

EPCOS Application Note 2020

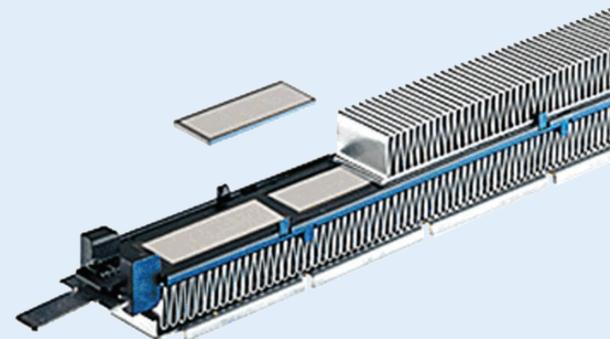
# Smart Sorting for PTC Thermistors

PTC thermistors are ceramic components whose electrical resistance rapidly increases when a certain temperature is exceeded. This feature makes them ideal for use in wide applications of modern electrical and electronic engineering.

The PTC thermistor ceramics is based on mixtures of barium, titanium and other materials. Such composition produces desired electrical and thermal characteristics. These mixtures are mixed, pressed in desired shape and then sintered.

Resistance distribution of PTC thermistors, gained at the sintering process, can rather be Weibull than Gauss, leading to not equal quantity of parts in parallel resistance classes.

TDK's smart sorting solution solves this issue of unequal electrical distribution and helps customer to receive a ready-to-use combination of PTC thermistors and to minimize the leftover stock.

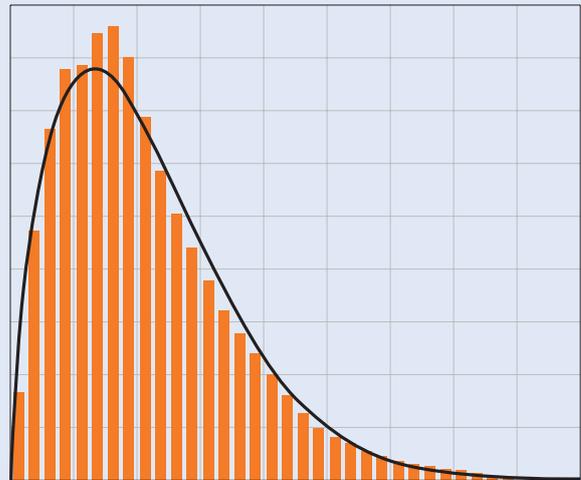
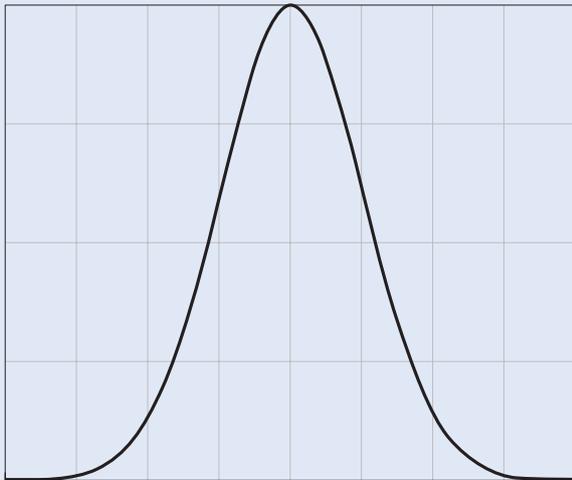


# Smart Sorting for PTC Thermistors

## PTC thermistor resistance distribution

Electrical characteristics of PTC thermistors are formed during the sintering process. TDK has gathered in more than 50 years of PTC thermistor production a deep know-how, which considers the material behavior of the PTC thermistor ceramic powder, the buildup of pressed stones in the sintering kiln and environmental

effects during sintering. All these effects influence the resistance distribution of a PTC thermistor and can change it from a Gauss to a Weibull shape, which leads to an uneven number of PTC thermistor stones in parallel resistance classes.



**Figure 1** Normal Gauss vs. Weibull distribution

Production of a PTC heater register with optimal heating power requires that each PTC register is within specific resistance limits. Therefore, manufacturers use specific combinations of resistance classes of PTC thermistors. TDK's smart sorting is a method where

based on customer inputs ready-to-use combinations of resistance classes are being delivered where the sorting of the PTC thermistors is already done. It supports customers to improve their production effectivity and to minimize customer's leftover stock.

## TDK's smart sorting solution

TDK's smart sorting software is an algorithm that calculates the most optimal combinations of resistance classes. To be able to use TDK's smart sorting solution, TDK and customer define number of resistance classes of the product into which the full range of resistance specification is divided. Then customer specifies the combinations of resistance classes of the PTC thermistor, which can be used in the PTC heater register. For optimal usage of TDK's smart sorting application TDK proposes an uneven number of resistance classes, ideally 5.

Based on this information and the requested number of PTC thermistors in customer's application, TDK's smart sorting solution calculates from given resistance distribution of production lot an optimal number of pre-defined combinations of resistance classes. TDK packs the PTC thermistors into primary packaging units (i.e. sticks), each contains only one resistance class. Based on smart sorting software, TDK then combines primary packaging units into secondary packaging units (i.e. groups of sticks). The resulting secondary packaging unit has pre-defined combination of primary packages which correlates with total number of PTC thermistor parts in customer heater assembly. smart sorting software reduces number of combinations of secondary packaging units to minimum (typically 4 to 6).

# Smart Sorting for PTC Thermistors

## TDK's smart sorting solution



**Figure 2** Example – Optimized quantity of secondary packaging unit containing four primary units (sticks) from pre-defined combinations of 6 resistance classes (A to F)

## Process at customer

Received combined packaging can then be easily used in customer application because every secondary packaging unit has the same number of primary packaging units (i.e. sticks) as the number of PTC thermistors in the heater element. They are furthermore in pre-defined combinations of resistance classes which can be used in the heater. Customer can simply open secondary packaging unit and use in heater assembly every time one PTC thermistor element from every primary packaging.

Smart sorting solution removes complicated combining of resistance classes after delivery, simplifies the logistics and reduces the stock of unused material, because every PTC thermistor can be used in the application. It significantly improves productivity and efficiency of the PTC thermistor assembly process.

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