



The Secret Technique of Marking Your Fingers

The attached stickers permit you to eliminate your fingers as a variable in your board quality. If you are reading us via e-mail, feel free to contact us for a set of finger marking stickers free of charge. This simple technique can be implemented on each of your wave machines right now. It is the critical partner to the measurement and control of your board-to-wave parallelism. Implementation of these procedures will immediately and significantly lower your operating costs.

Bent, crooked, loose, broken and dirty fingers are an epidemic. Use these stickers to stamp out this plague.

Finger variations are THE leading cause of board-to-wave disparallelism. Disparallelism is a major factor in many defects, including bridging, skipping, insufficient solder fill, solder balls and icicles. It is THE major culprit in inconsistent board quality during a single shift, even more common than defects caused by actual solder wave problems. Remember, boards that sit on a problematic finger may no longer be parallel to your solder wave. It only takes one bent finger to lift every board that runs on it.

Measuring and controlling your finger consistency allows you to easily eliminate your fingers as a cause of disparallelism. Attacking parallelism issues identified by your Wave Solder Optimizer becomes easy, because you know which set of fingers to focus on. Once you have corrected such variations, you will be able to quickly identify the real source of any remaining or future parallelism problems, such as those caused by your rail, solder pot, nozzle, etc. For a discussion of the causes of disparallelism (other than finger variations), go to <http://www.WaveSoldering.com/wso/parallelism.htm>

In fact, the most persistent, difficult, defect-causing finger variations are imperceptible to the naked eye. This includes variations of 12, 24 or even 36 mil. These significant variations will appear insignificant to the naked eye, even if your eyes have their clothes on (gotcha!).

It is critical that you mark your fingers for the entire length of your conveyor. Since you run your boards on all of your fingers, you must mark them in their entirety, on all of your wave machines. It is useless to mark only one set of fingers and run your Optimizer only on that one set. That would mean that day after day you are taking measurements from only one set of fingers while at the same time running your boards on all of your fingers. To verify the integrity of your fingers, your Optimizer must over time acquire data from ALL of your finger sets. The accompanying Finger Set Tracking chart lets you easily achieve this.

The elimination of bent, crooked, loose, broken and dirty fingers as a factor in your boards' parallelism to the wave allows you to move on to high impact, daily wave solder process control. This includes the following fundamental sequence for world class wave solder quality: (1) Establishment of Parallelism; (2) Control of Immersion Depth; (3) Optimization of Dwell Time by Board Type; (4) All in conjunction with your Optimizer's daily verification of your temperatures and fluxer performance.

Procedure to Eliminate Finger Variations as a Cause of Defects

Step 1 Mark Your Fingers in Numbered Groups

- a. If your Optimizer includes the Flux Distribution Window upgrade, apply the stickers in sequence to a finger approximately every 16 inches.
- b. If your Optimizer doesn't have this capability, then apply the stickers in sequence to a finger approximately every 13 inches.
- c. The stickers should be applied to the TOP ledge of the finger (not the side of the finger) to prevent contact with flux and solder. Number your fingers in sets of 16 (or 13) inches over the entire length of your conveyor.
- d. To ensure that the sticker adheres properly to the finger you will put it on, you must clean off any residue or dirt that may be on the top surface of the finger!
- e. Now it's time to run your Optimizer.

Step 2 Running Your Optimizer

- a. Run your Optimizer through your wave machine as usual.
- b. Document which finger set # your Optimizer ran on.
- c. Record your parallelism reading.

Step 3 When You have a Parallel Reading

- a. If your parallelism reading is between 0.2 seconds and -0.2 seconds... Congratulations, you're within the conventional upper and lower limits!
- b. When you run your Optimizer on the same wave machine again - later in the same shift or on the next shift - follow the same procedure as (a) through (c) in Step 2, except run the Optimizer on a different finger set #.
- c. Continue to carefully document the finger set #'s on which you run your Optimizer. (It will be simpler for you to do this in numerical order.)
- d. By recording your parallelism readings and the finger set #'s used each time you run your Optimizer, you successfully document that your boards are being run parallel to your wave AND that your fingers are intact.
- e. This is a unique form of continual finger maintenance. It pays off big, saving you money, downtime, troubleshooting and aggravation when you do have a disparallel reading.

