



Advanced Multi-Channel Digital Power Management Controller

ADVANCED TECHNOLOGIES FOR NEW GENERATION PRODUCTS

VS8801A

GENERAL VIEW

VSMC's Programmable Power Management IC, VS8801A, with Adaptive ASPWM Control Technology, by driving up to eight PWM converter channels in sequence, provides a new and effective tools for power-management control of new generations of portable devices such as: smart phones, PDAs, MP4-players ... This controller family are designed to offer advanced specifications which fully adapted to common and particular demands from portable-device markets.

With eight channel in eight phases, each capable of working at 1MHz operation, the VS8801A can be used to build up to 8 separated channels of DC/DC converters that provide energy to various types of load with excellent efficiency, low ripples, and with lowest external component count.

For energy saving reasons while all the loads are turned off, the **VS8801A** offers a stand-by mode, where the quiescent current does not exceed 50 μ A typically. In this stand-by mode just the stand-by LDOs remain active.

FEATURES

- High efficiency DC/DC converter controller system
- Low operating voltage range, from 3V to 5.5V portable device standard batteries.
- Stand-by mode with low current consumption
- Selectable step-down converters as pre-regulator: 1.1V, 1.8V, 2.5V and 3.3V, and step-up converters: 5V, 10V and 15V
- Programmable step-down slope control, suitable for wide range of applications
- Switching loss minimization
- 8 channels with independent programmable output controllers:
 - 4 step-down controllers
 - 2 step-up controllers
 - 1 white-LED controller
 - 1 negative voltage power supply controller
- Stand-by regulator with 1mA current capability
- 8 separate voltage feedback circuits for each channel
- Power-on reset functionality
- Internal watchdog reset
- Internal crystal oscillator with 32,768 Hz output
- Un-used channels can be segregated-off from the system without power-consumption
- Communication with host-CPU through SPI / I²C serial bus
- PLCC-84 standard package or (8mm x 8mm) FBGA package with 0.5 mm ball pitch (options)



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MAXIMUM RATINGS

ESD Rating

Human Body Model (Per MIL-STD-883 Method 3015.7)

(100pF, 1.5kΩ) 3,000V

Charged Device Model (Per EOS/ESD DS5.3, 4/14/93) 1,000V

Machine Model 300V

Operating Conditions

Ambient Temperature Range 0°C to 85°C

Supply Voltage Range (Typical) +3.0V to +5.5V

Thermal Information

PLCC Package 84

Maximum Storage Temperature Range -65°C to 150°C

Maximum Junction Temperature Range 0°C to 125°C

Maximum Lead Temperature (Soldering 10s) 300°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only, rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

VSMC preliminary information
 VS8801A Specification
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APPLICATIONS

- **Portable media players and MP3 players**
- **Feature phones and smart phones**
- **Other portable electronic devices**
- **Eight switching converters**
 - Four buck (step-down) converters
 - Two converters available in Low Power mode for high efficiency at low load currents
 - Two boost (step-up) converters
 - One buck-boost (step-up) converter for negative output voltage
 - One constant current boost White LED driver
 - High efficiency (typically 90%+) from 5% to 100% of programmed maximum current in active mode
 - Converters drive external MOSFET(s) directly
- **Switching converters feature all-digital loop control technology**
 - Real-time analysis provides optimal power system control and operation
 - Precise supply-to-supply matching and tracking
 - Programmable power-up and -down slew rates
 - Programmable load connection and shedding
 - Smaller quantity and sizes of inductors and capacitors yield reduced size and cost
- **Three LDOs**
 - Three low-noise LDOs with separate pins-out.
- **Input voltage range: 3V to 5.5 Volts**
- **Programming for all PWM controller and LDO power rails**
- **Power-up supply characteristics can be modified without hardware changes by reprogramming the device's E²PROM**
- **Capable of stand-alone operation using the parameters loaded from the E²PROM at start-up**
 - No serial interface with host required
 - Utilizing device pins for status / control
- **Integrated system support**
 - Real time clock (RTC) with 32,768 Hz clock-pulse output
 - Watchdog-timer (WDT)
 - Programmable host controller interrupt output
 - Power Good and Power-on-Reset outputs



