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EPN is proud to present this latest power electronics supplement, which looks at dealing with energy efficiency in consumer products and solutions to power-supply testing. For additional information on any advertisements or products covered in this issue, you may inquire online at www.epn-online.com.

Cover: The LS series of rad-hard DC/DC converters delivers an output power of up to 30W. Courtesy of International Rectifier.

power electronics

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Enhancing Set-Top-Box Power-

By Laurent Jenck, ON Semiconductor

Even with the continuation of all existing appliance policy measures, domestic electricity consumption here in Europe is expected to see a significant increase between now and 2014, according to the IEA (International Energy Agency). Though few of us probably realise it, the electricity needed to power equipment for the receiving, decoding and processing of digital broadcasts makes a considerable contribution to this figure, which, European Commission calculations suggest, now constitute a combined total of 23TWh/year for member states. This article looks at how better power-system design can restrict the huge energy overhead that STBs (set-top boxes) represent.

Worldwide STB shipments have kept up a run rate of between 120 and 140 million units annually over the last three years, according to research from both In-Stat and i-Suppli (Figure 1). These devices have seen huge market penetration across the entire continent; in the UK, broadcast regulator Ofcom estimates that over 90% of households are now using an STB.

Although, on average, an STB is in standby mode 80% of the time, many models consume the same amount of energy when they are not in use as they do when fully operational. This is because they have to stay connected in order to receive software upgrades and programming-guide information. If the impact of STBs on our CO^2 emissions is to be kept to a minimum, then OEMs will need to employ innovative power designs.

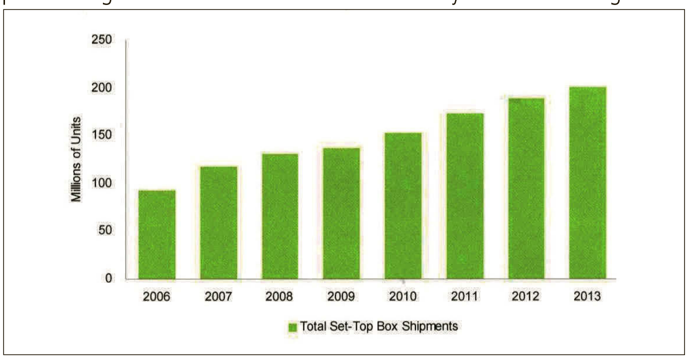

Figure 1: Worldwide shipments of STB devices (courtesy of i-Suppli).

An STB with a built-in DVR (digital video recorder) consumes about 350kWh per year. Furthermore, this figure could potentially double in the next few years as high-definition STBs start replacing their standard-definition counterparts. Figure 2 describes the correlation that exists between STB functionality levels —with added features such as DVR and gaming facilities—and increased power consumption. With OEMs looking to produce feature-rich STBs so that they can differentiate themselves from the competition, these devices will put further strain on the world's limited energy resources.

Improving efficiency

So how can STB manufacturers go about improving energy-efficiency levels? The design of the power supply is clearly important, with any improvements in conversion-efficiency levels offering some assistance in terms of limiting power consumption. The power supply of a standard STB consists of multiple output voltages, the regulation of which poses significant challenges. Improvements to an STB's power-supply-output regulation can be made by stacking up the windings. Alternatively the STB's outputs can be stacked, combining a number of them into a single feedback path.

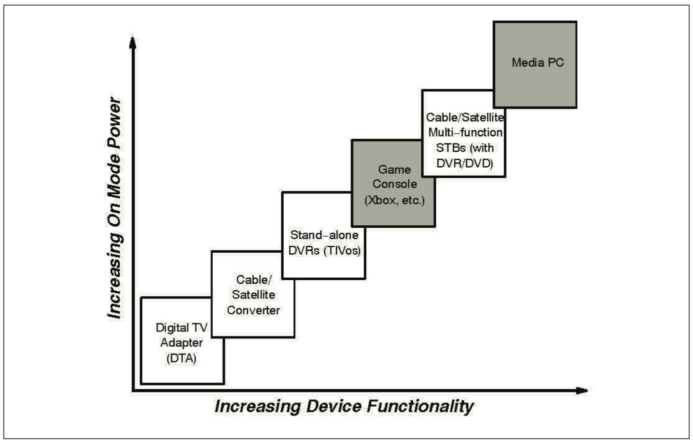

Figure 2: The increase in STB functionality is mirrored by rising power-consumption levels.

