TA0334
Technical article

DDR2/3 multiphase power supply with multistate phase-shedding to maximize energy savings

Introduction

The worldwide trend in the computing industry is energy savings. In this sector, the focus is shifting from speed to performance per watt. STMicroelectronics is very sensitive to this trend, anticipating it, and being among the first silicon vendors to produce energy-saving devices according to Intel and AMD specifications. Today, thanks to a complete silicon portfolio, ST is able to offer an application for DDR2/3 memory power supply, with the highest efficiency over the whole range of current. The application is based on ST's L6756D Intel VR11.1 controller, with proprietary phase-shedding technology. The main feature of the application is the ability to automatically and dynamically change the number of phases (one, two, or four), based on the output current which allows saving switching losses when some phases are not needed. The energy savings is significant and can be up to four watts at light load and depending on application details, compared to standard power supply solutions. The size of such a design is small, making it suitable for both VRM and VRD solutions. The flexibility of the controller allows easily implementing a voltage regulator that can switch at one phase or two, one phase or three, or one phase or four. Three-state designs are also possible: one, two and three phases, according to the load; one, two and four phases, according to the load (multistate phase-shedding).

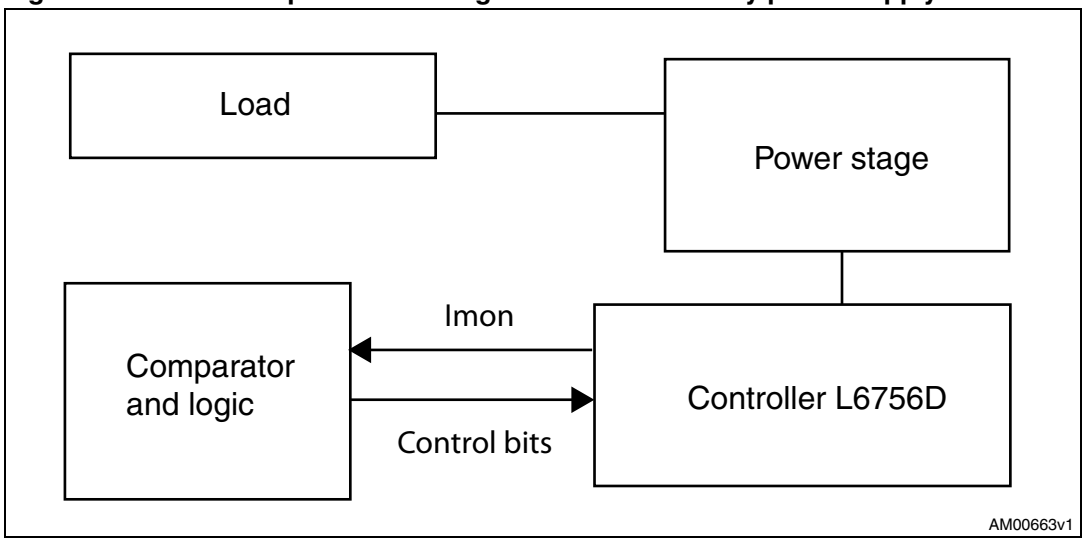
Contents

1 Operating principle

The operating principle of the DDR2/3 memory power supply with efficiency boost is based on the two input control pins (PSI, PSI_A) of the ST L6756D controller and on the output IMON pin of the L6756D. The IMON output pin voltage is proportional to the output current according to Intel VR11.1 specifications. The PSI and PSI_A input pins allow multiple states of power savings (multistate phase-shedding).

The load condition is automatically monitored by the controller, represented by IMON, and fed to the input pin of two comparators with programmable references. The phase number is changed by acting on the PSI and PSI_A pins (based on the IMON pin value). The output of the comparators drives the PSI pin and PSI_A pin respectively. The user has the freedom to adjust load threshold and hysteresis by changing the external resistor partitions. Overall, the external component count is small, with minimal impact on size. *Figure 1* illustrates multistate phase-shedding.

Figure 1. Multistate phase-shedding of a DDR2/3 memory power supply (a)



a. This solution leads to maximizing power savings over the whole current range, especially at light load.

