Integrated Load Switches

An Easy and Fast Solution to Simplify Subsystem Load Management in Wireless Applications

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Integrated power switches are increasingly being used in battery-powered systems to disconnect any unused subsystem. These include RF power amplifiers, wireless local area networks (WLAN) or Bluetooth® modules, LCD display, etc., with the goal of reducing current leakages or distribute power from a single regulated source. Load switches are being considered more often now in non-portable applications such as communications infrastructures with the intent of optimizing the system's overall power consumption to comply with energy saving or green regulations.

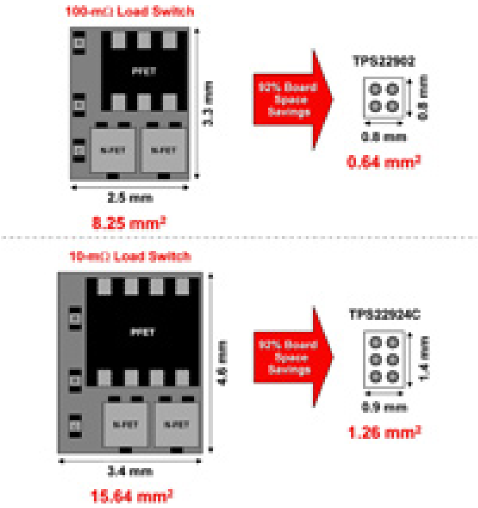
This article discusses important specifications you need to consider to switch loads in wireless applications. We also describe traditional solutions and show how integrated load switches can be used to create an optimized, easy-to-implement solution.

Reducing Overall Power Budget

Most portable, battery-powered, wireless applications (mobile phones, portable consumer electronics, notebooks or any portable equipment with WLAN, Bluetooth or any other wireless protocol) and a growing number of non-battery-powered applications deployed in the field (like RF microwave subsystems) face the challenge of managing their unused subsystem power consumption. The goal is to optimize their power budget while complying with severe space and cost constraints.

A popular and simple option to reduce the system's overall power budget is to shut-off subsystems not in use. This can be done easily by placing a load switch on the power rail to connect and disconnect the rail when required. For instance, a WLAN power module can be disabled while unused and, therefore, eliminate current losses due to subsystem leakages. In a similar way, an emerging number of mobile phone manufacturers tend to disable the RF power amplifier when unused as its represents a reasonable amount of leakage. In communications infrastructure applications, some subsystems can be shut-off during the night to reduce overall leakages when the amount of processing required isn't as high as during the day.

Load Switch Implementation



[1]

The load switch discrete implementation generally consists of a power MOSFET (usually a p-channel FET, but n-channel can be used depending of the application needs) with its gate biased to obtain the required performance. The MOSFET bias circuitry usually consists of an NMOS in order to be compatible with low-voltage control signals, but can be more complex (for instance a charge-pump) in order to boost the performance of the power FET.

Ideally, you should have an output of the load switch that is identical to its input. However, in real operation, the output signal is altered due to parasitic effects of the switch.

To design a load switch-based solution, here are the most important parameters to consider:

* rON – On-state resistance from drain to source of the pass FET

* IMAX and IPLS – Maximum continuous and maximum pulsed current

* tRISE – Rise time

* VIH/VIL – Control thresholds

* ICC and ISHUTDOWN – Quiescent and shutdown current

* Output discharge feature.

ON-resistance Specification

ON-resistance is clearly a critical specification as it determines the dropout seen through the FET. An application with low-current ratings (
In addition to the maximum continuous current the designer targets to switch, it is crucial to consider what the maximum pulsed-current is that the switch can accept. In wireless applications some loads consist of moderate continuous currents

followed by current bursts due to the RF power amplifiers. A good example is the GSM/GPRS transmit burst that sinks up to 1.7A during 576µS with a duty cycle of 12.5 percent. It is important to scale the design to comply with such pulsed current.

In-rush Current

Another critical parameter you need to consider is the inrush current generated when the switch is initially enabled. If the switch turns on without being controlled, and depending on how large the output capacitance is, a supply rail drop due to a large inrush current could be seen at the switch output and ultimately could impact the functionality of the entire system. An easy way to avoid this inrush current is to slow-down the switch’s rise time. This slowly charges the output capacitor and reduces the current peak. In order to control the power FET’s rise time, try using an external resistor-capacitor network.

Additionally, when the switch is turned from ON to an OFF state, some users prefer not to have the power rail floating. Therefore, use an additional transistor to pull down-to-ground the output when the switch turns off.

Basic Load Switch

After considering these key concerns, it is fairly simple for an experienced designer to implement a solution based on discrete semiconductor components to switch the different loads in the systems. However, implementing the solution from scratch may take a reasonable amount of time. More importantly, it may not be optimized from a solution size and cost stand point.

A basic load switch consists of a power PMOS FET, two NMOS FETs, and a pull-up resistor to make it compatible with low-voltage logic and discharge the rail when unused, and an RC time constant to control the rise time and avoid inrush currents. This solution takes a minimum of six components and requires from 8 mm2 to more than 20 mm2, depending of the ON-resistance requirement and the kind of package used.

In order to ease design and enable a faster time-to-market, semiconductor suppliers offer some easy-to-implement, proven, and fully qualified, integrated load switches as part of their catalog portfolio, like the TPS22924C or TPS22902. ICs like these offer the features discussed earlier in a single ultra-small package. Users can now simplify their subsystem load management while reducing the needed board space by up to 90 percent, as shown in Figure 1.

Conclusion

Using integrated load switches is an easy way to implement distributed power architecture and to optimize subsystem power management. Integrated load switches solve wireless applications challenges faced by designers by providing flexibility, ease to implementation, and reduced component counts with increased overall reliability – ultimately resulting in getting to market much faster.

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References

For more information on the technologies and products discussed in this article, visit: http://www.ti.com/loadswitches-ca [2]

Links:
[1] http://www.wirelessdesignmag.com/sites/wirelessdesignmag.com/files/legacyimages/1012/TI_Figure1_lrg.jpg
[2] http://www.ti.com/loadswitches-ca