

**Soldering Condition (version 0.0.0.3)**

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## 1. Inspection Overview

**Soldering Condition** is the algorithm to inspect the solder shape and solder condition in the PAD area using 3D and 2D information.

Soldering Condition has the following features.

- Detecting defects with minimum input parameters set up.
- Easy outputs for easy debugging.
- Same logic for chips, ICs.
- Following inspection recommendation of **IPC-A-610 Acceptability of Electronic Assemblies** on inspection steps relevant for automated optical inspection systems with coaxial camera and inspection area of this algorithm.

※Component shift is not inspected by SolderingCondition and must be covered by another relevant algorithm (i.e “Rect Align” or “Lead Side Black White”).

## 2. Parameters

Name	Value	
Lead Height Threshold [μm]	213	▶
Fillet Lighting	Custom image (Top)	▶
- Upper Threshold	230	▶
Lifted terminal detection		▶
- Lead start ratio [%]	15	▶
- Lead start finetuning [pix]	30	▶
- Lead end ratio [%]	85	▶
Excessive solder detection		▶
- Area ratio 3H/3 [%]	70	▶
- Depth overhang [%]	33	▶
Fillet search distance [μm]	200	▶

Figure 1 Parameter Grid

Table1. Parameter

Parameter	Description
Lead Height Treshold [μm] <sup>1</sup>	Set the Lead Height Treshold. (Algorithm Optimization – If used, threshold is set as menian height of an object in related Shape Element)
Fillet Lightning	Select a lightning that inspect to Fillet. ※Recommended to use TrueTop Light if available
Fillet Lightning -Upper Treshold	Set the upper threshold of Fillet lightning. ※ Pixel birghtness > Upper Threshold is considered not acceptable for given inspection step
Lifted terminal detection -Lead start ratio[%]	Set the ratio of start position of the Lead using height information.

<sup>1</sup> Parameter can be automatically modified by “Algorithm Optimization” function

Lifted terminal detection -Lead start finetuning[pix]	Set the number of pixels for finetuning start position of the Lead using RGB color information. ※Searching flat area
Lifted terminal detection -Lead end ratio[%]	Set the ratio of end position of the Lead using height information.
Excessive solder detection -Area ratio 3H/3[%]	Set the upper threshold of height area ratio in the Inspection Area <sup>2</sup> : [1]-R3.
Excessive solder detection -Depth overhang[%]	Set the overhang ratio in Inspection Area <sup>2</sup> : [1]-R3. ※Required "overhang" of detected Excessive solder above "Lead height threshold [um]" in order to judge Excess Solder
Fillet search distance [μm]	Limiting the "region of interest" for Fillet Area [%] & Fillet Average Height [μm] & Solder Flat Brightness up to the specified distance from detected terminal position or to the end of the pad, whichever is smaller. ※If Fillet search distance [μm] = 0, parameter is not used.

