How CAD Data and Threshold Settings Affect Pin Length on the Agilent Medalist 5DX

Application Note

Pin Length Threshold

Pin length is a required setting for controlling the toe and center positions of a pin so that the pin can be properly tested for defects and process variations. Once the pin length is set, the nominal solder thicknesses (NST) and the algorithms for insufficient, open, and misalignment can be properly setup and tuned. As shown in Figure 1, items higher in the pyramid build on the ones that are lower in the pyramid, i.e., if background profile location is set incorrectly then expect everything else above it to also be incorrect.

The pin length SPC threshold determines the distance, in mils, that the toe should be placed from the heel. The threshold cannot be measured directly from the image window and entered into the algorithm tuner without first doing some calculations. Since the pin length threshold setting in algorithm tuner is actually decreased by a certain amount, this means you must add something to the measurement from the image window. The actual distance that the threshold will be decreased by is [Pin Length Decrease * Heel Length]. You will arrive at the proper pin length by using diagnostics to check the threshold value and change it accordingly.

Note: Agilent recommends new programmers working on the Medalist 5DX to follow Agilent Supported Application Program (ASAP) guidelines and documentation. After experience in working with the algorithm tuner and FPGullwing-SPC setup process, the following application note will provide you with additional insight into the inner workings of the pin length threshold.

SPC
Locator
Camera setting
CAD data
Surface map
Board alignment

4x nominal solder thickness
Center location
Pin length
Secondary heel search distance
Heel search distance
Heel length & pin length decrease
Heel search thickness
Pad profile width & voiding compensation
Background profile location
SPC
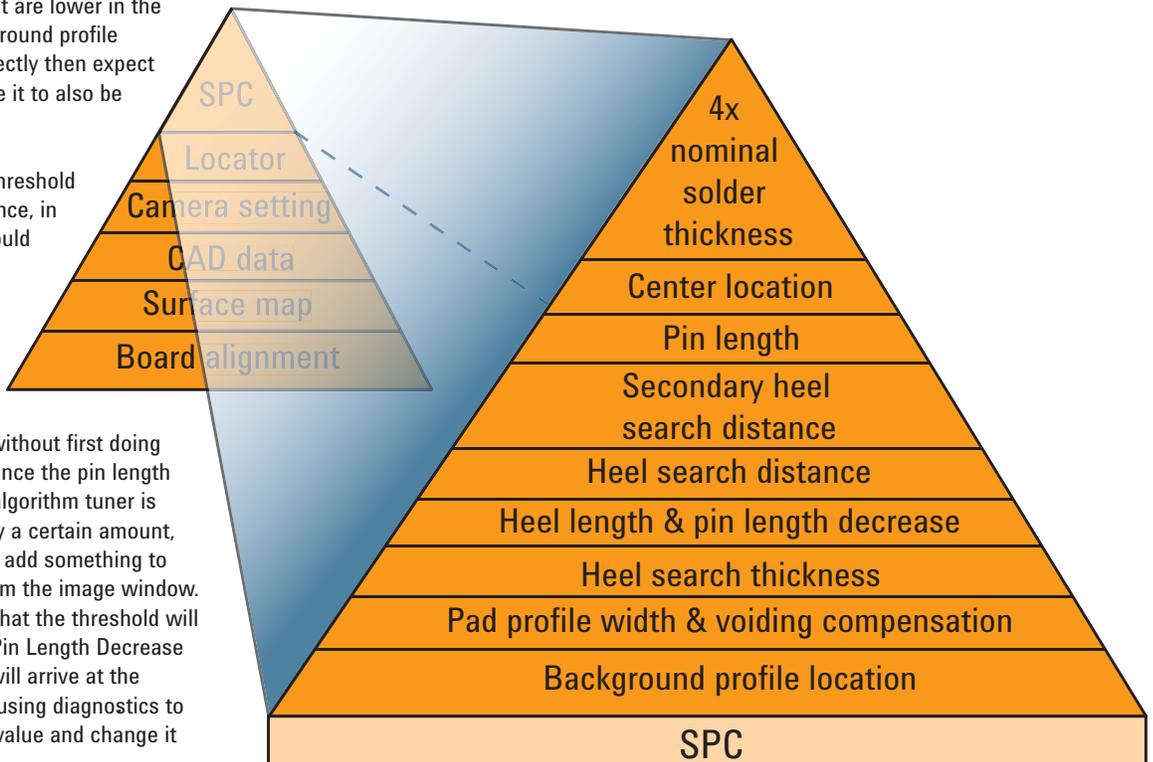
Figure 1. NST pyramid

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The displayed pin length formula for a subtype's pin length is:
"Pin length threshold" − ("Pin length decrease" * "Heel length" * "CAD pad width")

If the "pin length threshold" = 42 and the "CAD pad width" = 25, then:
- Displayed pin length = 42 − (2.00[1] * 0.40[1] * 25)
- Displayed pin length = 42 − (0.80[1] * 25)
- Displayed pin length = 22 mils
- If you measured the pin length with the cursor in the image window, you will get 22 mils.