Step 4 When You Have a Disparallel Reading

- a. If your parallelism reading is 0.3 seconds or more or -0.3 seconds or less... Congratulations, you have identified an important disparallelism!
- b. Now, follow the procedures reflected in the scenarios below.
- c. We have presented several scenarios to illustrate how you can respond to different sets of data.

Scenario 1

In this scenario Marla, one of your operators, runs your Optimizer at the beginning of the shift on finger set #1. Your Optimizer shows a disparallelism, in this example, of 0.5 seconds.

She wants to compare that reading to parallelism readings from three other sets of fingers. She runs your Optimizer three more times, on three other finger sets (in this example, finger set #'s 2, 3 and 4).

Here are Marla's results, recorded by her on the accompanying Finger Set Tracking and Parallelism Chart.

Finger Set Tracking and Parallelism - Wave Solder Optimizer									
Finger Set #	Date	Time	User Name	Optimizer Controller Serial #	Optimizer Carrier Board Serial #	Wave Machine Description	Parallelsim Reading	Parallel? Y / N	Action Taken
1	7/10/2001	7:21 AM	Marla	2734	2734A	Line 2	0.5	N	
2	7/10/2001	7:26 AM	Marla	2734	2734A	Line 2	0.1	Y	
3	7/10/2001	7:32 AM	Marla	2734	2734A	Line 2	0.2	Y	
4	7/10/2001	7:37 AM	Marla	2734	2734A	Line 2	0.1	Y	

Scenario 1 Diagnosis:

In this scenario, Marla's readings from finger set #'s 2, 3 and 4 were parallel (between 0.2 seconds and -0.2 seconds). This suggests that her disparallelism reading on finger set #1 was due to a finger variation.

Scenario 1 Corrective Action:

Finger set #1 was scrutinized for bent, loose, crooked, broken or dirty fingers. Remember, difficult, defect-causing finger variations can be almost imperceptible to the naked eye. One finger had solder where the board sits, and another was bent. The problems with these two specific fingers were addressed. Next, at 7:55 AM the Optimizer was run again on finger set #1. The parallelism reading from this run was 0.1 seconds, as reflected below, showing that the corrective action was successful. Marla is now ready to wave solder your boards.

Finger Set Tracking and Parallelism - Wave Solder Optimizer									
Finger Set #	Date	Time	User Name	Optimizer Controller Serial #	Optimizer Carrier Board Serial #	Wave Machine Description	Parallelsim Reading	Parallel? Y / N	Action Taken
1	7/10/2001	7:21 AM	Marla	2734	2734A	Line 2	0.5	N	
2	7/10/2001	7:26 AM	Marla	2734	2734A	Line 2	0.1	Y	
3	7/10/2001	7:32 AM	Marla	2734	2734A	Line 2	0.2	Y	
4	7/10/2001	7:37 AM	Marla	2734	2734A	Line 2	0.1	Y	
1	7/10/2001	7:55 AM	Marla	2734	2734A	Line 2	0.1	Y	cleaned 1 dirty finger, fixed 1 bent finger

Scenario 2

In this scenario another one of your wave machine operators, Samantha, runs your Optimizer at the beginning of the shift on finger set #11. A disparallelism of 0.6 seconds is identified.

She wants to compare that reading to parallelism readings from three other sets of fingers. She runs your Optimizer three more times, on three other finger sets (in this example, finger set #'s 12,13 and 14).

Here are Samantha's results, recorded by her on the Finger Set Tracking and Parallelism Chart.

