemish]</b>  Related documents: <a href="#">Using Blemish Detect</a>   <a href="#">Blemish INI file reference</a></p>	
Dead_pixels_max = 10	<p>Maximum number of dead pixels allows. Thresholds for dead pixel detection (% or absolute) are set in the <a href="#">[blemish]</a> section of the ini file.</p>
Hot_pixels_max = 10	<p>Maximum number of hot pixels allows. Thresholds for hot pixel detection (% or absolute) are set in the <a href="#">[blemish]</a> section of the ini file.</p>
Optical_center_offset_max = 50	<p>Maximum offset in pixels of the optical center (location of highest luminance) from the center of the image. To minimize the effects of noise, X and Y optical centers are defined using the centroid of the of the curve between the points where the smoothed values fall below 95% of the maximum. (The actual maximum is highly susceptible to noise since it's very broad.)</p>
Relative_illumination_worst_corner_pct_min = 40	<p>The minimum corner region luminance divided by the maximum luminance of the smoothed image.</p>

Uniformity_RoverG_corners_pct_max = 10	Maximum R/G corner nonuniformity = $100\%(RG_{\max} - RG_{\min})/RG_{\max}$ , where $RG_{\max}$ = maximum R/G ratio in the four corners; $RG_{\min}$ = minimum R/G ratio in the four corners.
Uniformity_BoverG_corners_pct_max = 10	Maximum B/G corner nonuniformity = $100\%(BG_{\max} - BG_{\min})/BG_{\max}$ , where $BG_{\max}$ = maximum B/G ratio in the four corners; $BG_{\min}$ = minimum B/G ratio in the four corners.
Blemish_size_pixels = 10 80	
Blemish_maximum_count = 3 1	

## Referencing the pass fail file in the main ini file

The main ini settings file should contain the [api] section, which includes the Pass/Fail settings file location.

```
[api]
nomsg = 1
savedel = 1
sfrrefine = 1
passFail = C:\Imatest\Data\passfailtest_1.txt
```

## Sending UUT (Unit Under Test) information to Imatest IT

Each test may have a part number and serial number (both strings) that identifies the UUT (Unit Under Test).

The part and serial numbers are passed to Imatest IT along with the image file and data that defines the size of the image. It is contained inside a JSON object, as shown in the example below, written in *Matlab*. C, C++ etc. examples will be supplied with Imatest IT builds.

```
% Start by reading an image as a binary file.
rdfname = 'C:\Imatest\projects\sfrplus\SFRplus_5.rw3';
infile = 'C:\Imatest\projects\sfrplus\SFRplus_5_rw3.ini';
endian_str = 'ieee-le'; precision = 'uint16=>uint16';
jstr.width = 1280; jstr.height = 720; jstr.ncolors = 1; % Not used for raw files.
jstr.extension = 'rw3';
jstr.fileroot = rdfname;
jstr.serial_number = '46-062';
```

```

jstr.part_number = 'X-1 Rocket Plane';
jsonObj = savejson(' ',jstr,[]); % Convert structure into JSON object.
fd = fopen(rdfname, 'r', endian_str); % Open the image file for reading.
[ im_orig count ] = fread(fd, inf, precision); % inf allows bits to be skipped.
disp(char{' ','';'DIRECT READ: SINGLE IMAGE'}));
output = sfrplus_shell(' ', 'C:\Imatest\projects\sfrplus', inputKeys, opMode, ...
'C:\Imatest\projects\sfrplus\SFRplus_5_rw3.ini',im_orig,jsonObj);
% 'C:\Imatest\matlab\trunk\AP\it_samples\sfr\sfr_gf1_1file.ini',im_orig,jsonObj);
disp(output)

```

Note: jstr.extension = 'rw3' refers to the file extension, whose decoding parameters are set in [Generalized Read Raw setup](#).

jstr.width = 1280; jstr.height = 720; jstr.ncolors = 1; are not used for raw files decoded by [Generalized Read Raw](#). They are used to decode processed images in standard formats.

## Overriding values set in the main ini file

There are occasions where we may want to override settings in the main ini file (C:\Imatest\projects\sfrplus\SFRplus\_5\_rw3.ini in the above example) at runtime, for example, when several different images are to be analyzed in sequence. This can be done with statements in the calling sequence. The three variables shown below in **burgundy** are currently supported. (The fields, i.e., crop\_borders, lens\_to\_chart\_distance\_cm. etc.) must be entered exactly as shown (they're hard-coded into the program). More can be added on request.

```

...
jstr.serial_number = '46-062';
jstr.part_number = 'X-1 Rocket Plane';
jstr.crop_borders = [5 5 5 5]; % Crop borders ( [L T R B] )
jstr.lens_to_chart_distance_cm = 33.3;
jstr.chart_height_cm = 39.99;
jsonObj = savejson(' ',jstr,[]); % Convert structure into JSON object.