Using the Pin Length Formula

1. **Using the formula, you can calculate backwards from the image window to the threshold.**

An example from an unknown subtype:
- X = Pin length threshold to calculate
- 25 = CAD pad width (mils)
- 22 mils = Measured pin length from image window
- Then X = 22 + (2.00 * 0.40 * 25) = 42 mils.
- So, the correct value for the algorithm tuner pin length threshold is 42.

2. **The pin length threshold is reduced by "pin length decrease" multiplied by "heel length" and "heel length" is a multiplier for "CAD pad width".**

This means that if we changed any of the above 3 variables we are modifying our pin length threshold indirectly. For example, keep algorithm tuner pin length (PL) threshold at 42 and change the other parameters in the formula.

- CAD pad width in mils (CPW)
- Pin length decrease (PLD)
- Heel length (HL)
- Displayed pin length in the image window (PLIW)

As shown in Table 1 below, 22.0 mils is correct and the others are wrong based on diagnostic measurements.

Table 1. CAD pad widths

PL threshold	CPW	PLD	HL	PLIW
42	25	2.00	0.40	22.00 mils
42	22	2.00	0.40	24.40 mils
42	25	1.00	0.40	32.00 mils
42	25	2.00	0.25	29.50 mils

Pin Length in the Image Window

The pin length in the image window is what we see displayed in the image window, when we run diagnostics in algorithm tuner. There are three likely contributors for any modifications that occur to the pin length in the image window, one for each of the parameters in the algorithm tuner's pin length threshold. Remember, the algorithm tuner threshold setting is being held at a constant value for pin length as we have already used diagnostics to set the value correctly.

1. Calculation is based on algorithm tuner machine defaults.

1. Component CAD data

This tends to be a subtle problem that is not immediately obvious and can occur in one of three ways:

    a. You modified your CAD data after you finished setting your thresholds. As you will see from the NST pyramid in Figure 1, if you modify your CAD data, it will impact multiple levels. Always make sure that you have good CAD data before going on to the thresholds.

    b. You utilized the threshold settings out of the component library, without pulling the CAD data as well (that would include overwriting the CAD data after pulling it from the library). Mismatched CAD data to threshold settings will cause problems, resulting in an increased setup time (you lose the time savings that the component library is supposed to give you).

    c. The component land pattern has changing pad dimensions. As you can see in Figure 2, width 1 is not equal to width 2, and so the pin length calculation will be different as a result for each of the pins. Pads of differing sizes should be put into separate subtypes, because this will affect false call and escape rates.
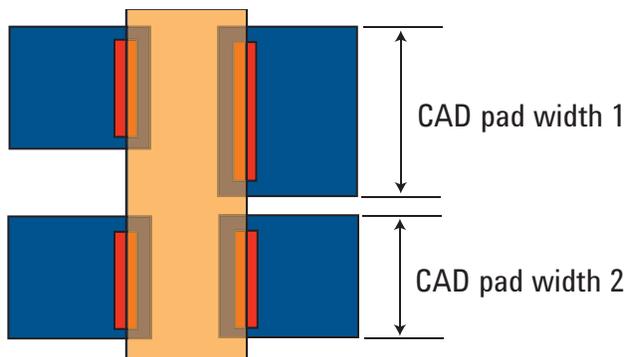
CAD pad width 1 ≠ CAD pad width 2

Figure 2. CAD pad widths

2. Application developer

Although it is not usually adjusted, if the "pin length decrease" threshold setting has been modified, then you can expect your pin length to be modified as well (it may also have been done by some in-house software or script).

3. Subtype learning, if used

Never use subtype learning for FPGullwing – SPC, not even for guessing the pin length. A better option is to use the update feature in review measurements, which is available when you have created a summary data sheet or using diagnostics as previously discussed. Subtype learning modifies the following threshold settings:

- Nominal fillet thickness
- Nominal heel thickness
- Nominal center thickness
- Nominal toe thickness
- Heel length
- Heel search distance
- Pin length (only if set to 0.0 before running subtype learning)

Summary and Recommendations

- Follow the NST pyramid.
- Do not use subtype learning for FPGullwing – SPC.
- Keep CAD data and thresholds together as a single unit.
- Once your thresholds are set, avoid changing the CAD data, especially the CAD pad width and pitch values.

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