Power Redundancy Technology – Formats and Outlines

Direct View LED Displays (dvLED) are becoming the standard display medium in sensitive or critical markets where continuous functionality and higher reliability is expected. Many parts in the display system are highly reliable however, some components do exhibit a higher failure rate than others.

One component that has a higher failure rate is the power supply. When a power supply fails, the electronic block that was powered by it, stops operating. This can cause an even larger block of the screen to fail as the data path is daisy chained and the outage causes a disruption on this path. Due to this fact, power redundancy is not new in the industry, and it can be implemented into LED display topologies to make sure this weakest link is not the guilt element of a disruption of service.

To have a redundant system you must have a secondary component to compliment whatever component is being backed up. This format is known as N+1 Redundancy. Power supply components (N) have at least one independent backup component (+1). The level of resilience is referred to as active/passive or standby when backup components do not actively participate within the system during normal operation. It is also possible to have N+1 redundancy with active-active components, in such cases the backup component will remain active in the operation even if all other components are fully functional, however the system will be able to perform in the event that one component is faulted and recover from a single component failure.

In this White Paper we will explore the various redundancy formats and outline Nanolumens redundant power solution.

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Onboard vs. Remote Redundancy

In some instances, there is concern that internal heat may promote pre-mature failure of the power supplies in the LED display. There are multiple sources of heat on any LED screen:

- LED Package
- LED Column/Row Drivers
- PCB Traces
- Power Distribution Cables
- Power Supply

Usually, the power supplies operate between 40% to 85% efficiency depending on the quality of the power supply and load. When playing standard video content, the display consumes approximately 30% to 35% of its output, making power supplies operate between 40%-60% efficiency. The wasted power is exercised in the form of heat.

It is true that power supplies do generate heat, and power supplies can fail prematurely due to excess heat. However, if properly planned for through (1) thermal management and (2) quality power supplies, heat related failures become practically non-existent.

1. Thermal Management - For dissipating the conductive heat, good thermal management practices allow the heat to be dissipated in a way that keeps the system performing well without interfering the LED operation.

These practices involve fans for proving forces air flow OR heatsinks to transfer the heat to a larger area and cool with natural air flow. If these practices are well implemented, there is no need to remove the power supplies from the vicinity of the LED modules and can be hosted within the same building block and/or cabinet

Figure 1. shows a typical LED screen cabinet design. It illustrates the sources of heat and its dissipation paths either conductive or radiated. It is very important to have the power supply installed on the back of the cabinet and have an excellent mechanical and thermal mount. Most of its heat will be conductive into the cabinet. If this mount is not efficient, then the heat will be radiated into the cabinet raising internal temperatures.

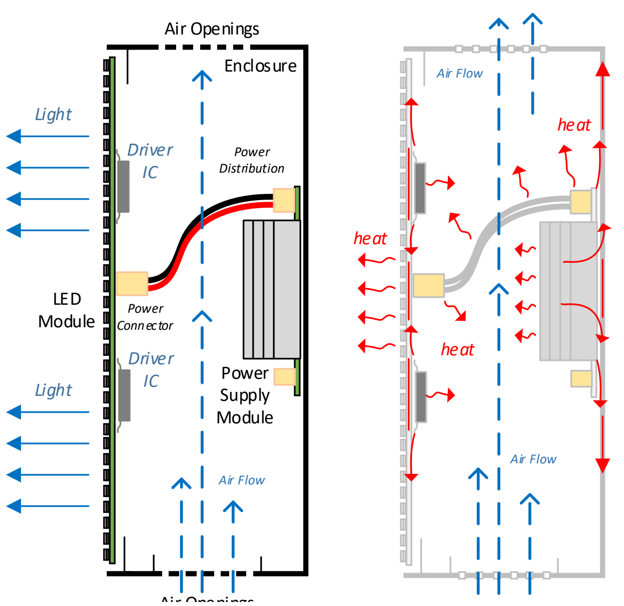

Figure 1. Heat generation and its dissipation paths in a typical cabinet design

Remote power, as illustrated in Figure 2. eliminates the conductive and radiated heat generated by the AC/DC power supply inside the cabinet by moving the power supply away from the LED board, usually in a different structure reducing heat load. For this, a new element to be added, a DC/DC regulator is needed as this topology usually requires a higher voltage due to the long distribution cable. Some vendors eliminate this DC/DC regulators to save money, which is not ideal as the ohmic losses (resistance) in the cable distribution is too high which will deteriorate the LED screen performance.