```

## Output

The available output is being expanded. It will eventually include both JSON and XML objects.

## JSON output

Pass/Fail results are added at the end of the JSON object. For Blemish,

```

{
  "blemishResults": {

```

```

"dateRun": "10-Apr-2012 17:59:58",
...
"N_blemish_count": [1],
"blemishSizePxls": [1651],
"blemishCenter_X": [781.5],
"blemishCenter_Y": [644.2],
"passfail": {
  "started_at": "2012-04-10 17:59:58",
  "part_number": "X-1 Rocket Plane",
  "serial_number": "46-062",
  "ended_at": "2012-04-10 18:00:00",
  "runtime": [1.848969517],
  "Dead_pixels_max": [10],
  "Dead_pixels": [0],
  "Dead_pixels_pf": [1],
  "Dead_pixels_status": "Passed",
  "Hot_pixels_max": [10],
  "Hot_pixels": [0],
  "Hot_pixels_pf": [1],
  "Hot_pixels_status": "Passed",
  "Optical_center_offset_max": [50],
  "Optical_center_offset": [-30,14],
  "Optical_center_offset_pf": [1],
  "Optical_center_offset_status": "Passed"
}
}
}

```

**Interpretation:** For Dead pixels, a maximum of 10 is allowed (specified by ...\_max). 0 have been detected. "...\_pf": [1] means the image passed the criteria. "...\_status": "Passed" also means that the image passed.

For SFRplus,

```

{
  "sfrplusResults": {
    "dateRun": "10-Apr-2012 20:22:27",
    ...
    "k1_3rd_order_dist_coeff": [0.0117],
    "h1_5th_order_dist_coeff": [-0.036],
    "h2_5th_order_dist_coeff": [0.0443],

```

```
"passfail": {  
  "started_at": "2012-04-15 16:05:10",  
  "part_number": "X-1 Rocket Plane",  
  "serial_number": "46-062",  
  "ended_at": "2012-04-15 16:05:15",  
  "runtime": [4.52085684],  
  "all_tests_passed": [0],  
  "MTF50P_ratio_min": [0.5],  
  "MTF50P_ratio": [0.7628270592],  
  "MTF50P_ratio_passed": [1],  
  "MTF50P_CP_weighted_mean_min": [0.13],  
  "MTF50P_CP_weighted_mean": [0.132948091],  
  "MTF50P_CP_weighted_mean_passed": [1],  
  "Rotation_degrees_max": [1],  
  "Horizontal_bars_OK_min": [1],  
  "Horizontal_bars_OK": [1],  
  "Horizontal_bars_OK_passed": [1],  
  "All_Edge_IDs_detected": [1],  
  "All_Edge_IDs_detected_OK": [1],  
  "All_Edge_IDs_detected_passed": [1],  
  "Mirrored_chart": [1],  
  "Mirrored_chart_OK": [1],  
  "Mirrored_chart_passed": [1],  
  "Bayer_decode": [1],  
  "Bayer_decode_OK": [1],  
  "Bayer_decode_passed": [1],  
  "Color_expected_detected": [1],  
  "Color_expected_OK": [0],  
  "Color_expected_passed": [0],  
  "Stepchart_expected_detected": [1],  
  "Stepchart_expected_OK": [1],  
  "Stepchart_expected_passed": [1],  
  "Rotation_degrees": [-0.6021933244],  
  "Rotation_degrees_passed": [1],  
  "FOV_degrees_diagonal_min": [62],  
  "FOV_degrees_diagonal": [103.8954245],  
  "FOV_passed": [1],  
  "Convergence_angle_max": [5],  
  "Convergence_angle_degrees_horz": [-1.816256865],  
  "Convergence_angle_degrees_vert": [-4.310448164],
```



```
"Convergence_angle_passed": [1],
"Secondary_readout_1_center_mean_min": [0.2],
"Secondary_readout_1_center_name": "MTF @ .25 LP/mm",
"Secondary_readout_1_center_mean": [0.1525933797],
"Secondary_readout_1_center_mean_passed": [0],
"Secondary_readout_1_outer_mean_min": [0.2],
"Secondary_readout_1_outer_name": "MTF @ .25 LP/mm",
"Secondary_readout_1_outer_mean": [0.1827151453],
"Secondary_readout_1_outer_mean_passed": [0],
"Secondary_readout_2_center_mean_min": [0.2],
"Secondary_readout_2_center_name": "MTF @ .125 LP/mm",
"Secondary_readout_2_center_mean": [0.5577878056],
"Secondary_readout_2_center_mean_passed": [1],
"Secondary_readout_2_outer_mean_min": [0.2],
"Secondary_readout_2_outer_name": "MTF @ .125 LP/mm",
"Secondary_readout_2_outer_mean": [0.5271610521],
"Secondary_readout_2_outer_mean_passed": [1]
}
}
}
```