#### Algorithm Embedded Visualisation:

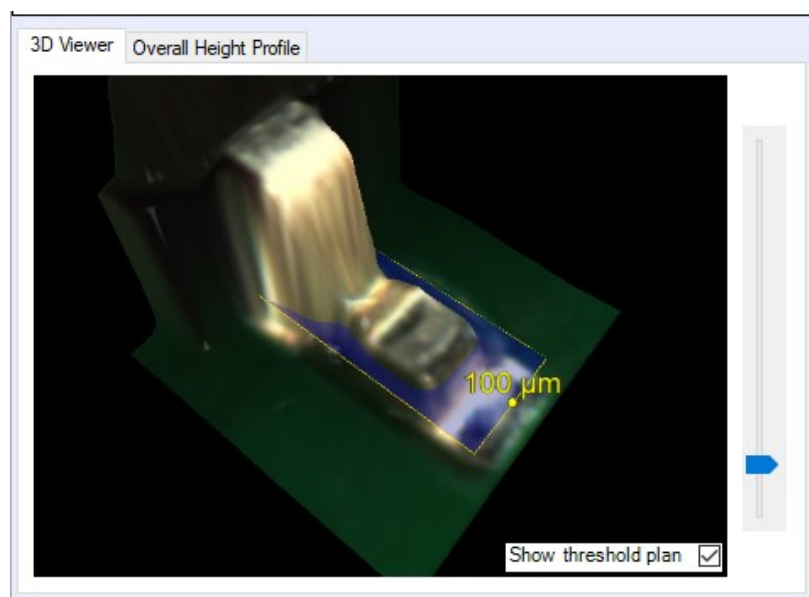


Figure 2 3D Viewer

3D viewer
Display 3D viewer of inspection component and Lead Height Threshold. The position determined by the slider is also reflected in Lead Height Threshold.

<sup>2</sup> Definition of respective "inspection areas" is described further in Chapter 3. Inspection Area  
SFM20103-03EA

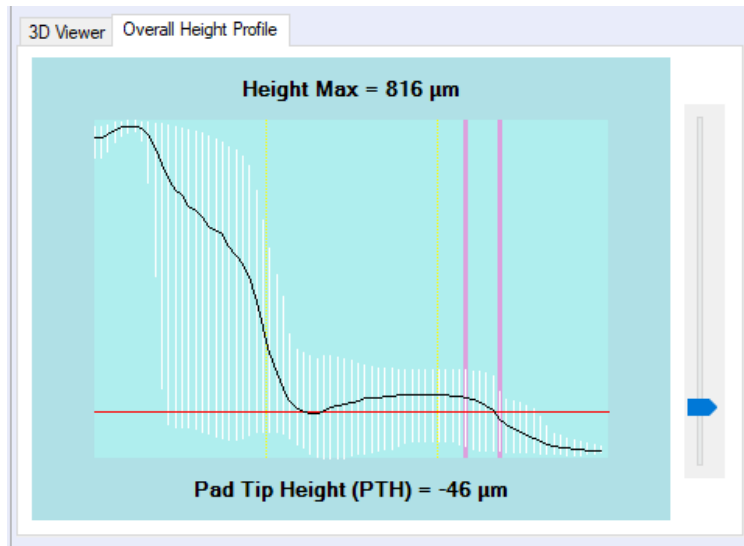


Figure 3 Height Profile Graph

Overall Height Profile
Display of the height profile of the inspection area averaged over its width.
The position determined by the slider is also reflected in Terminal Height parameter.

### 3. Inspection Area

The inspection area varies depending on respective sample value.

#### Inspection Area [1]:

Using inspection window area or gerber area automatically (if gerber is detected)

The inspection region is divided into the three regions of equal size (denoted as R1...3).

Related inspection steps, are using automatically suitable area for the inspection task (Refer to Table2).

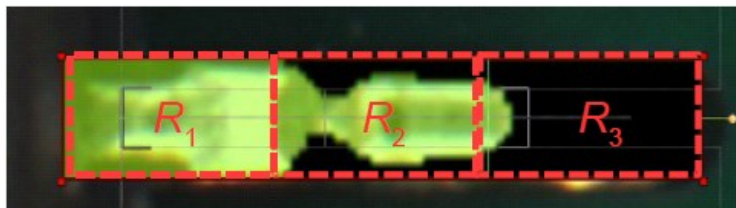


Figure 4 Fixed Separation of inspection area

**Inspection Area [2]:**

The area from the Terminal Start to the **the Fillet search distance [um]** or to the **Pad End**, **whichever is smaller**. In case Fillet search distance [um] is set to =0, Pad End will be used automatically.

