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Control Chart Methodology Change for Certain Variable Characteristics in ATP

by

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ABSTRACT

Processes change over time. One of the key tools used by manufacturing industries to detect when a stable process departs from stability is the method of Statistical Process Control (SPC). Control chart is the most widely used tool to monitor process stability across time. When used and practiced correctly, it provides a clear picture of the process performance that will help the process owner to react accordingly to the variation being communicated by the control charts. Hence, control chart choice is an important part for SPC practitioner industries. The change of control chart methodology for certain characteristics in ATP from Xbar-R to Zbar-w is an alignment to the Company's Statistical Process Control specification requirement following continuous control method effectiveness review. In addition, it is an adaptation of Amkor World Wide Best-Known Method for control chart methodologies.

This study uses past three months data and the current process performance.

I. Introduction

Amkor - the world's industry leader in tailoring application-specific package design, assembly and test solutions - is always finding new concepts, complex designs, innovative product lines, superb systems and practical solutions to its operations helping the Company grow further by maximizing profitability and cost effectiveness but maintaining its hard-earned quality reputation, core values and the satisfaction of its Clients.

Popularity and usage-wise, Xbar-R and Xbar-s charts top the most commonly used control charts by the semiconductor industry. Amkor, as a subcontractor company, uses Xbar-R charts on almost all of its SPC-monitored characteristics. For 30 years in business, this has not raised concern to any of its Clients. Thus shifting to a "not-so-popular" control chart posed a challenge to ATP.

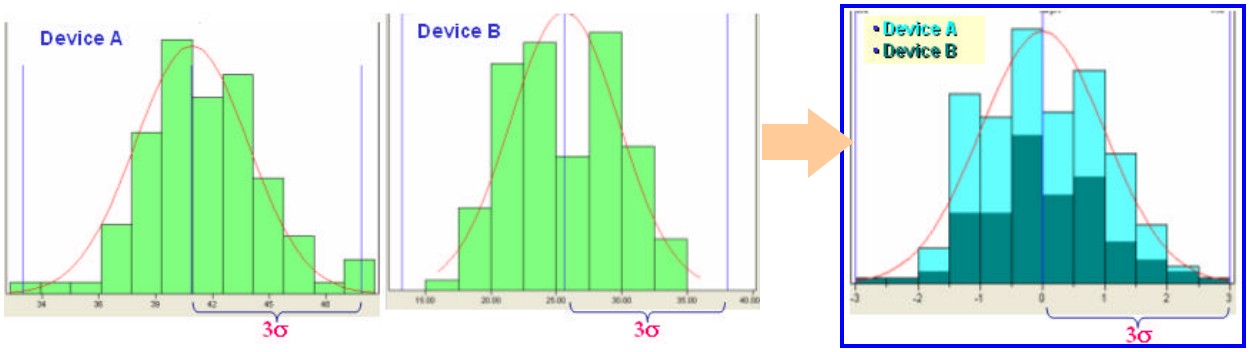
With the Company's global manufacturing footprint, Amkor is placed in a position wherein Clients continuously raise their bars higher with expectations of standard systems across different sites and factories. So - on the launching of "One Company-One Image Program" with the intent of the adaptation of Amkor Worldwide (AWW) Best-Known Methods

- the transition of certain characteristics to Zbar-w Methodology which has long been practiced in Amkor Technology Korea (ATK) is inevitable. This move is further substantiated to address potential over reaction to device-to-device variability that is apparent on some Xbar charts.

This control chart methodology transition is discussed on this paper to ensure that the Company's top bottleneck operation will have a smooth transfer without affecting its products' form, fit and function thereby ensuring the Clients' approval and continued patronage.7

