Design Solution # 38

DC/DC for Ultra-Portables Features Digital Output Voltage Scaling

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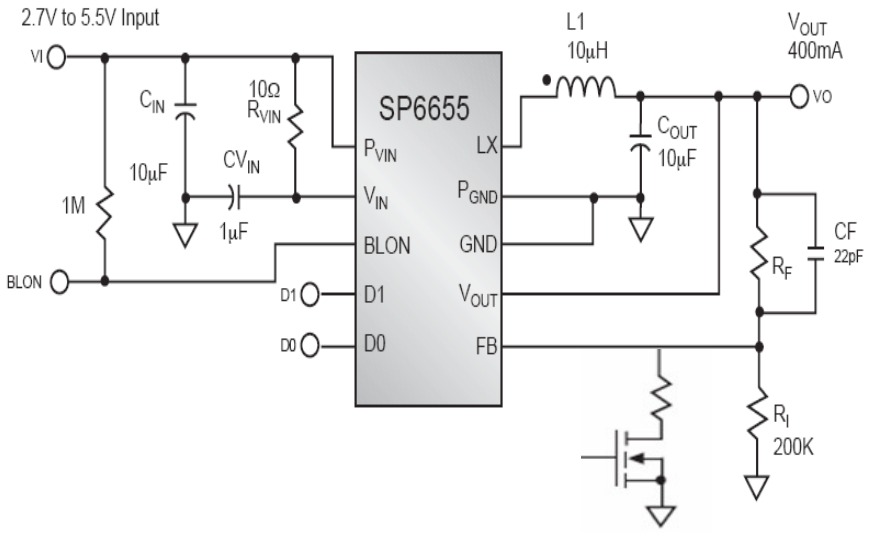
Part Number: SP6656

Application Description: DC/DC for Ultra-Portables Features Digital Output Voltage Scaling using the SP6655/SP6656

Circuit Description:
This circuit has been designed to provide power for today's most modern ultraportables utilizing DSPs with advanced Dynamic Power Management Systems such as the Samsung S3C2440A CPU. The SP6655/56 can meet customer key desires for performance, cost, and reliability for today's high volume product lines, while conserving valuable board space and parts count.



As information technology products demand ever increasing migration towards portability, battery lifetime continues to become a more important consideration *earlier* in the product conception stage. System power efficiency used to be mostly optimized *after* the digital portions and software code were completed and ready to be placed onto a complete system board, in many cases only done for worst case (maximum utilization) conditions with no thought given to optimization over a *user utilization profile* of real-life operating conditions.

At the same time, users are also demanding an ever increasing amount of functionality for their ultra-portable products, so the DSP needs to process more and more data in a smaller time, further tasking the battery capacity. This increased efficiency requirement further screams for more power efficiency architecture that is much more than just analyzed at static or maximum worst-case conditions, but as power efficiency integrated over the various user-utilization modes. In an effort to address these needs, DSP products with advanced *dynamic power management systems* are now seeping into the ultra-portable product space, and not just relegated to most power hungry portables, such as notebook computers.

As a result of the newest user demands, many of the newest portable DSP chips now feature an enhanced dynamic power management system (DPMS) for further extending battery life of ultra-portables. This functionality is reminiscent of that found in the most modern notebook computer microprocessors (a.k.a. Intel Mobile Voltage Positioning, or "IMVP"), which has been applied to systems requiring processing power in excess of 15A, up to 32A. By scaling the supply voltage, the power usage ($P = V \times I$) can be greatly reduced, intermittently, with no difference noticed by the end user of the product. Today's newest DSP offerings for ultraportables require less than 2A maximum current draw (modern smartphones, 3G handsets, and Personal Media Players), and now integrate an ever increasing amount of this functionality to extend the power operating profile efficiency. These new smart DSPs shut down functions (in a predetermined grouping), entering into a quasi-standby operating mode, when possible. The DSP first demands a change in Vcc operating supply voltage, and in turn, adjusts clock frequency to a more appropriate (power saving) speed that meets the operating needs in intermediate modes of functionality. Also, certain portions of the DSP blocks, usually referred to as peripheral functions, can be shut down as well, further decreasing power consumption.