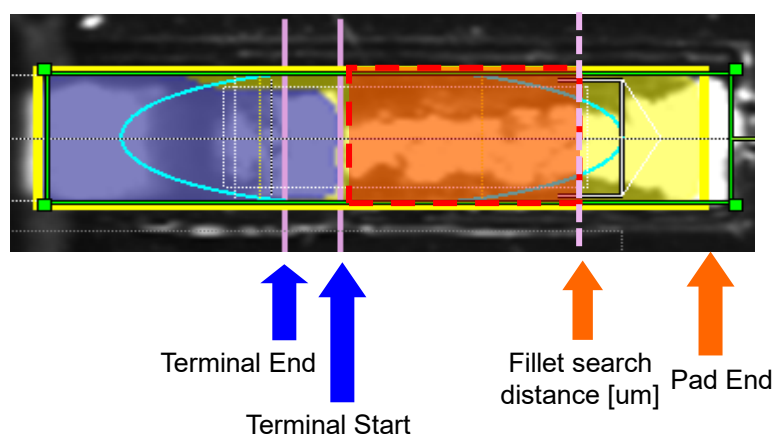


Figure 5 Soldering inspection area

※ Region of interest is from detected terminal position (Terminal Start) up to the end of inspection area (Pad End) or “Fillet search distance” whichever shorter.

※ In case gerber is not detected, inspection window area is used instead of gerber area

#### 4. Inspection Results (Sample Values)

	Name	Value	OK Range		NG Type	
<input type="checkbox"/>	Gerber used for inspection	Yes	-		-	▶
<input checked="" type="checkbox"/>	Component presence	Detected	Detected		Missing	▶
<input checked="" type="checkbox"/>	Excessive Solder	Not detected	Not detected		Soldering	▶
<input checked="" type="checkbox"/>	Solder Flat Brightness	39	15	215	Soldering	▶
<input checked="" type="checkbox"/>	Lead Height [um]	267	224	540	Lifted Lead	▶
<input checked="" type="checkbox"/>	Fillet Average Height [um]	77	20	564	Soldering	▶
<input checked="" type="checkbox"/>	Fillet Height [%]	69.3	25	100	Soldering	▶
<input checked="" type="checkbox"/>	Fillet Height [um]	185	20	635	Not Wet	▶
<input checked="" type="checkbox"/>	End Joint Width [%]	100.0	75	100	Not Wet	▶
<input checked="" type="checkbox"/>	Fillet Area[%]	100.0	30	100	Soldering	▶

Figure 6 Sample Values Grid

Table2. Sample Values

Parameter	Description
Gerber used for inspection	Gerber data for inspection detected & used. (Default= Disabled)
Component presence	Detected component presence. ※ Detecting object above “Lead Height Threshold [um]” in Area: [1]-R1
Excessive Solder	Detected excessive solder. ※Detection only in nspection Area: [1]-R3

Solder Flat Brightness	Detection of non-wetting by brightness of pixels of solder joint in "Fillet Lighting" for all pixels with height < Lead Height Threshold [um] ※Using Inspection Area: [2]
Lead Height [um]	Detected Lead height
Fillet Average Height [um]	Detected Solder Fillet Average Height of the Pad area. ※Using Inspection Area: [2]
Fillet Height [%]	Height of the wetting detected on the respective terminal in relation to height of the terminal "Lead Height [um]" (IPC-A-610)
Fillet Height [um]	Detected Solder Fillet Height from the Pad end to the Terminal tip. ※Using RGB color information. ※Using Inspection Area: [2] (From Pad End only)
End Joint Width [%]	The "wetted" joint width in the contact with terminal (IPC-A-610)
Fillet Area [%]	Size of soldering fillet based on [%] of pixels in "Fillet Lighting" with brightness lower than "Upper Threshold" ※Using Inspection Area: [2]

**Fillet Height [%] (IPC-A-610)**

Inspection step is targeting acceptability of a joint condition in relation to the height of the wetting on given terminal.

Fillet height is calculated as a ratio between detected height of the terminal (Lead Height [um]) and the height of wetting.

Sample is calculated as a **ratio between "Lead Height [um]" and "Fillet height [um]" or "Fillet Average Height [um]"**, whichever is higher.

