Tech Note

Achieve Power Efficiency in Building Automation Applications with the TPS2116

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A backup battery or supercapacitor is commonly employed in building automation applications to maintain system power and normal device operations during an unexpected power loss event. For example, a smoke detector or video doorbell relies on backup power to preserve home safety and security during a power outage. Additionally, a smart thermostat powers its flash and volatile memory from a backup source to ensure the system settings and data accesses are not wiped when safely shutting down.

A power switching device is used to select between the main voltage supply and a secondary voltage source to provide uninterrupted power to downstream loads when one power supply fails. Typically, power supply selection has been implemented using discrete diodes or MOSFETs. Now, small footprint, high efficiency integrated solutions like the TPS2116 power multiplexer (MUX) are available and contain protection features shown in Table 1-1. This document will discuss these differences and their effect on system reliability and performance

Priority Power MUXing vs. ORing Selection

If no priority is needed, an ORing configuration ensures the highest input voltage source is always selected. Figure 1 illustrates a common ORing configuration using two Schottky diodes.

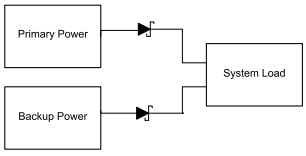

Figure 1. Diode ORing Configuration

In contrast, a power multiplexer (power MUX) is a switching solution that selects between two or more input power supplies based on priority, which is often dictated by a signal from a microprocessor (MPU) or microcontroller (MCU) in building automation applications. A power MUX can be implemented using discrete components such as back-to-back P-channel MOSFETs, as shown in Figure 2.

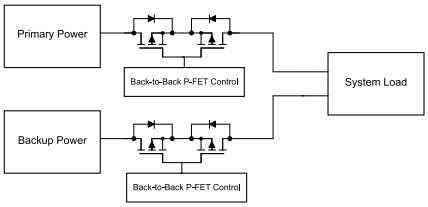

Figure 2. Discrete P-Channel MOSFET Power MUXing Configuration

An integrated power MUX builds on discrete solutions by incorporating protection features and flexible modes of operation. The TPS2116 in Figure 3 is equipped with three switchover modes: automatic priority, manual, and ideal diode. These modes allow the TPS2116 to act as a power MUXing or ORing device depending on which switchover mode is selected.

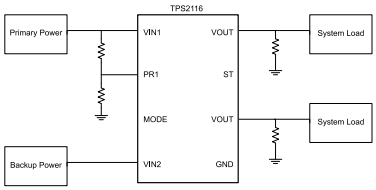

Figure 3. TPS2116 Power MUX

Extend Battery Life with the Low-Power TPS2116

A rechargable battery is often used as either a primary or backup power source in building automation applications. When less power is drawn from a battery, battery stress and degradation are reduced, which means it needs to be recharged or replaced less often. The extended run time improves customer ease-of-use by minimizing the need for frequent battery recharging or replacement. Furthermore, boosting battery life yields increased cost savings, that is especially important for businesses with large-scale, integrated building safety, and security systems.

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Ideally, a power MUXing solution draws no current from the battery when enabled or disabled. However, most solutions will consume some battery power through quiescent (I_Q) and shutdown (I_{SD}) currents. Quiescent current is the current drawn from the battery to enable the device's internal circuitry while shutdown current is the current consumed by the device when in standby mode. The TPS2116 minimizes I_Q to 1 uA and I_{SD} to 100 nA so that running the device does not heavily expend the battery's power budget. The tech note Extend Battery Life Using Load Switches and Ideal Diodes further investigates how integrated power ORing and MUXing solutions contribute to extended battery life.

TPS2116 Additional Features Enhance Power MUX-ing

One key benefit of the TPS2116 is its fast switchover control. Whether the main power supply is a 16-24 V AC transformer or a rechargeable battery pack, implementing a power MUX solution with fast switchover prevents data loss during a transition from one power source to another. Fast switchover time reduces the voltage dip on the output which could trigger a system reset. This is a concern in building automation applications where programmed settings that contribute to smart feature functionality could be erased during a power outage. Unlike discrete power MUX solutions that have relatively slow switchover times due to RC delays that limit inrush current, the TPS2116 uses a controlled linear rise time to limit inrush current and maximize faster switchover time.

Discrete solutions like diodes suffer from forward voltage drops between 0.4 – 0.7 V and reverse leakage current, both of which contribute to high power dissipation and thermal management issues. In contrast, the TPS2116 maintains a constant on-resistance of 40-mΩ across a relatively low input voltage range of 1.6 V – 5.5 V, resulting in a smaller voltage drop across the device. By keeping the voltage drop across the power MUX low, less heat is dissipated. This reduces thermal management concerns for both the device and the end equipment.

Compact end equipments require small internal components. While discrete power MUXing solutions increase BOM count and solution size with additional required components, the TPS2116 features a 3.36 mm^2 solution size to optimize space and cost. Thermal management is also an important aspect of these applications. An instance where maintaining high reliability is especially important is the smart thermostat, where the sensor's ability to accurately read room temperature is compromised if too much heat is dissipated from the surrounding mechanisms. As end equipments becomes more small-scale, the densely packed devices housed within radiate heat that can affect system performance if an internal device fails, especially when exposed to high ambient outdoor temperatures.

Additionally, without a thermal protection mechanism, a power MUX can be permanently damaged if temperatures exceed the junction temperature. Thermal shutdown protects the TPS2116 by safely resetting the device when the junction temperature exceeds 125º C. The integrated temperature monitoring feature safeguards the device during fault conditions such as a power up into a short circuit.

Conclusion

Power-supply selection is crucial in building automation applications that rely on the backup-power source to maintain or supplement power to various end equipments. Extending battery life, minimizing power dissipation, and executing seamless power transition all optimize system performance. The TPS2116 contributes to battery life extension by keeping quiescent and shutdown currents low. Additionally, integrated features like fast switchover control, small solution size, low on-resistance, and thermal shutdown protection work together to maximize power MUXing efficiency and reliability.

Table 1-1. Power Selection Configurations for I_{LOAD} = 2.5 A

Device	Switchover Mode	Low I_Q and I_{SD}	Thermal Shutdown	Voltage Drop (V)	Power Dissipation (mW)	BOM Count	Solution Size (mm^2)
TPS2116	ORing and MUXing	✓	✓	0.1	250	1	3.6
MOSFETs	ORing and MUXing	✗	✗	0.125	312.5	7+	25.36
Diode	ORing	✗	✗	0.7	1750 mW	2	10

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