One example DSP that utilizes this power saving mode of operation is the Samsung S3C2440A CPU, which has built-in memory controller, I/O ports, LCD controller, a Real-Time Clock, and other functional blocks (refer S3C2440A datasheet).

http://www.samsung.com/Products/Semiconductor/common/product_list.aspx?family_cd=MSC0102

The S3C2440A has various power management schemes to optimize power consumption for a given task. The power management block in the S3C2440A can activate four modes: **Normal Mode, Slow Mode, Idle Mode, & Sleep Mode**.

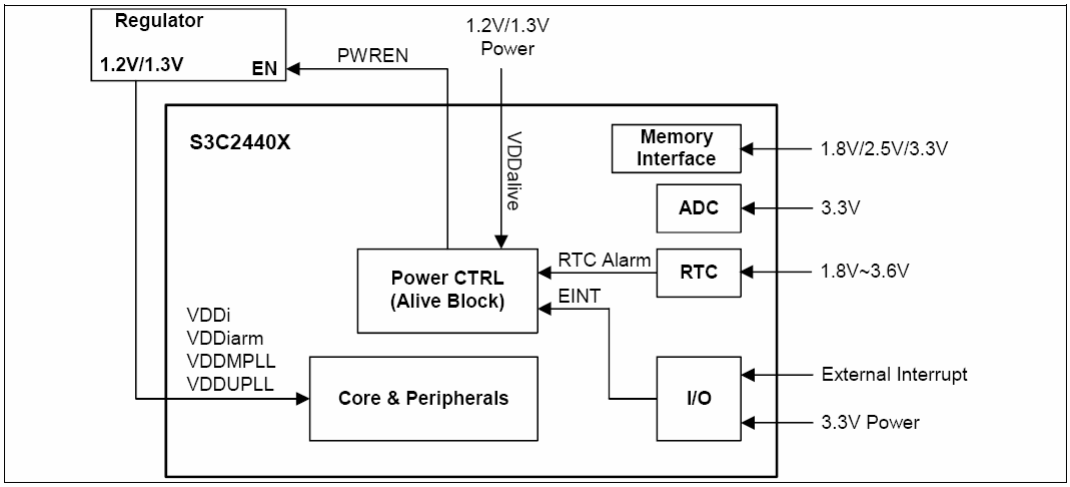


Figure 1. Power control of S3C2440A

In general, to power such a DSP, customers have used a standard single output voltage buck regulator and added an extra MOSFET, plus a third feedback resistor to meet the Vcore change request of the DSP by turn-on and turn-off of the added external switch, as shown in Figure 2 below.

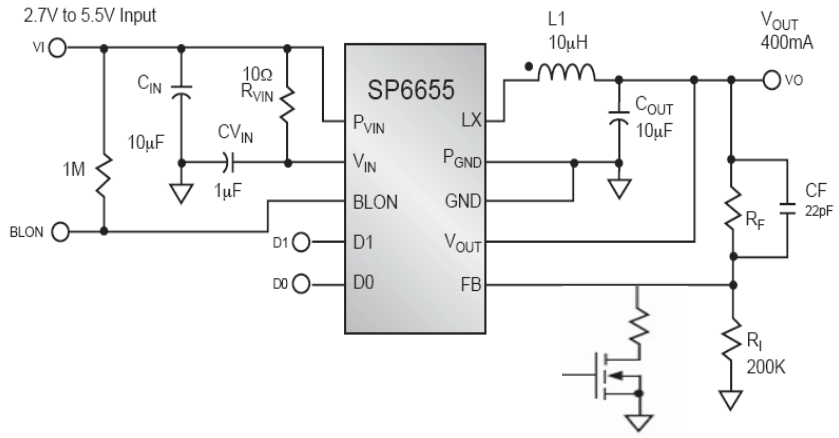
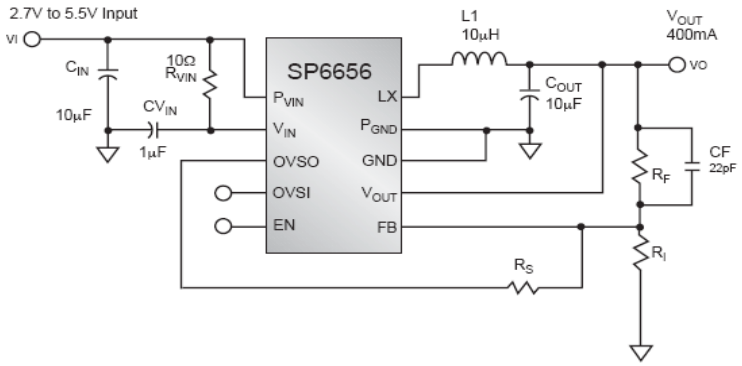