### End Joint Width [%] (IPC-A-610)

Inspection step is targeting acceptability of a joint condition in relation to the width of the wetting on given terminal.

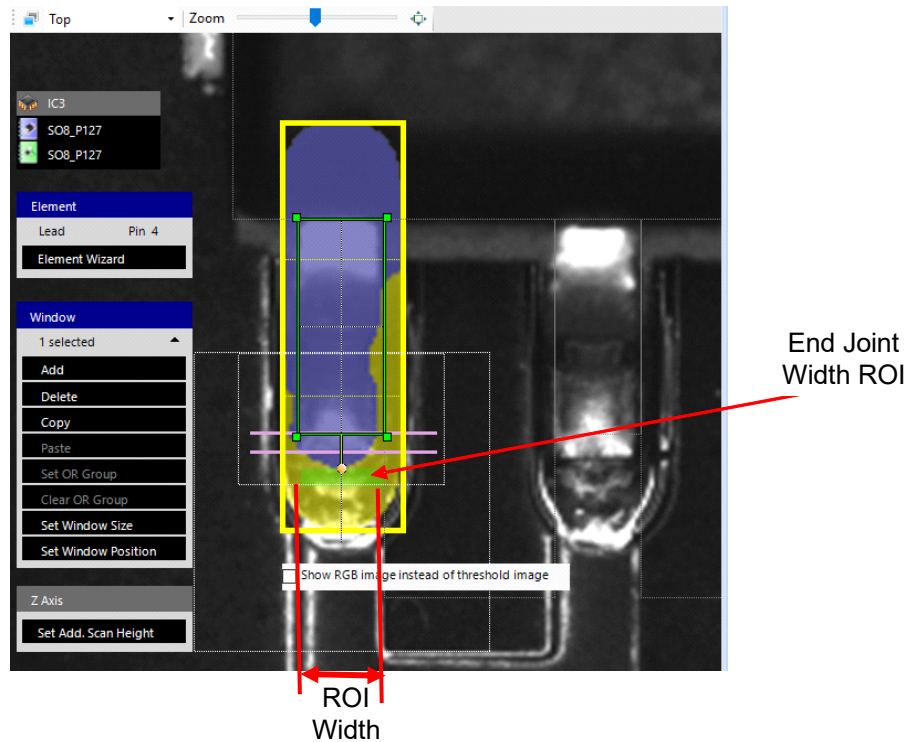


Figure 7 End Joint Width ROI

Sample value is calculated as the **ratio between “End Joint Width ROI” width and the detected width of the solder fillet** using “Fillet Lighting” and “Fillet Lighting – Upper Thershold”

The width of “End Joint Width ROI” corresponds to the width of related “Shape Element” or to PAD region, whichever is smaller.

### Solder Flat Brightness

Supplemental inspection test to the sample value Fillet Height [%], aiming to validate the solder wetting condition. This is aiming to separate solder joints with steep soldering meniscuss and small volumes of solder vs. non-wetting case with sufficient volume of solder.

The sample value is calculating average brightness of pixels in Inspection Area [2]

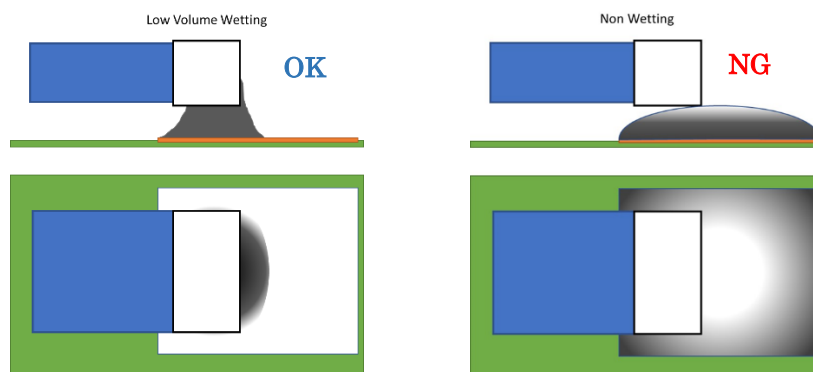


Figure 8 Steep & slim meniscus vs. non-wetting

## 5. Setting Procedure

Step1 : Select the Soldering Condition from the Algorithm drop-down list.