2 Efficiency boost

The breakthrough of a phase-shedding solution, compared to designs with a fixed number of phases, is the possibility of saving energy at light loads. Of course the amount of energy and watts saved depends on the application details. However, on a standard DDR3 memory, the efficiency increase at light load has been measured to be in the range of 10% up to even 25% if the load is small which means up to 3.8 watts saved at a very light load. *Figure 2* illustrates these details. The red line is the efficiency measured with ST's multistate phase-shedding application, whereas the blue line is the efficiency measured in a similar condition with a fixed-phase application. It is also very important to remark that usually PCs spend most of their time in idle mode, so it is very likely that the memory stays in low-consumption mode for a long time, leading to considerable energy savings if it is supplied with a phase-shedding application. ST's L6756D, with its very flexible multistate phase-shedding, allows not only energy savings at light load, but also at medium load. As can be understood from *Figure 2*, the L6756D is running up to 18 A at one phase, from 18 A to 27 A at two phases, and from current values higher than 27 A at four phases.

Figure 2. Efficiency measurement of a power supply for a DDR3 memory (b)

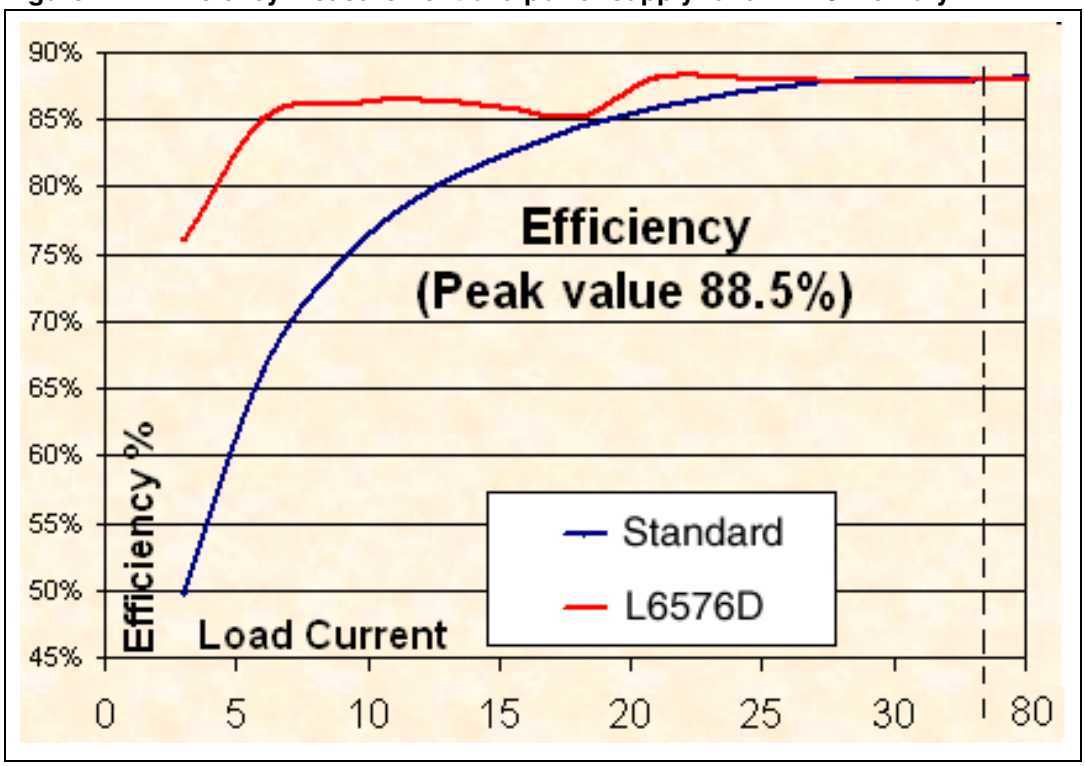


Figure 2 depicts a representation of one specific case. The current thresholds, as well as hysteresis values, can be easily changed.

b. A multistate phase-shedding vs. a fixed-phase power supply. The first method results in considerable energy savings.

3 Additional features

The solution described in this article also has many other very interesting features. Soft-start is always performed at full load, in order to be compatible with any load. After the soft-start is finished, the controller uses the best number of phases. Phase shift among phases is always optimized at 90° at four phases, 120° at three phases, and 180° at two phases. The voltage regulation of the controller is outstanding. Whatever the number of phases, the voltage ripple is small and almost constant, and transient performance matches the application expectations.

4 References

1. STMicroelectronics L6756D datasheet

5 Revision history

Table 1. Revision history

Date	Revision	Changes
09-Sep-2008	1	First issue

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST’s terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST’S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER’S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com