Finger Set Tracking and Parallelism - Wave Solder Optimizer									
Finger Set #	Date	Time	User Name	Optimizer Controller Serial #	Optimizer Carrier Board Serial #	Wave Machine Description	Parallelsim Reading	Parallel? Y / N	Action Taken
11	6/3/2001	3:05 PM	Samantha	2734	2734A	Line 4	0.6	N	
12	6/3/2001	3:10 PM	Samantha	2734	2734A	Line 4	0.1	Y	
13	6/3/2001	3:14 PM	Samantha	2734	2734A	Line 4	0.2	Y	
14	6/3/2001	3:19 PM	Samantha	2734	2734A	Line 4	0.2	Y	

Scenario 2 Diagnosis:

In this scenario, Samantha's readings from finger set #'s 12,13 and 14 were parallel (between 0.2 seconds and -0.2 seconds). This strongly indicated that your disparallelism reading on finger set #11 was due to a finger variation.

Scenario 2 Corrective Action:

Finger set #11 was scrutinized for bent, loose, crooked, broken or dirty fingers. Remember, difficult, defect-causing finger variations can be almost imperceptible to the naked eye. In this instance, there were no visible finger problems found. Therefore, Samantha performed the finger maintenance procedures per the guidelines set forth by your wave machine manufacturer, on finger set #11 only (It was not necessary to perform a time consuming, expensive, full finger maintenance exercise on all fingers along the length of your wave machine). Next, at 3:51 PM your Optimizer was run again on finger set #11. The parallelism reading from this run was 0.1 seconds, showing that your corrective action was successful. Samantha is now ready to wave solder your boards.

Finger Set Tracking and Parallelism - Wave Solder Optimizer									
Finger Set #	Date	Time	User Name	Optimizer Controller Serial #	Optimizer Carrier Board Serial #	Wave Machine Description	Parallelsim Reading	Parallel? Y / N	Action Taken
11	6/3/2001	3:05 PM	Samantha	2734	2734A	Line 4	0.6	N	
12	6/3/2001	3:10 PM	Samantha	2734	2734A	Line 4	0.1	Y	
13	6/3/2001	3:14 PM	Samantha	2734	2734A	Line 4	0.2	Y	
14	6/3/2001	3:19 PM	Samantha	2734	2734A	Line 4	0.2	Y	
11	6/3/2001	3:51 PM	Samantha	2734	2734A	Line 4	0.1	Y	finger maintenance procedure on finger set #11 only

Scenario 3

In this scenario David, your newest operator, runs your Optimizer at the beginning of the shift on finger set #21. Your Optimizer shows a disparallelism, in this example, of 0.7 seconds.

He wants to compare that reading to parallelism readings from three other sets of fingers. He runs your Optimizer three more times, on three other finger sets (in this example, finger set #'s 22, 23 and 24).

Here are David's results, recorded by him on the Finger Set Tracking and Parallelism Chart.

Finger Set Tracking and Parallelism - Wave Solder Optimizer									
Finger Set #	Date	Time	User Name	Optimizer Controller Serial #	Optimizer Carrier Board Serial #	Wave Machine Description	Parallelsim Reading	Parallel? Y / N	Action Taken
21	6/7/2001	8:04 PM	David	2734	2734A	Line 5	0.7	N	
22	6/7/2001	8:10 PM	David	2734	2734A	Line 5	0.6	N	
23	6/7/2001	8:15 PM	David	2734	2734A	Line 5	0.8	N	
24	6/7/2001	8:21 PM	David	2734	2734A	Line 5	0.7	N	

Scenario 3 Diagnosis:

In this scenario, your readings from finger set #'s 22, 23, and 24 were consistently disparallel at around 0.7 seconds. This strongly indicated that your disparallelism reading on finger set #21 was not due to a finger variation, but an actual machine problem.

Scenario 3 Corrective Action:

A carpenter's level was used to check your rails and your solder pot. This showed that your solder pot was not level. It was then adjusted accordingly. Next, at 8:53 AM David ran your Optimizer again on finger set #21 to confirm that your solder pot was the only cause of your disparallelism. The parallelism reading from this run was 0.0 seconds, showing that your corrective action was successful. For additional verification, David ran the Optimizer on finger set #24. As you can see below, this produced a parallel reading of 0.1 seconds. David is now ready to wave solder your boards.