Step2 : Adjust the inspection window from terminal to the end of Pad.

If there is gerber information, Soldering Condition automatically inspects according to PAD size and position.

If there is no gerber information, Soldering Condition inspect according to inspection window size and position.

**NOTE: Recommended location and size of inspection window based on PAD size & location.**



Figure 9 Adjusting the Inspection Window (using pad information)

Step3 : Set the Lead Height Treshold parameter using the slider in the Overall Height Profile.

Move the slider up and down to change the size of the purple area.

Adjust Lead Height so that the electrode part becomes purple.

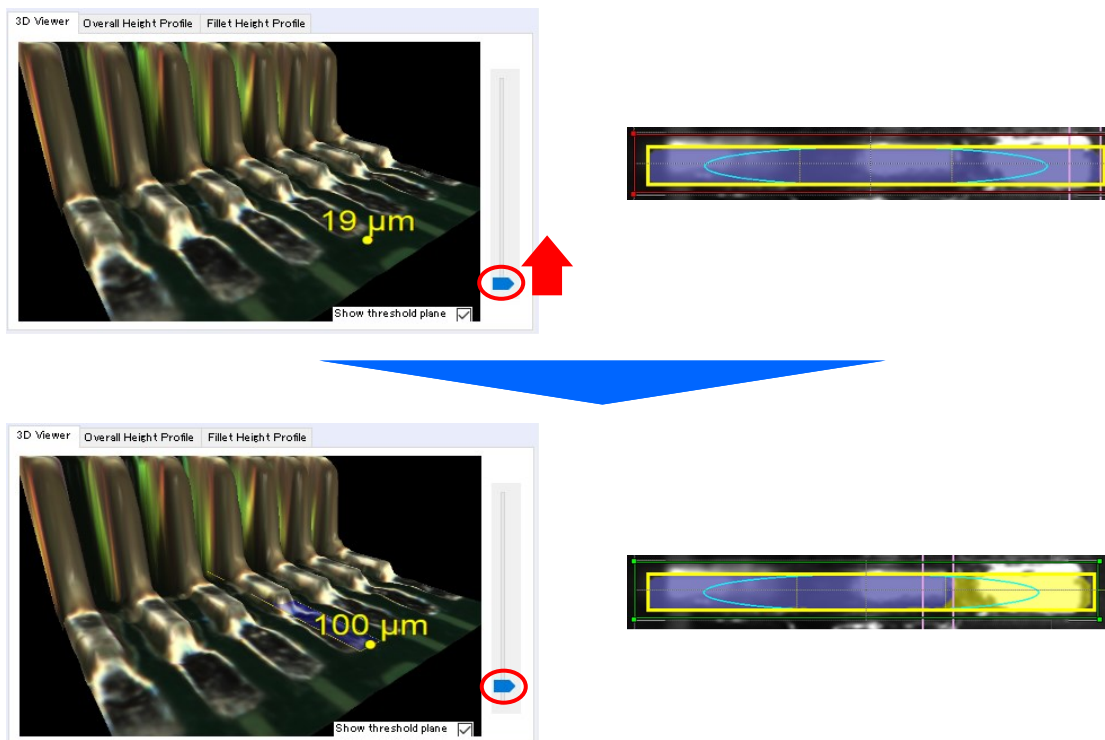


Figure 10 Set terminal height using slider



Step4 : Set **Solder Fillet Avelage Height Inspection** parameters.

Step4.1 : Choose a Fillet Lightning. Recommended setting is **TrueTop**.

