Standby Power:
The Phantom in the Machine

Standby power, also called “vampire power” or “phantom power”, refers to the small amount of electricity consumed by many appliances when they are switched off or are not being used for their primary function. Standby power broadly covers a range of different modes in different products – so-called low power modes, which occur when the product is connected to main power but is not performing its main function. These include off mode (no user function provided), standby mode (some user oriented function present, typically remote operation or display) and network standby mode (where a product retains some network connectivity).

Although typical standby power use per appliance is relatively low (less than 3 W in many cases), when multiplied by the billions of electronic appliances in homes and businesses, and the long duration of such power consumption, standby represents a significant fraction of world electricity use. Estimates of the percentage of household electricity consumed by appliances in standby range between 8 and 22%, accounting for approximately 1% of the world's CO_2 emissions.[1] International efforts began to address standby power back in the early 1990s. Most notably, the 1-watt Initiative launched by the International Energy Agency (IEA) sets an aspirational target for electronic products to less than 1 W of power in standby mode. Both South Korea and Europe have introduced the 1 W benchmark in many new electrical devices. Other governing bodies such as Japan, China and the United States have also addressed standby power through regulation of certain products. Australia is planning to regulate many products at a 1 W level by 2013.

Standby power is perhaps the most broadly applicable global savings opportunity and fortunately, manufacturers continue to produce more efficient power electronics components, some enabling near-zero standby power. There is no one-size-fits-all solution for efficient standby, however, and designers need to be encouraged and rewarded for achieving low standby designs that still meet end user requirements. The design principles discussed below are on the cutting edge of extreme low standby.

Designing Products to Sleep Deeper, Longer

Standby is least wasteful when products power down as many processes and functions as possible, for the longest possible time. Efficient televisions, for example, power many unnecessary processes down. When in standby, power is only supplied to the remote control sensor. This sensor has just enough processing capability to recognize a wakeup command and generate an electronic signal to awaken the next level of electronics.

In addition to shutting down unnecessary processes and functions, well-designed products may also power down or disconnect the main power supply during low power mode operation to further reduce standby power. For example, a number of semiconductor manufacturers are producing controllers for efficient switch mode power supplies (SMPS) that can send a signal to shut down the main power supply. Additionally, new integrated circuits (ICs) are available that can effectively switch out certain components such as capacitors when the SMPS is shut down. The combination of these efficient components can reduce power consumption to a point almost too low to measure.

Certain standby functions still require some energy when the main function is inactive. SMPS operate most efficiently between 50 and 100% of rated load. Therefore, an approach to minimize standby power is to use a separate (parallel) standby power supply that is optimized for and dedicated to these small standby functions. In a TV, for example, this can

[1] According to International Energy Agency estimates.

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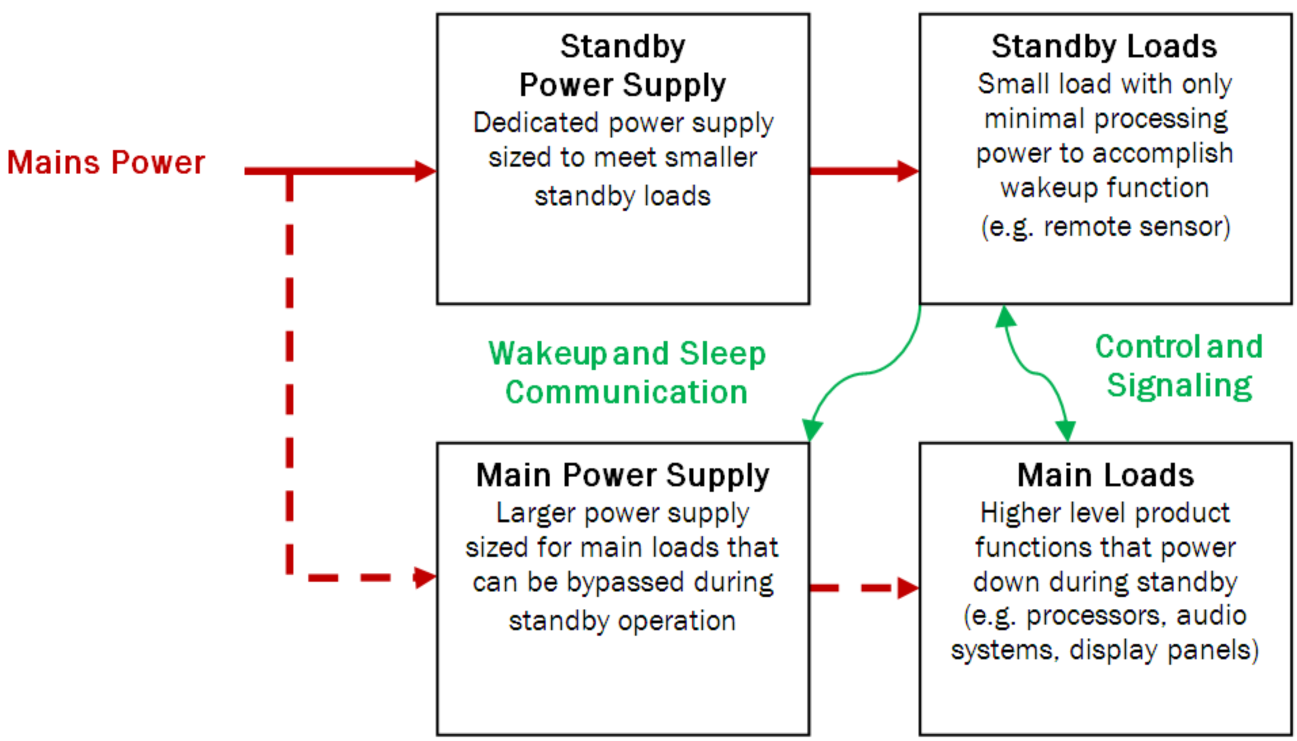
reduce the normal power supply losses of 5 to 10 W (if supplied by the main power supply) to a mere 30 mW, resulting in overall standby consumption of less than 0.10 W (where a small dedicated power supply is used).