Finger Set Tracking and Parallelism - Wave Solder Optimizer									
Finger Set #	Date	Time	User Name	Optimizer Controller Serial #	Optimizer Carrier Board Serial #	Wave Machine Description	Parallelsim Reading	Parallel? Y / N	Action Taken
21	6/7/2001	8:04 PM	David	2734	2734A	Line 5	0.7	N	
22	6/7/2001	8:10 PM	David	2734	2734A	Line 5	0.6	N	
23	6/7/2001	8:15 PM	David	2734	2734A	Line 5	0.8	N	
24	6/7/2001	8:21 PM	David	2734	2734A	Line 5	0.7	N	
21	6/7/2001	8:53 PM	David	2734	2734A	Line 5	0.0	Y	solder pot crooked - leveled to wave
24	6/7/2001	8:57 PM	David	2734	2734A	Line 5	0.1	Y	

Revolutionary

These scenarios illustrate a monumental achievement in wave solder process control and the opportunity to permanently lower your operating costs. You now know “The Secret Technique of Marking Your Fingers.” It should immediately and forever change the way you approach wave soldering every day. Remember, every board that is run on a set of problem fingers is more likely to have quality variations. You can now easily solve this problem by eliminating your fingers as a variable in your board quality.

Disparallelism Checklist

- ✓ Am I measuring parallelism every shift on each of my wave machines?
- ✓ Am I measuring my wave for parallelism across its full width?
- ✓ Do my boards see a dwell time on their left hand side that is within 0.2 seconds of the dwell time on their right hand side?
- ✓ Does my wave machine have any fingers that are loose, crooked, bent (even slightly), dirty or broken?
- ✓ Are my rails level to my solder pot?
- ✓ Is my solder pot level to the ground?
- ✓ Is my nozzle bent or crooked?
- ✓ Is dross clogging my nozzle?
- ✓ If I run my boards on pallets, can I obtain data to show that my pallets are, or are not, warped?
- ✓ Is my backplate uneven, causing my wave to collapse more quickly on one side?

Sample Solder Wave Adjustments For Defect Elimination

Problem: Skipping on the left side of printed circuit board and/or bridging on the right side.

Solution: Address disparallelism.

Problem: Bridging.

Solution: Decrease dwell time by increasing conveyor speed. If problem persists, decrease immersion depth.

Problem: Skipping.

Solution: Increase dwell time by reducing conveyor speed. If problem persists, increase immersion depth. If problem continues, verify fluxer performance.

To order more of the special, numbered stickers for marking the fingers of your wave machines, call Technology Information Corporation at 1-240-631-6746.



Parallelism Checklist

- ✓ Am I measuring parallelism every shift on each of my wave machines?
- ✓ For my most common board type, am I able to measure parallelism without moving my rails?
- ✓ Am I measuring my wave for parallelism across the width of my widest boards?
- ✓ Have I implemented 'The Secret Technique of Marking Your Fingers' to continuously measure the impact of finger variations on my parallelism data? Parallelism readings that are taken in the context of this technique are meaningful and helpful; parallelism readings taken outside of this framework are not reliable.
- ✓ Do my boards see a dwell time on their left hand side that is within 0.2 seconds of the dwell time on their right hand side? Go to www.WaveSoldering.com/WSO/Parallelism.htm.
- ✓ Does my wave machine have any fingers that are loose, crooked, bent (even slightly), dirty or broken?
- ✓ Are my rails level to my solder pot?
- ✓ Is my solder pot level to the ground?
- ✓ Is my nozzle bent or crooked?
- ✓ Is dross clogging my nozzle?
- ✓ If I run my boards on pallets, have I obtained data to verify that my pallets are not warped.
- ✓ Is my backplate uneven, causing my wave to collapse more quickly on one side?
- ✓ Is my solder nozzle firmly connected to my solder housing, so that solder is not leaking back into my solder pot thereby causing my solder wave to flow unevenly?