

Automating Preconditioning and Package Qualification Reflow Cycles

Introduction

This paper demonstrates automation of thermal reflow simulation process on Surface Mount Devices (SMDs) per IPC/JEDEC J-STD-020E and JESD22-A113G standards. Package suppliers subject their products to these tests for classification and preconditioning purposes. This standard requires SMDs to be reflowed three (3) times and then evaluated for quality compliance. Each of the three reflow cycles must be nearly identical to one another in order to maintain the profile tolerances specified in the standard. By automating the three cycles within a reflow simulator, consistency is attainable, chance of operator errors that may invalidate the test are eliminated, and efficiency greatly improved.

Set Up

A total of 80 QFN-64 SMDs were placed on 2 carriers (see Figure 1) in a live-bug orientation. The carriers were then placed onto the simulators loading tray with 30 AWG K-type thermocouples (2) attached to the surface of sample SMD's. Thermocouples will provide feedback of actual part temperatures throughout each of the 3 reflow cycles. When processing these QFN-64 parts, attaching thermocouples is not required since an established profile is already stored in the software. However, if feedback data of part temperatures is desired, thermocouples should be installed.



Figure 1: SMDs positioned on carriers inside the reflow simulator

Process

Once the SMD's have been placed inside the reflow simulator, an operator selects a preset profile within the software screen and clicks "Start" to begin reflow. Loading tray automatically moves inside the heating chamber and heating is initiated. From this point on, [PRO 1600 RS](#) would automatically cycle the parts 3 times without operator intervention. Data from each cycle is recorded into a raw data file as well as a graph on the software screen. Figure 2 below represents the oven's software generated graph of all 3 reflow cycles.



Figure 2: Software's Screenshot After Completion of 3 Solder Reflow Cycles

Screenshots of each of the 3 individual reflow cycles are outlined below. Referring to Figures 3-5: Reflow Cycle 1-3, red line (Int. TC) on the graph represents air temperature inside an oven while blue (Ext. TC1) and green (Ext. TC2) lines that are graphed close together represent the part temperatures. Graph's Y-axis represents temperature in Celsius and X-axis represents time in seconds.