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- Remote management via I²C, SPI interface to host processor
- Operates from a low-cost 32,768 KHz crystal or external clock input
 - Provides buffered 32,768 KHz output to internal RTC and the external system
- Low power consumption
 - 50 μ A in shutdown mode with RTC enabled
- PLCC-84 standard package or (8mm x 8mm) FBGA package with 0.5 mm ball pitch (options)

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GENERAL DESCRIPTION

The VS8801A is a digital multi-phase pulse-width-modulation controller integrated circuit for use in 8-phase synchronous buck/boost converters, designed to supply power for new generations of portable devices such as: smart phones, PDAs, MP4 Players The device is optimized for delivering voltages from 1.1V to 15V with PWM 1 MHz switching frequency.

The VS8801A is designed to provide an advantageous means to the designers of portable devices by providing fully-programmable features of power-management for new generation of portable devices, helps the host-CPU of the devices to enhance ability to control the system and therefore improves the overall performance of the system. Simultaneously, VS8801A helps to minimize the quantity and sizes of discrete components and thus save space. Owing to such features, VS8801A helps to cut-down efficiently the dimensions and the cost of the devices.

The VS8801A provides both ease-of-use and flexibility to the user. Major features include:

- Internal Voltage Reference - An internal factory-trimmed $\pm 0.5\%$ voltage reference sets the voltage ADC. In addition, an $1.25V \pm 0.5\%$ voltage reference (with pinout) for system applications is available.
- Internal Oscillator - Provides a factory-trimmed 100MHz $\pm 5\%$ clock reference. Programmable dividers generate all the needed internal clocks to configure the controller's switching frequency and number of active phases.
- Dedicated Voltage ADC - A high precision differential input voltage ADC digitizes the feedback voltage. An anti-alias filter and ripple frequency null filter is required to minimize the impact of high frequency noise on the system.
- Digital Control Loop and DSP - A multiplexing-demultiplexing combination synthesized by low- $R_{DS(ON)}$ analog-switches shall select feedback signal from each channel, put it into the ADC to be calculated, processed, digitalized and synchronously sent to the PWM-controllers.
- Slew-Rate Control (SRC) and Amplitude-Modulation Control (AMC) engines - with programmable thresholds are used to provide "smart" response to dynamic load transients, minimizing spike overshoots and droop undershoots. This mechanism guarantees to keep all the system always in accurate operation conditions and optimized dynamic performance.
- Configurable PWM Controllers : 2 - to - 8 PWM waveforms are digitally generated, ensuring low jitter and high linearity. The PWM outputs have soft-start circuits which are programmable to keep-track with output load demands.
- Integrated NVM - Digital configuration is stored in an integrated NVM, allowing fully independent (stand-alone) operation.
- Serial Interface - GUI software provides easy access to all configuration, telemetry, and testability features over a I²C/SPI serial interface.