It is important to have a high quality DC/DC regulator as it also generates heat. Depending on the switching topology the regulator can generate a great amount of heat that it is conductive and radiated to the LED module, thermally stressing it. This topology adds additional cost to the LED screen as a high quality DC/DC converter needs to have an efficiency above 90% otherwise it becomes more inefficient thermally than having the power supply inside the cabinet.

2. Power Supply Quality - Like many electronic components there are varying degrees of quality. A cheaper power supply will run less efficient, generating more heat, and be prone to early failure. In contrast, a high quality power supply will run more efficient, generating less heat, and be more resilient to heat thus reducing the failure rate even further. This is why all Nanolumens power supplies are stringently tested to ensure even high quality power supplies pass strict standards.

When assessing onboard vs. remote power, there are many factors to consider. Most importantly will be what issues are you trying to overcome. High quality power supplies and product design can nearly eliminate premature failure of the power supply component leaving the question to be simply, what architecture do you prefer: a completely encapsulated solution or remote rack mounted components. Of course, rack mounted components are easier to access however they do require more space and additional wire runs. On board power is condensed into one package but in the event of a failure the display would need to be accessed (can remain on).

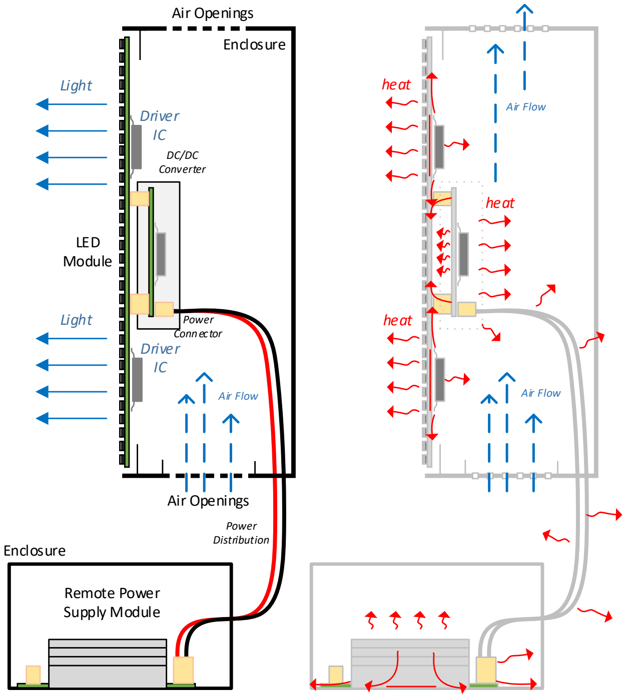

Figure 2. Heat generation and its dissipation paths in a typical cabinet design with Remote Power

Full Redundancy or Power Sharing

Power Sharing

Power sharing is an active/active form of power redundancy. Power Sharing showed in Figure 3, has two power supply units connected in parallel, so both units are sharing the load in a nominal display state. This is not true redundancy, and it has its more disadvantages than advantages.

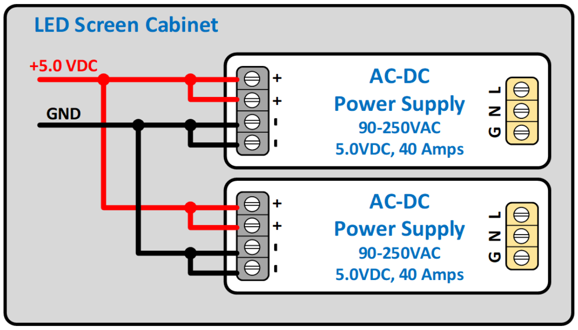

Figure 3. Power Sharing Topology

Advantages

- Seamless failure mode
- Smaller internal foot print

Disadvantages

- Difficult to maintain the same voltage at the output.
- When sharing power, both power supplies are delivering one half of the maximum load. Lower efficiency generates more heat which stresses the internal components of a power supply.
- When the output voltages are different, the lower voltage output power supply becomes an active load, increasing the active power supply power delivery and heat.
- If one power supply fails as a short (low impedance), it makes the other power supply fail as well.
- When a failure occurs, the total voltage drops which results in the dimming of the display.

Full Redundancy

A fully redundant topology has two power supplies where one operates in an active state and the redundant power supply is in standby (standby format). This architecture is controlled by an active system called the Redundancy Controller Block (RCB) which monitors real time conditions of the output of the power supplies and the load, outlined in Figure 4.

By having this RCB and allowing the power supply to provide nominal power to the load, it results in higher efficiency and thus less heat. Most of the power supplies will be inefficient when operating at 25% of its maximum capacity. See Figure 5 for a typical efficiency curve on AC-DC power supply modules.