Figure 3: Reflow Cycle 1

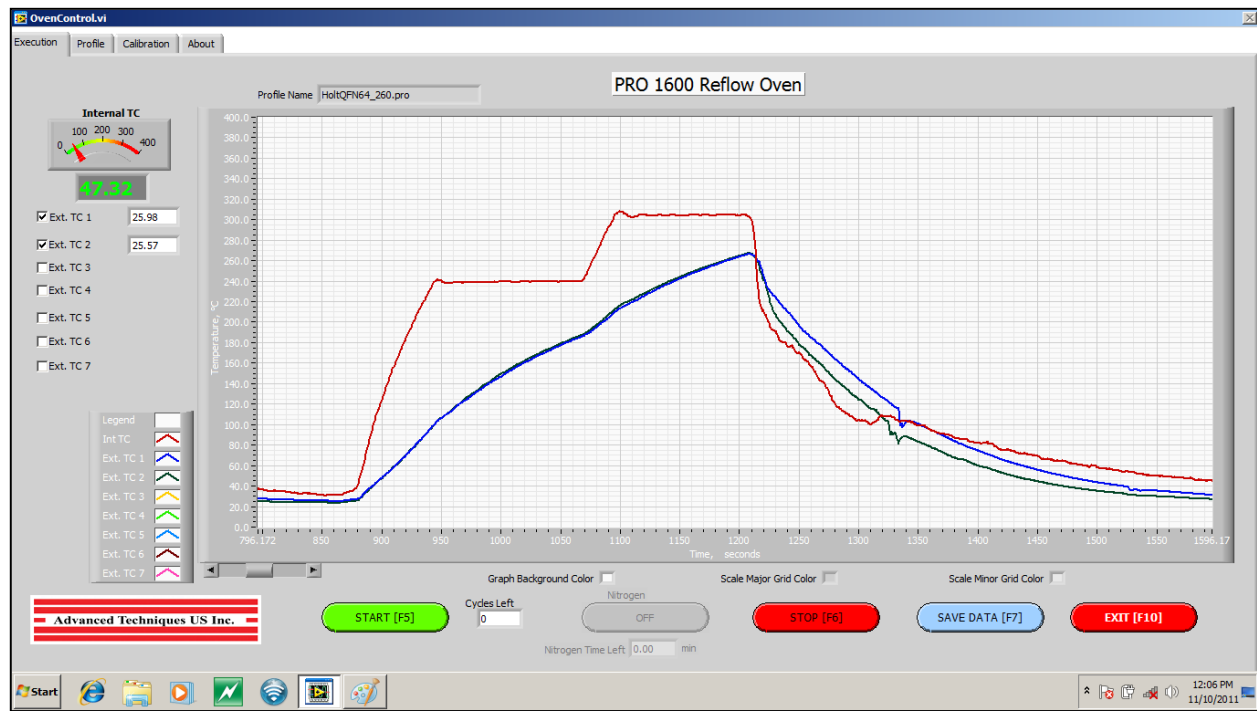


Figure 4: Reflow Cycle 2



Figure 5: Reflow Cycle 3

Results

Raw data from the 3 reflow cycles is saved in a single file for documentation and analysis. Results of the data show that the SMDs were subjected to reflows that met all specifications in Table 5-2 (Classification Reflow Profiles) of IPC/JEDEC J-STD-020E for supplier testing of Pb-Free assembly. Target parameters were achieved throughout the 3 reflow cycles and are consistent. Tables 1 – 7 below, compare the desired parameters listed in Table 5-2 for supplier per Pb-Free Assembly of IPC/JEDEC J-STD-020E vs. the data measured on each SMD (TC 1-2).

Table 1: Preheat / Soak between 150C – 200C for 60 – 120 seconds

	TC 1	TC 2
Reflow Cycle 1	83 seconds	85 seconds
Reflow Cycle 2	81 seconds	83 seconds
Reflow Cycle 3	81 seconds	83 seconds

Table 2: Ramp up rate (Tl to Tp): 3 deg. C/second maximum

	TC 1	TC 2
Reflow Cycle 1	0.55 deg. C/ second	0.54 deg. C/ second
Reflow Cycle 2	0.54 deg. C/ second	0.53 deg. C/ second
Reflow Cycle 3	0.54 deg. C/ second	0.53 deg. C/ second

Table 3: Time above liquidous temperature (Tl:) above 217 Celsius for 60-150 seconds

	TC 1	TC 2
Reflow Cycle 1	125 seconds	122 seconds
Reflow Cycle 2	126 seconds	122 seconds
Reflow Cycle 3	126 seconds	123 seconds

Table 4: Peak Package body temperature (Tp): For suppliers greater than or equal to 260 Celsius

	TC 1	TC 2
Reflow Cycle 1	265 Celsius	266 Celsius
Reflow Cycle 2	266 Celsius	267 Celsius
Reflow Cycle 3	266 Celsius	267 Celsius

Table 5: Time within 5 deg. Celsius of peak classification temperature: at least 30 seconds

	TC 1	TC 2
Reflow Cycle 1	38 seconds	39 seconds
Reflow Cycle 2	39 seconds	41 seconds
Reflow Cycle 3	40 seconds	42 seconds

Table 6: Ramp down rate: 6 deg. C/second maximum

	TC 1	TC 2
Reflow Cycle 1	-2.5 deg. C/ second	-3.2 deg. C/ second
Reflow Cycle 2	-2.6 deg. C/ second	-3.4 deg. C/ second
Reflow Cycle 3	-2.5 deg. C/ second	-3.4 deg. C/ second

Table 7: Time from 25 Celsius to peak temperature: 8 minutes maximum

	TC 1	TC 2
Reflow Cycle 1	~ 5 ½ minutes	~ 5 ½ minutes
Reflow Cycle 2	~ 5 ½ minutes	~ 5 ½ minutes
Reflow Cycle 3	~ 5 ½ minutes	~ 5 ½ minutes

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Conclusion

Above data demonstrates repeatability of each reflow cycle to be within the standard's profile tolerances. Profile parameters may be adjusted to change results of the target values in above data. Substantial variation in package dimensions and lot size may affect results of a profile. Therefore, individual profiles should be developed depending on the packages processed and their approximate lot size. [PRO 1600 Reflow Simulators'](#) automated profile repeat function eliminates operator involvement during the 3 reflow cycles. This ensures consistency, prevents operator error that may jeopardize validity of the test, and provides documentation / raw data in a single file for all 3 reflows.

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