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Benefits of Supercapacitors in Industrial Handheld Devices

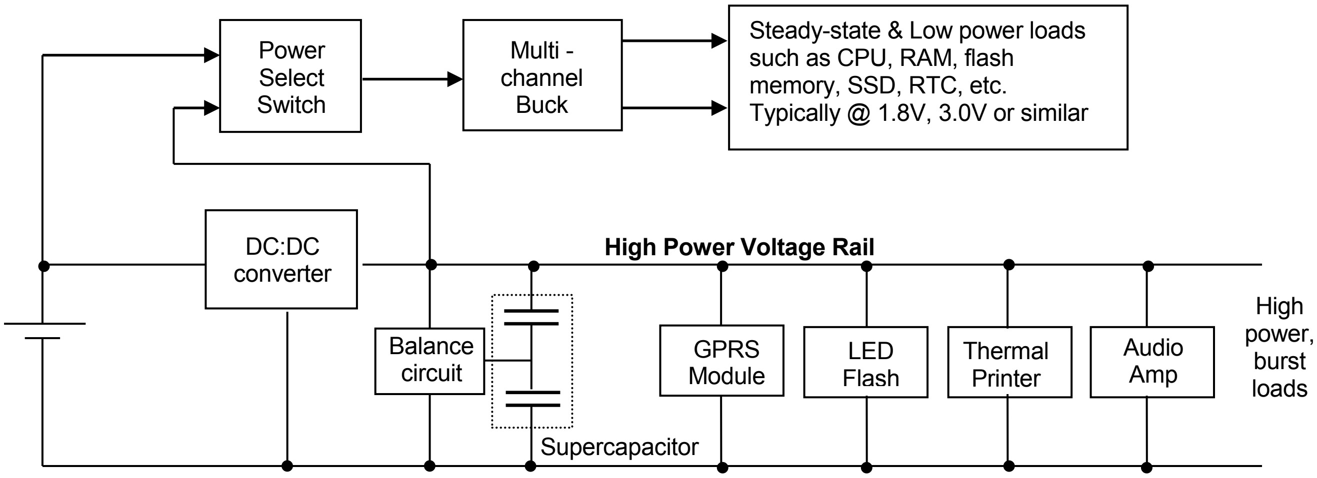
(Portable POS terminals, PDAs, Barcode scanners, Tablet PCs, etc.)

Portable electronic devices for commercial applications must meet more stringent performance requirements and specifications than their consumer counterparts, and may have many power hungry features which need to operate simultaneously. A **supercapacitor** offers several **key benefits** when incorporated into the power architecture of an industrial handheld device:

- **Pulse power support**
  The supercapacitor provides the peak current required by *all* high power loads in the device, including GSM/GPRS and RFID communications, thermal printers, LED flash, bar code scanners, GPS chips, display refreshes, hard disk drives and audio amplifiers. This reduces stress on the battery, minimizing voltage droop, improving run-time (transactions per charge) and extending battery life.
- **"Drop test" and "hot swap" support**
  Battery contacts can disconnect when a device is dropped, giving rise to transient losses of power ("battery contact chatter"). This can result in data loss, interrupted communications, and even shut down the device. A supercapacitor solves this problem by providing short-term, uninterruptable power during any such voltage transients. A suitably specified supercapacitor can even provide enough power to support a battery hot swap - without losing any data or requiring a system restart.
- **Support for "last gasp" transmissions and "graceful shutdown"**
  In the event of more permanent loss of power, a supercapacitor will ensure that the device shuts down in an orderly fashion - undertaking critical house-keeping operations, writing volatile cache data to secure storage, and even sending a final transmission regarding the impending/actual power loss. The supercapacitor removes the need for a separate back-up battery to meet these requirements.
- **Support for low temperature operation**
  Handheld terminals are often used in low temperature environments such as refrigerated warehouses, outdoor restaurants and parcel delivery trucks. Battery impedance rises rapidly as the temperature falls, increasing the voltage drop during high current events. This could cause an under-voltage lockout, and shut down the function (or even the device), even though there is still plenty of energy left in the battery. The low ESR of the supercapacitor, even at low temperatures, shields the battery from the peak loads, and enables the device to function at temperatures as low as -40°C.
- **Extended battery run-time and operational life…**
  For much the same reason, battery run-time and operational life will be significantly improved by a supercapacitor, simply because the battery voltage droop will be reduced for any given load. As the battery ages, and its impedance increases, the support given by the supercapacitor becomes even more important, and extends its operational life.
- **… or smaller, cheaper, lighter and more efficient batteries/power supplies**
  With a supercapacitor now meeting the peak loads, the power supply can be optimized for energy and sized to provide the *average* current to charge the supercapacitor, rather than the *peak* current required for the loads. This allows the size, weight and cost of the battery and related DC:DC components to be reduced, or a lower cost alkaline/primary cell to be used, while still supporting all high power functions. And if environmental concerns are significant, or maximum energy availability/flexibility is the objective, it even opens up the potential to use a renewable, low power source such as solar or vibration.