When the Primary power supply fails (Figure 6), the RCB automatically switches to the secondary power supply allowing the load now to be powered by the secondary power supply while the primary is electrically disconnected from the load.

When the primary power supply condition has been restored, the RCB automatically switches back to the primary as indicated in Figure 7.

Figure 7. Power Redundancy operation during normal conditions.

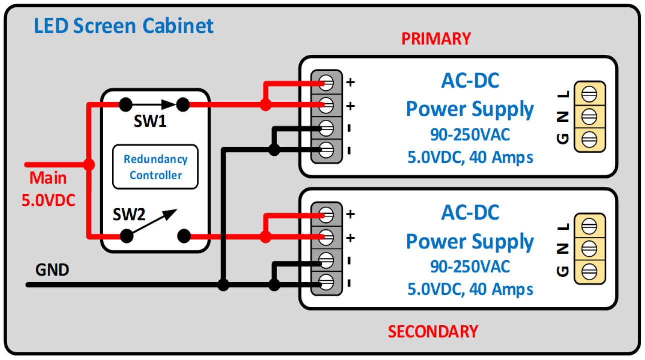

Figure 4. Full Power Redundancy

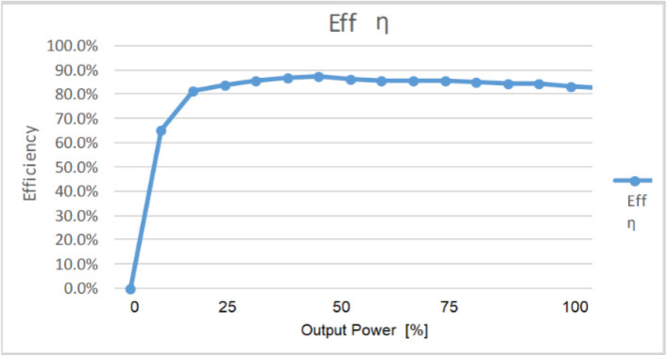

Figure 5. Power supply efficiency vs output power

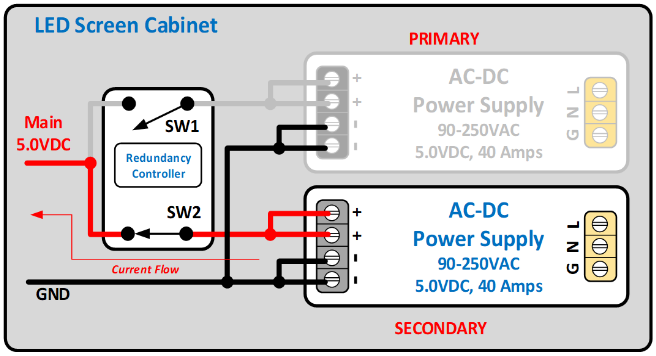

Figure 6. Power Redundancy operation when primary power supply is a fault condition

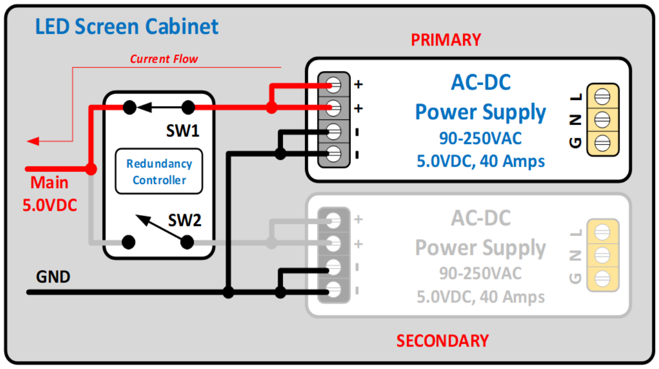

Figure 7. Power Redundancy operation during normal conditions

This topology has more advantages than disadvantages.

Advantages

- Nominal power consumption pro-longing component life.
- If there is a fault condition at the load, the **RCB** disconnects both power supplies until the fault condition is cleared.
- During normal conditions (Figure 7), only the primary power supply is providing power. The secondary power supply is in standby allowing the primary power supply to operate at nominal capacity minimizing heat.
- Back up will operate at nominal power allowing the display to remain at full brightness even after failure.

Disadvantages

- Momentary blip (milliseconds) when failure occurs.

Summary

Having an active Redundancy Controller Block (RCB) in a power supply redundancy topology allows to have true N+1 redundancy as intended and let the power supplies to extend their operation time, reduce excessive heat on the system and most important have a peace of mind that in a fault condition, the LED screen will be full 100% operation. In most cases, this is the redundancy architecture of choice for Nanolumens.