To stay asleep longer, efficient standby technologies use a process we call "staged wakeup". If the standby process cannot determine if a signal can be ignored, it wakes the next layer of intelligence (but not the entire system) and passes the signal on to the next level. This allows higher-power functions to sleep longer. Staged wakeup is especially important for network-connected devices, where there is frequent activity on the network, but most of the activity does not require the full functionality of the product (See our 'Small Networking Equipment' report). These principles are illustrated in the diagram below.

User-Friendly Standby

The most effective standby designs are user-friendly. In fact, standby power is usually present to provide users with greater convenience and better functionality when the appliance is not performing its main function. A product that does not wake quickly will frustrate users – who will find ways to keep the product active – resulting in greater energy use. A few innovative products take user-friendly standby a step further by observing the relationship of the users to the device. Presence sensors can recognize when certain functions can power down. For example, televisions can turn off or dim screens when nobody is in the room, and cell phones can turn off touchpads and backlights when the phone is against a person's cheek (See our 'Other Promising Technologies report – Context-Aware Devices').

CONCEPTUAL LOW STANDBY POWER BLOCK DIAGRAM



Standby State of the Art in Power Supplies

The 300 W SMPS Ecos tested (See our 'Ac-Dc Power Supplies' report) has the ability to shut down its main supply and only operate the standby supply where required. The Power Integrations (PI) TFS762HG provides independent switching for the main and standby supplies and when put in standby, disengages the main supply. The standby mode also shuts down the ON Semiconductor NCP1654 Power Factor Correction (PFC) controller, allowing the front end to go to a lower power simple rectification mode. This combination of small standby load, an efficient standby PS, and a lower standby current on the main supply, results in a highly efficient supply with standby no-load dissipation within the SMPS of 0.10 W. This 300 W supply uses less than half of the no-load power of a small cell phone PS,[2] cutting the standby losses in the power supply to a minimum. It should be noted, however, that a PS is only as efficient as the product it powers. End use devices must still be carefully designed to generate very small standby loads on the power supply.

ON Semiconductor PFC (left) and Power Integrations switch mode PS (right)

Ecos tested an efficient 2 W SMPS (See our 'Ac-Dc Power Supplies' report) for use in small battery chargers like mobile phones. This supply is based on a PI LNK574 controller. In addition to being efficient relative to its size, it's also is able to detect no-load conditions and switch to extremely low standby power by suspending the switching when it detects that the output capacitor is fully charged. In this mode, Ecos found the no-load standby power consumption to be only 4 mW, or approximately 1% of the consumption of typical mobile phone adapters (0.26 W). If these efficient technologies were adopted in cell phones,[3] worldwide annual energy savings would be approximately 7 TWh, roughly equivalent to the annual energy output of two typical coal-fired power plants.[4]

Efficient 2 W External SMPS based on PI controller

Next Steps

Great strides have been made since the late 1990s in minimizing power draw when products are not providing their main function. Market incentives to increase portability, together with energy efficiency initiatives and legislation (e.g. the Energy Using Products directive in Europe) have decreased standby power consumption for some devices. For such products (e.g. notebook and cell phone adapters) further reductions in standby consumption may be limited in the short term. However, new features, secondary functions and network capabilities have been added to products, driving standby power consumption to increase. Many of these products (e.g. digital cordless phones and routers) have received limited attention to date and such products offer important savings potential in standby.

[2] http://standby.lbl.gov/summary-table.html
[3] Assuming cell phone chargers are left plugged in when not in use, or 16 hours a day.

[4] Koomey, J., et al., Defining a standard metric for electricity savings. Environmental Research Letters, 2010. 5(1): p. 014017. Available at http://iopscience.iop.org/1748-9326/5/1/014017/.