Suggested Power Architecture

The following block diagram shows a possible architecture to deliver all the benefits listed above:



Notes:

1. With a 3V-4.2V battery and the high power rail at 5V, the DC:DC converter would be a boost. When the unit is first powered on, this must manage in-rush current to the supercapacitor by limiting the charging current. The TPS61200, TPS61202, TPS61020-8, and LTC3625 incorporate this feature.
2. If the battery voltage can be higher or lower than that on the high power rail, the DC:DC converter would be a buck-boost. Suitable examples include the LTC3442a or TPS6300, which also manage supercapacitor in-rush current. The TI boost regulators listed in above can also be used in this case, since they regulate as LDOs if Vbatt > Vo.
3. If LED flash is one of the functions on the high power rail, a high power LED flash driver can be used as the DC:DC converter. Suitable examples include the TPS61325, LM3550, CAT3224 and AAT1282.
4. If the GPRS module must operate at a lower voltage than the other high power loads, consider placing a regulator between the high power rail and the GPRS module.
5. If battery power is lost, the supercapacitor will support the entire unit - directly via the high power rail, and indirectly through the Power Select Switch for the low power and steady-state loads. This switch should be set to source all power from the supercapacitor if the battery voltage drops below a set threshold. The CAT6500 from ON Semi, Si4700DY from Vishay, or AAT4674 from AnalogicTech will perform this function.
6. An alternative architecture could supply the multi-channel buck converter directly from the supercapacitor, and do away with the Power Select Switch, but would be less efficient due to the losses in the DC:DC converter.
7. The dual cell supercapacitor module shown requires a balancing circuit to ensure that one cell does not go over-voltage. The simplest balancing circuit is a pair of resistors - one across each cell. The resistor value will depend on supercapacitor voltage and typical operating temperature. Resistor values are normally in the range 10KΩ - 39KΩ. To minimise leakage current, use an active balancing circuit, which will draw ~2 - 3µA (including that from the supercapacitor). The LTC3625 boost converter mentioned above has active balancing built in.

CAP-XX supercapacitors deliver these benefits due to their unique combination of:

very high power (low ESR) to minimize resistive voltage drop under load
high energy density (high capacitance) to minimize voltage drop under load
high cell voltage to maximize energy headroom
ultra-low leakage current (~1uA) to minimise unwanted energy losses
high temperature rating to support industrial grade performance and specification
low temperature operation to ensure unimpeded outdoor & refrigerated warehouse use
thin, prismatic form factor to fit into the smallest and slimmest enclosures
long operational life (low ESR rise rate and capacitance loss over time, long MTTF)
operational and disposal safety: UL 810A certification; RoHS, REACH and WEEE compliant; Halogen-free and Conflict metal free to support environmental requirements

For more information on how to take your industrial handheld to the next level, contact CAP-XX at sales@cap-xx.com

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