Step4.2 : Set the upper threshold of Fillet lightning. Recommended value =230

Step5 : Set **Lifted terminal detection** parameters.

Step5.1 : Set the ratio of start position of the Lead.

Recommended to keep default setting.

Step5.2 : Set the number of pixels for finetuning start position of the Lead. (Default =10)

Terminal Start Position search by height information may be unstable in some cases. Therefore, using the RGB color information, searching for the Red of RGB on the component side from Terminal Start Position in Step5.1. If there is Red in the set number of pixels make it a new Terminal Start Position.

Step5.3 : Set the ratio of end position of the Lead.

Recommended to keep default setting.

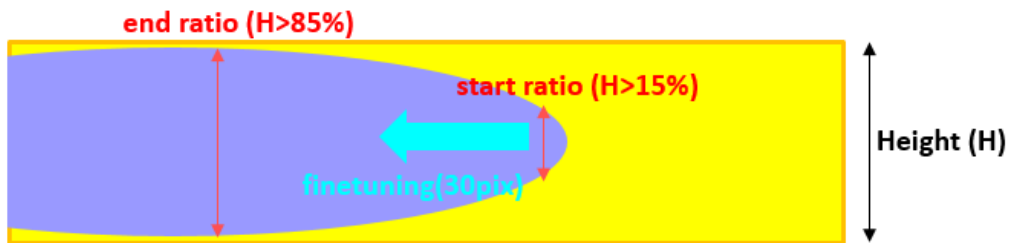


Figure 11 Lifted terminal detection parameter

Step6 : Set **Excessive solder detection** parameters.

Step6.1 : Set the upper threshold of height area ratio in Inspection Area: [1]-R3.

Step6.2 : Set the overhang ratio in Inspection Area: [1]-R3.

Condition of NG is ① or ②

T: Lead Height Treshold

- ①  $R3 \text{ Height Area} / R3 \text{ Area} > \text{Area ratio } 3H/3[\%]$
  - ②  $\text{Median (R3 Height Area)} > D * T$
- $D = (100 + \text{Depth overhang}[\%]) / 100$

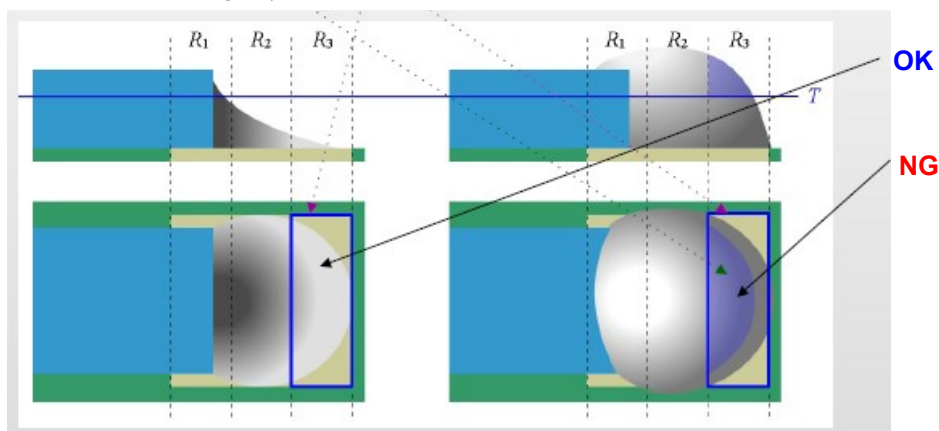


Figure 12 Excessive solder detection

**6. Revision History**

Revision	Date	Description	Written by
01	2020/12/10	First (Updated SFM18050-02EA)	M. Kostadinov
02rc	2021/02/03	Updated modification Soldering Condition 0.0.0.3	M. Kostadinov
02	2021/06/09	Updated Fillet Area [%], Fillet Search Distance	M. Kostadinov
03	2021/08/01	Updated Chapter 3 & 4 BF2: v2021.1.3.3	M. Kostadinov