Having remote power is not always more efficient when compared with the internal power supply topology. Many design considerations must be taken including a cost premium to be more efficient. High quality and robust power supplies have dispelled this need over the recent years.

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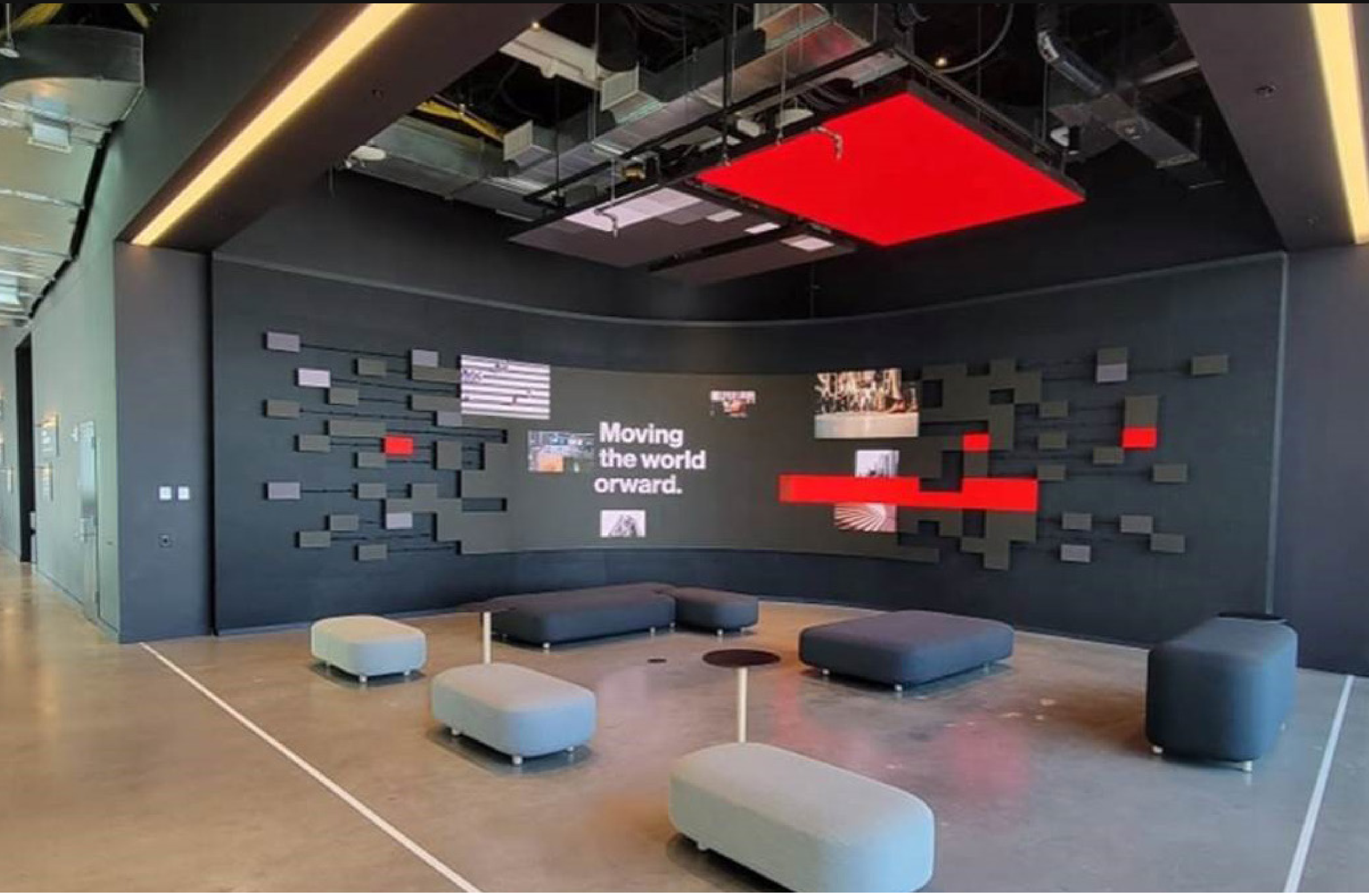

About Nanolumens

Nanolumens is a US-Based LED design and manufacturer headquartered in Atlanta, Georgia. Nanolumens offers world-class displays across multiple market segments adding wonder to physical spaces. Nanolumens is a pioneer of the true curve technology and are committed to being better. With a bold and visionary team of experts Nanolumens will take your project, in all shapes and sizes, from concept to reality. Nanolumens brings your creative visions to life, leaving a first and lasting impression. We are LED! For more information, visit www.nanolumens.com

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