II. The Zbar-w Concept and Interpretation

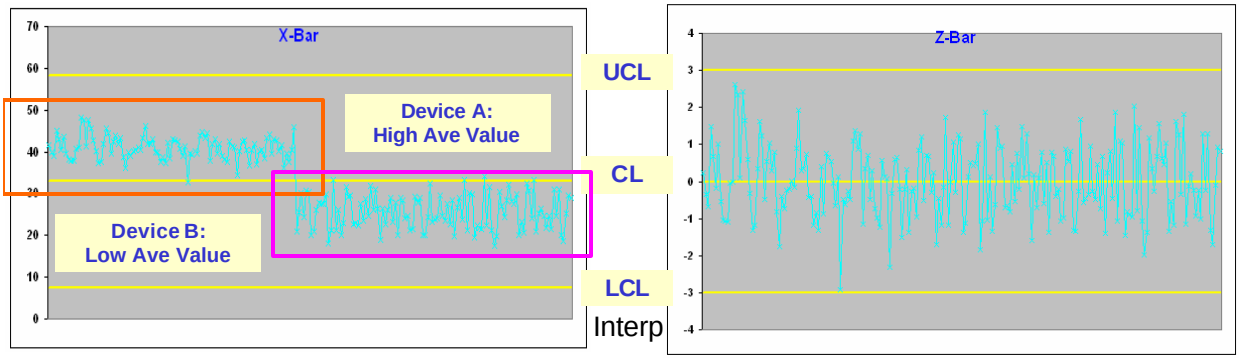
Zbar concept is to control data on the same scale by transforming the X Bar values to the Z Bar values. It is developed from Standard Normal Distribution Theory shown on the illustration below:



Zbar-w enables different devices run on one machine to be plotted in one control chart without being excessively sensitive to device-to-device variation. Top variability contributors are addressed via the data stratification and continuous improvement projects such as the Target Value system. For this project, the same template categorization will be applied as follows:

For Ballshear: Per BPO size and applicable Wire Size Range

For Wirepull: Per wire size



Interp

X-bar

How to Calculate

$$\bar{X} = \frac{\Sigma X_i}{n}$$

Where:
X_i : data readings
n: number of data points in the data set

Interpretation

- The arithmetic mean gives the number where most of the data are "centered". However, the average is very sensitive to outliers that it may vary depending on the number and magnitude of outliers present with respect to the rest of the data set.
- An Xbar value of say, 88.75 from a data range of 50 to 100 means majority of the data lies around 88.75
- Statistical process control aims to make the average approach the center of a two-sided spec or as far away from a one-sided spec for the process to be capable

Z-bar

$$\bar{Z} = \frac{\bar{X} - \bar{\bar{X}}}{S_{\bar{X}}}$$

Where:
X Bar : Mean of current sampling data
X Double Bar: Average of X Bar values for past 3 months
S (X Bar) : Standard Deviation of the Xbar values for the past three (3) months

- Zbar defines the normalized value of how far is the current average from the historical average. Standard deviation of the averages is used for normalization.
- The higher the zbar value is, the bigger the average values compared to the historical average and vice versa in terms of standard deviation units

e.g. If Zbar = 2, this means that the current average is 2 std deviation units higher than the historical average

If Z = -1, this means that the current average is 1 std deviation unit lower than the historical average

- A zbar value of zero would infer process consistency as indicated by having the current average at par with the historical average performance

R

How to Calculate

$$R = \max(X_i) - \min(X_i)$$

Where:
Max (X_i): maximum value in the data set
Min (X_i): minimum value in the data set

