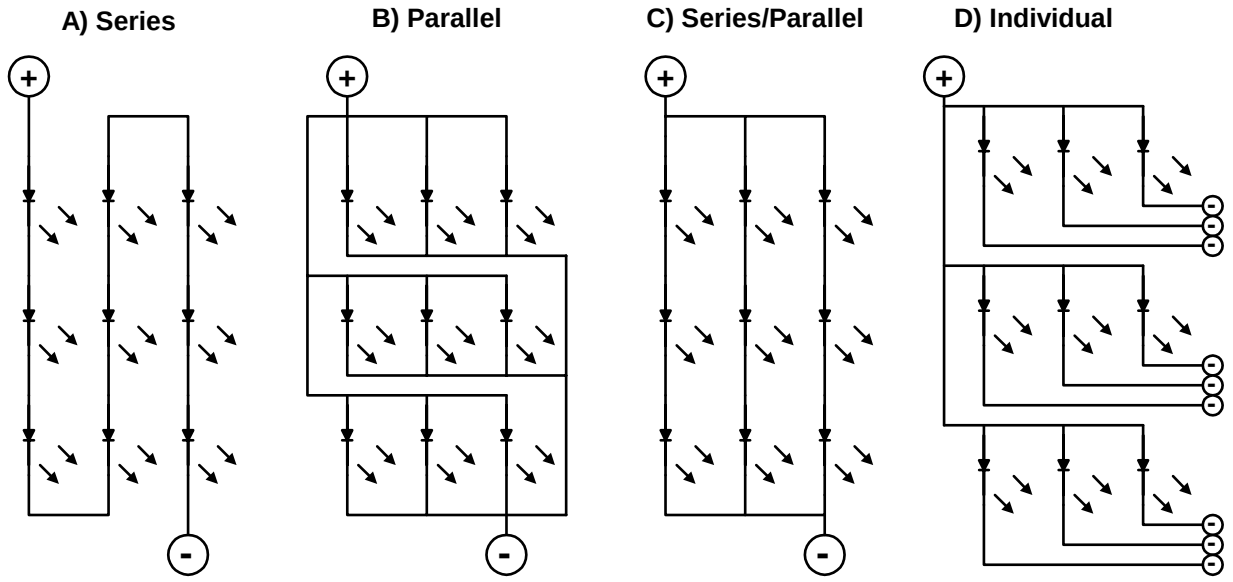
LED Array Thermal Measurement Considerations

A LED Array is defined as two or more individual LED chips mounted in a package or on a substrate in a manner such that any device in array can be powered through either series, parallel or individual connections while the other devices in the array may or may not be operating. The individual LED chips may also consist of an array of LED junctions on the chip as well.

Thermal measurements on an LED array can either be done on the array as a whole or on individual chips within the array, depending on the electrical connections available. Shown below are schematics for different connection alternatives for an example 3X3 array. The Series configuration requires the highest power supply voltage but also requires the lowest current. Conversely, the Parallel configuration requires the highest current but the lowest voltage. The Series/Parallel configuration requires moderate current and voltage and, by modifying the series and parallel arrangement, can be more easily tailored to meet specific application requirements. The Individual configuration, shown here with a common Anode connection, is most often used when the LEDs are dissimilar – i.e., different color, etc. Other Individual configurations include separate contacts for each device, X-Y addressing and common Cathode.



Thermal measurements of any of these array configurations are necessary to insure that each array element is operating in an acceptable junction temperature (T_J) range for that specific element. When the array product is available only in packaged form with only the + and – leads/contacts available, the array can only be measured as a composite LED. The data results will assume equal power distribution and the same value of temperature-sensitive parameter (TSP) variation and the same junction temperature change (ΔT_J) for each LED in the array. These assumptions are only valid if the parametric characteristics of each LED and if the each LED chip attachment to the mounting surface (i.e., the die attachment) are truly the same for al the elements in the array. Given the current state of LED fabrication, the parametric variation is probably in the 5% to 10% range and the die attachment thermal per

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formance variation is probably in the same range. This means that under the best of conditions there could be a ±10% to ±20% T_J variation between the elements of an array. This variation will affect the array's emitted light power and wavelength uniformity.

Thermal measurements on the LEDs in the Series configuration require the direct electrical connection to be made to specific LED of interest. With the measurement of forward voltage across the diode (V_F), it is possible to determine the K Factor (see TB-02) and measure the Heating Voltage (V_H) and the change in voltage due to heating (ΔV_F) to determine ΔT_J and θ_{JX} values for the specific diode. The thermal measurement system can supply the heating and measurement conditions to the series string if it has sufficient voltage compliance. It also must have high voltage measurement capability.

The Parallel configuration can use the same approach but the specific diode of thermal interest must have at least one electrical contact isolated from the others in the array; the isolated diode must be powered by the thermal test system while a separate supply provides power to the remaining diodes in the array.

The Series/Parallel configuration is the most difficult to test. The diode of interest must have at least one electrical contact isolated from the others in the array and the remaining diodes in its series string must be appropriately powered with a diode missing. Further, the other diode strings must be powered separately.

Thermal measurements on the LEDs in the Individual connection array configuration are much easier because there are separated electrical connections to each element. However, powering all the other diodes in the array during the thermal measurement on a specific diode can be difficult depending on the number of connections and power supplies required.