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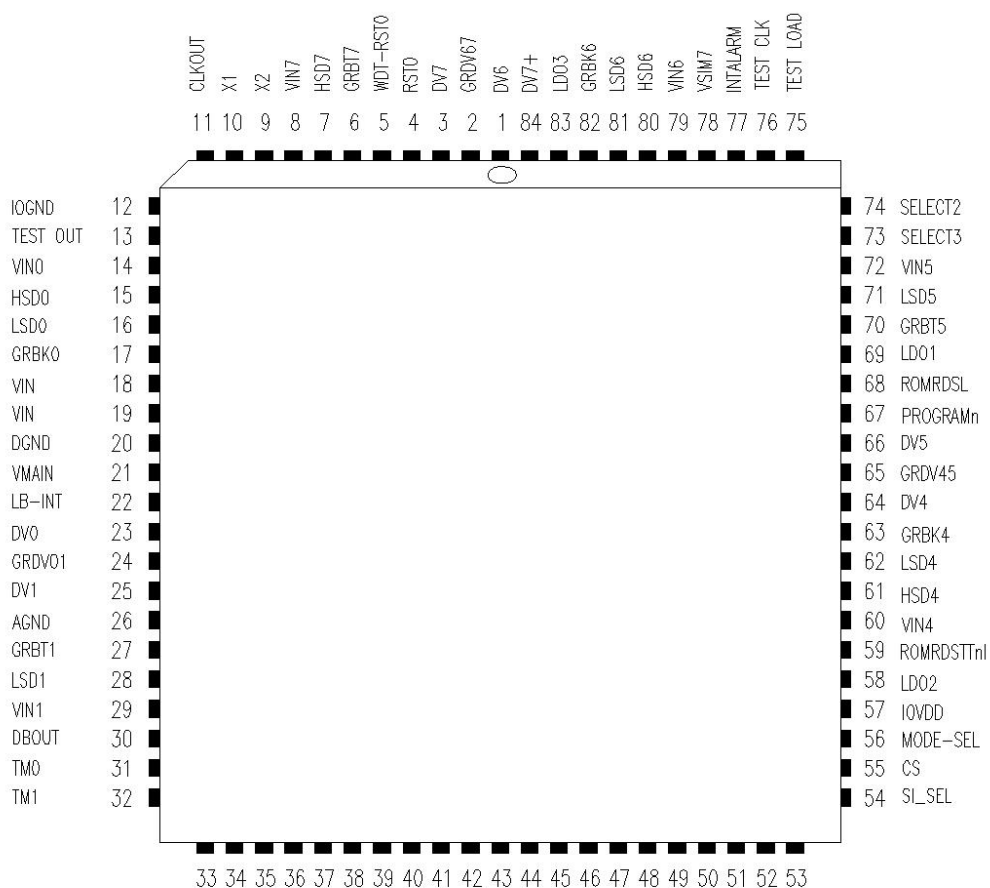
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PACKAGE

- VS8801A chips shall be marketed in 2 types of standard package, which help the customers convenient to choose the suitable one for the manufacturing process: **PLCC-84 standard package or FPGA package with 0.5 mm ball pitch (options)**

Man



Application Note: April 02, 2008

Figure 1 – 84-pin PLCC Standard Package



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PIN CONFIGURATION

| PIN | FUNCTION | PIN | FUNCTION | PIN | FUNCTION | PIN | FUNCTION |
|-----|----------|-----|------------|-----|------------|-----|----------|
| 1 | DV6 | 22 | LB-INT | 43 | GRDV23 | 64 | DV4 |
| 2 | GNDV67 | 23 | DV0 | 44 | DV3 | 65 | GRDV45 |
| 3 | DV7 | 24 | GRDV01 | 45 | SELECT1 | 66 | DV5 |
| 4 | RST0 | 25 | DV1 | 46 | VINTESTADC | 67 | PROGRAMn |
| 5 | WDT-RST0 | 26 | AGND | 47 | RSTLn | 68 | ROMRDSL |
| 6 | GRBT7 | 27 | GRBT1 | 48 | STANDBY | 69 | LDO1 |
| 7 | HSD7 | 28 | LSD1 | 49 | VPP | 70 | GRBT5 |
| 8 | VIN7 | 29 | VIN1 | 50 | GRBT3 | 71 | LSD5 |
| 9 | X2 | 30 | DBOUT | 51 | LSD3 | 72 | VIN5 |
| 10 | X1 | 31 | TM0 | 52 | MOSI | 73 | SELECT3 |
| 11 | CLKOUT | 32 | TM1 | 53 | MISO | 74 | SELECT2 |
| 12 | IOGND | 33 | DO | 54 | SI-SEL | 75 | TESTLOAD |
| 13 | TESTOUT | 34 | CLK-CS2 | 55 | CS | 76 | TESTCKL |
| 14 | VIN0 | 35 | D1-CS1 | 56 | MODE-SEL | 77 | INTALARM |
| 15 | HSD0 | 36 | TESTEN-CS0 | 57 | IOVDD | 78 | VSIM7 |
| 16 | LSD0 | 37 | VIN2 | 58 | LDO2 | 79 | VIN6 |
| 17 | GRBK0 | 38 | HSD2 | 59 | ROMRDSTTnl | 80 | HSD6 |
| 18 | VIN | 39 | LSD2 | 60 | VIN4 | 81 | LSD6 |
| 19 | VIN | 40 | GRBK2 | 61 | HSD4 | 82 | GRBK6 |
| 20 | DGND | 41 | SCKL | 62 | LSD4 | 83 | LDO3 |
| 21 | VMAIN | 42 | DV2 | 63 | GRBK4 | 84 | DV7+ |