Far more essential, however, is the design of the system as a whole. If STB development is approached in a more energy-conscious manner, then substantial power savings can be made. Within the STB there are a number of different components that do not actually need to be powered up unless the system is tuning into live programming or recording video content. It is therefore possible for certain components to be powered down for much of the time. For example, the STB could be designed to power down the hard drive or tuner when not in use to reduce its energy consumption.

Optimised reference designs can help engineers to quickly produce more power-efficient STBs that can still boast the compelling features demanded by consumers. Complicated design and development processes can be avoided, enabling quicker time to market. For example, as part of its series of GreenPoint solutions, ON Semiconductor has created a 40W STB power-supply reference design with a free running QR (quasi-resonance) operation, the primary side of which is built around the company's NCP1308 current-mode controller IC.

Reference design

This reference design (Figure 3) utilises a flyback converter to store energy inside the transformer during the conduction time of the primary switch, then delivers this energy to the secondary circuits once the primary switch has been turned off. Since the energy storage occurs in the transformer, energy-storage inductors are not required within the secondary circuits as is usually the case when buck-derived topologies are employed. This leads to much simpler secondary circuits and is particularly suitable for multiple-output supplies.

The design has a total of four outputs (+5, –5, 3.3 and 12V) and can handle peak power levels of up to 50W. The QR flyback converter involved in this design is operated in the critical conduction mode, so that the primary MOSFET can switch back on only when the drain–to–source voltage is at its minimum level during the flyback ring-out process. This means that only very low switching losses are seen in the STB's MOSFET and the output rectifiers.

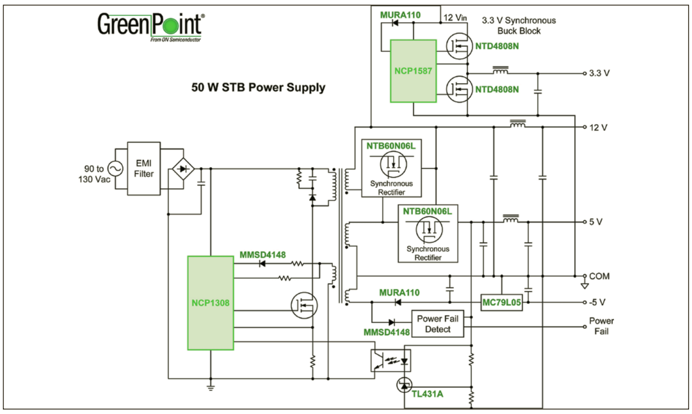

Figure 3: The simplified block diagram of ON Semiconductor's GreenPoint STB power-supply reference design.

Different options for the secondary circuit structure were investigated. The circuitry included the use of MOSFET synchronous rectifiers for the main flyback windings and synchronous MOSFET buck converters for low-voltage post regulators in various configurations. The configuration outlined in Figure 3 produced the highest conversion-efficiency levels: the 5V output is the main channel with the closed PWM loop, while the 3.3V output is derived from a synchronous NCP1587 buck DC/DC converter. The transformer windings in this configuration are definitely easy to implement using three turns for the 5V and seven for the 12V outputs. In this case, the quasi-regulated 12V secondary winding is again stacked onto the 5V winding with an additional four turns for improved cross regulation. Efficiency is yet increased through synchronous rectification of the 12V output.

Conclusion

STB manufacturers can now employ reference designs in order to create products that will have minimal power overhead. This will mean that STBs that exhibit far greater energy efficiencies can be realised without long development cycles or heavy use of engineering resources. If it were possible to deploy STBs where the ready-mode power consumption could be reduced to 5W and sleep-mode power reduced to 1W, then projections suggest that huge cumulative savings could be realised.

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