Interpretation

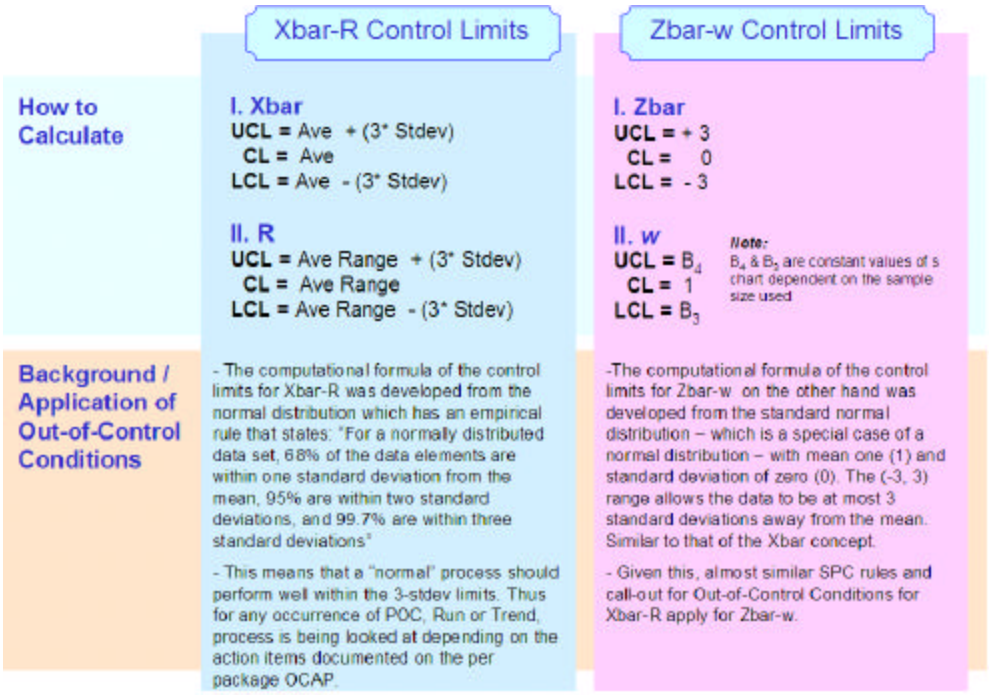
- The range gives the largest spread in the data set as it computes the distance between the maximum and minimum values
- A high R value means there's a wide spread of the data points in the data set
- R is easily influenced by presence of outliers
- To be in statistical process control, the range should be relatively small. This would infer consistency on within-sample variation.

w

$$w = \frac{s}{\bar{s}}$$

Where:
s : Current standard deviation
***s* Bar:** Average of the s value for the past three (3) months

- w value compares the std deviation of the current data set vs the std deviation (henceforth, stdev) of the historical data
- $w < 1$ means that the current stdev is smaller than the historical stdev
- $w = 1$ means that the current stdev is equal to the historical stdev
- $w > 1$ means that the current stdev is bigger than the historical stdev
- Just like the range, a lower w-value is preferred as this would mean that the current stdev has improved (or is lower) vs the historical stdev. Note that a lower stdev means that the spread of the data is small thereby communicating process stability.



Notes:

1. Computation of the past three months data is per characteristic, per criteria, per machine, per device
2. "Specific Device" is a device that garnered at least twenty-five (25) data subgroups for the past three months
3. "General Device" is a device with twenty-four or less subgroups for the past 3 months. Data for all general devices are pooled-in then the past three months statistics are computed.
4. Similar Out-of-Control Condition(OCC) rules apply for Xbar-R and Zbar-w charts will the addition of below
   a) Excluded data point - If the lot being monitored is included in the General Device category and Cpk =/> 2.0, the mark or tag on the SPC chart would be " **E** ". As the name implies, this point will be EXCLUDED in any of the OCC counting
   b) "G" – for data gathering. OCC is not counted for this point.

III. Activities to Ensure Smooth Transition

Below are the activities that each package or area owner must go-through to ensure Smooth transition:

ACTIVITIES	REMARKS
1. Zbar-w Team Identification and Initial Meeting	Champs per package are identified to lead the group transition
2. User Orientation / Zbar-w Walk-through	Project is communicated to the Line personnel its objectives and importance
3. User Acceptance Testing	Hands-on training for familiarization and reporting of concern / system bug, if any. Users' transactions are reported to ensure sytem practice
4. Champs' GO-NO GO Decision	
5. Pre-Implementation Preparation **a) Data Validation** **b) Clients' Requirements Check** **c) Proper documentation**	Position paper per area is generated as justification for the control methodology chang
6. Implementation and Assistance	
7. Data Validation after implementation includes: **a) Yield trend comparison** **b) Quality data look-up (VOP and VOC)** **c) Cpk Data Comparison** **d) Stability Index Comparison**	

IV. Impact on Performance of Key Quality Indicators:

INDICATORS	IMPACT
Quality	Improve (minimized process over-adjustment)
Process Capability	None
Productivity **- OCC Over-reaction** **- Control Chart Template Stratification**	Improve
Cost	None

V. Summary

1. The move to change current Ballshear / Wirepull control method from Xbar-R to Zbar-W is in compliance with Amkor specs
2. The change addresses potential over-reaction or over adjustment due to sensitivity level of current control method (Xbar-R Chart) for Ballshear and Wirepull. This change however will not have adverse impact on quality, process capability and cost.

References

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System – Statistical Process Control (02-0333-0403)

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