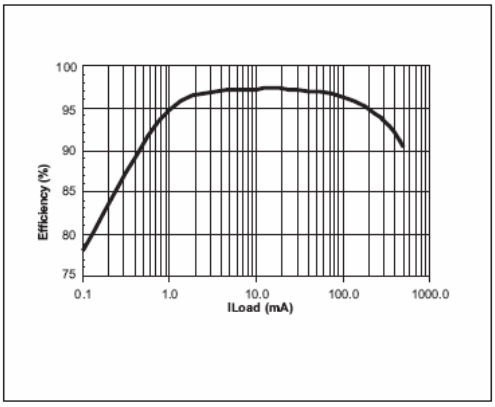
Figure 2. DSP Power Control Circuit using SP6655
(notice the extra switch & resistor, and required additional control line)

However, customers in these same high volume portable appliance applications demand the following:

1. lowest parts count
2. enhanced BOM cost
3. optimized performance (such as low overshoot and fast adjustment speed)
4. reduced circuit risk through IC integration

To address all of these customer demands, Sipex designed the SP6655/56 Digitally Adjustable Output Voltage 400mA High Efficiency Buck Regulator. Features of the SP6655/56, (which includes an externally programmable output voltage down to 0.9V), are 98% efficiency, digitally adjustable output voltage, logic level shutdown control, and highly reliable 140^0C over-temperature operation capability. Dynamically selectable output voltage makes the SP6656 especially suited to provide power for split-supply DSPs and chipsets like TI's OMAP59XX and the aforementioned SamSung S3C2440 family.



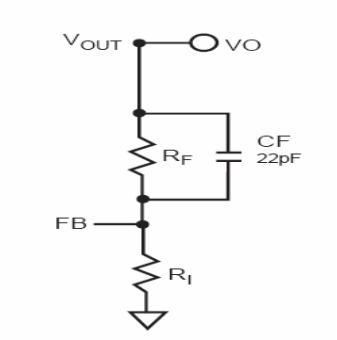


Efficiency vs. Load, V_{OUT}=3.3V, V_{IN}=3.6V

Figure 3. SP6656 Integrated DOVS Buck Regulator and Efficiency Plot

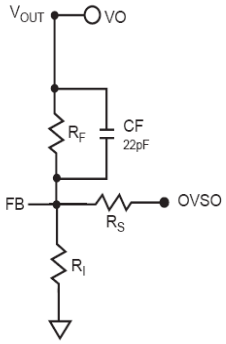
Explanation of Digital Output Voltage Scaling Function of SP6656

When the S3C2440A works in ***Normal*** mode,VDDi and VDDiarm need 1.3V input. But when S3C2440A works at ***Idle*** mode, VDDi and VDDiarm need 1.0V input. We can use the equation from the datasheet of the SP6655/56 to meet this power requirement.



$R_F=(Vout/0.8V -1) \times R_I$

We choose R_I=200KΩ at first, so we can get R_F=50KΩ. Then use the following equation to determine Rs from the datasheet of SP6656:



$$[R_I//R_S] = \frac{0.8 \times R_F}{V_{OUT\_HIGH} - 0.8}$$

$$R_S = \frac{[R_I//R_S]}{1 - \frac{[R_I//R_S]}{R_I}}$$

So we calculate that Rs= 133KΩ.

The SP6655/56 is a wise consideration for today's most modern ultraportables utilizing DSPs with advanced Dynamic Power Management Systems. The SP6655/56 can meet customer key desires for performance, cost, and reliability for today's high volume product lines, while conserving valuable board space and parts count. Please contact your nearest Sipex sales office, Sipex FAE, or visit www.sipex.com for a closer look at the SP6656 regulator solution.