KIC® Process Window Index™

What is Your PWI?

A Method for Quantifying Thermal Profile Performance

The Process

Defining, measuring and improving the thermal process is as important to the overall quality and performance of the manufacturing cycle as any other process. There are statistically valid methods for quantifying most manufacturing processes, such as pick and place and screen printer performance. There is no widely accepted method for measuring, analyzing and comparing the performance of thermal profiles, and thus, no quantifiable system of ranking thermal process performance.

The Process Window

Thermal profile specifications are ranges consisting of minimum or maximum values, and most commonly, both. Such ranges typically exist for every single part or component of the product that sees the thermal process as part of the assembly. Additionally, these ranges apply to numerous statistics such as soak time, slope, peak temperature and a variety of others. All of these elements combined as a matrix create a window in which the process must remain or the product will be compromised. Measuring and comparing the thermal profile to its process window is a subjective judgement with no real uniformity or statistically reproducible results; from one

engineer or operator to the next; from one product to the next... Until now!

The Process Window Index™

The Process Window Index (PWI™) is a quantifiable, reproducible, statistical measure of how well a profile performs relative to critical process limits. Every thermal profile is ranked on the basis of how it "fits" within the process window. The center of the process window is defined as zero, and the extreme edge of the process window as 99%. A PWI of 100% or more indicates that the profile will not process product within specification. A PWI of 99% indicates that the profile will process product within spec, but it is running at the very edge of the process window. A PWI of 70% indicates a profile is using 70% of the process spec.

The PWI tells you exactly how much of your process window a given profile uses, and thus how robust that profile is. The lower the PWI, the better the profile. The thermal process can now be reliably measured, analyzed, compared and tracked with the same level of SPC and Quality Control available to other manufacturing processes.
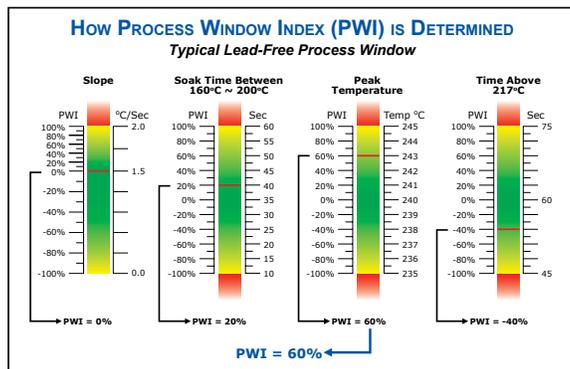

KIC® Innovation That Works™

CALCULATING THE PWI ™

PWI = 60%

PEAK

100%+
80%
60%
40%
20%

TAL

SOAK

SLOPE

TC #1
TC #2
TC #3

The Process Window Index for a complete set of profile statistics is calculated as the worst case (highest number) in the set of statistics. For example: if you run a profile with three thermocouples, and four profile statistics are logged for each thermocouple, then there will be a set of twelve statistics for that profile. The PWI will be the worst case (highest number expressed as a percentage) in that set of profile statistics.

HOW PROCESS WINDOW INDEX (PWI) IS DETERMINED
Typical Lead-Free Process Window

Slope		Soak Time Between 160°C ~ 200°C		Peak Temperature		Time Above 217°C	
PWI	°C/Sec	PWI	Sec	PWI	Temp °C	PWI	Sec
100%	2.0	100%	60	100%	245	100%	75
80%		80%	55	80%	244	80%	
60%		60%	50	60%	243	60%	
40%	1.5	40%	45	40%	242	40%	
20%		20%	40	20%	241	20%	
0%		0%	35	0%	240	0%	60
-20%		-20%	30	-20%	239	-20%	
-40%		-40%	25	-40%	238	-40%	
-60%		-60%	20	-60%	237	-60%	
-80%		-80%	15	-80%	236	-80%	
-100%	0.0	-100%	10	-100%	235	-100%	45

PWI = 0%   PWI = 20%   PWI = 60%   PWI = -40%

PWI = 60%

The Process Window Index is calculated using a formula that includes all statistics for all thermocouples. The formula for the PWI is calculated as follows:

$i=1$ to N (number of thermocouples)

$j=1$ to M (number of statistics per thermocouple)

$measured\_value_{[i,j]}$ = the $[i,j]^{th}$ statistic's value

$average\_limits_{[i,j]}$ = the average of the $[i,j]^{th}$ statistic's high and low limits

$range_{[i,j]}$ = the $[i,j]^{th}$ statistic's high limit minus the low limit

$$\textbf{PWI} = 100 \times \underset{N,M}{\overset{i,j=1}{\text{MAX}}} \left\{ \left| \frac{(measured\_value_{[i,j]} - average\_limits_{[i,j]})}{(range_{[i,j]} \div 2)} \right| \right\}$$

Thus, the PWI is the worst case profile statistic (Maximum, or highest percentage of the process window used), and all other values are less.

RISK-FREE GUARANTEE

All KIC products are designed to give maximum value and fast payback by streamlining your thermal process. Investment in a KIC product is a step toward total process control and quality management. All KIC products come with a no questions asked, 30-day money back guarantee.

BENEFITS OF RANKING WITH PWI

The simplicity of the Process Window Index makes its validity as a statistical tool readily apparent. Issues such as Lead-Free compliance mean that you can no longer be complacent about your thermal process. Adoption of the PWI as an industry standard clearly offers significant advantages:

Greatly simplifies the profiling process. All profile statistics are reduced to a single number—the PWI—that even the most inexperienced operator can understand. In just a few minutes even an inexperienced operator can set up an oven with the optimal profile—a job that formerly could take hours even for experienced engineers.

Confidence in thermal process capability. You can be confident you are using the best profile your process can achieve because the PWI reflects the performance of the entire profile, not just a single statistic. The PWI demystifies the thermal process and open the door to long-overdue precision control.

Profiles can be easily compared. You can quickly make comparisons between individual lines on the shop floor, between processes at multiple plants, and between processes using dissimilar equipment. Before the PWI, comparing profiles was subjective and you could not be certain you had the best profile for your product.

Improved Quality Control. The PWI is an ideal tool for use with SPC and other QC monitoring programs, providing you with an excellent opportunity for process improvement. This enables you to take a significant step toward Zero-Defect Production.

Significant production savings. You can quickly realize cost reduction in all of these areas: staff training; defects caused by operator error; production monitoring and data collection; process troubleshooting; and equipment selection evaluation and buy off.

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