Table 1: Pin configuration of VS8801A



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BLOCK DIAGRAM

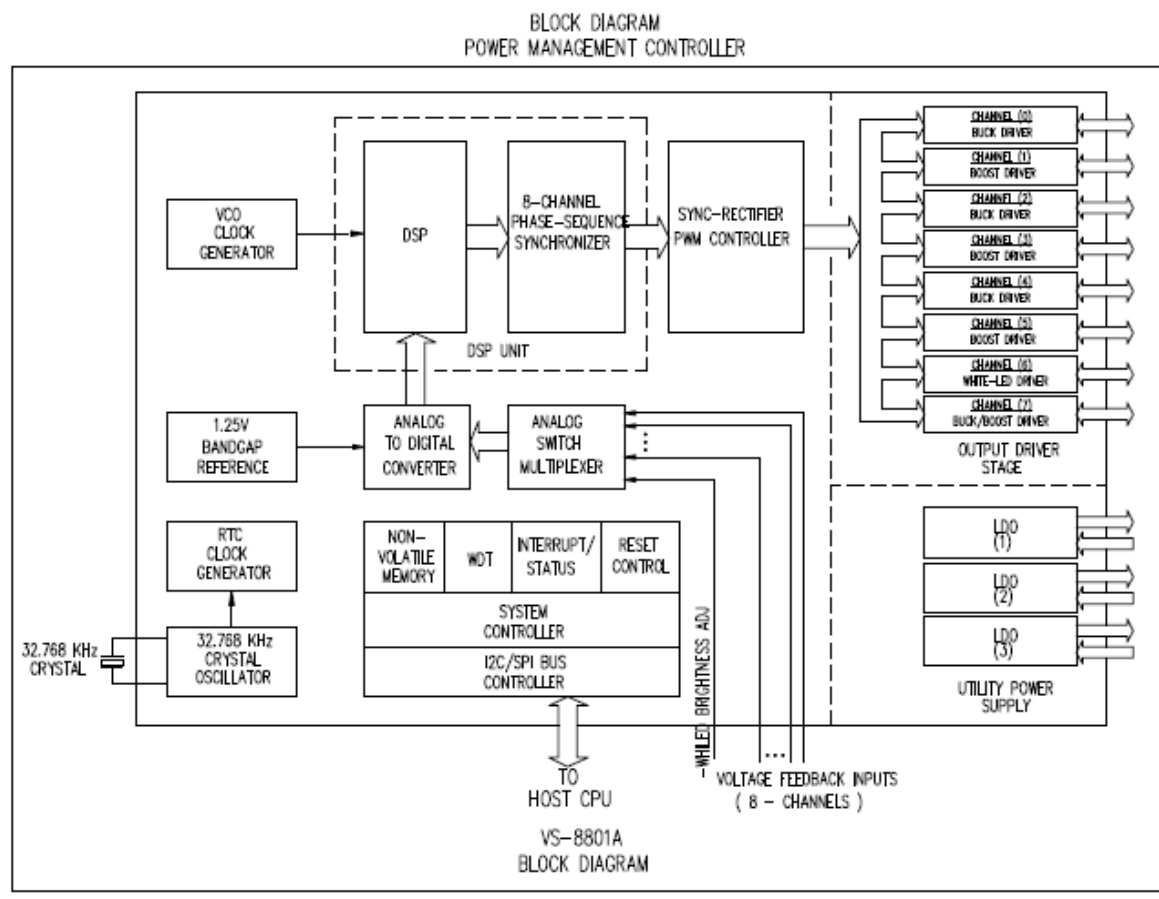


Figure 2 – Block diagram

OPERATION

The VS8801A utilizes adaptive technology to implement all control functions, providing the ultimate flexibility and stability, but still keeps advantages in applications. The VS8801A incorporates a programmable industry standard I²C / SPI serial bus for controlling and monitoring. Through the serial interface, the power supply designer can quickly optimize designs and monitor parameters. The interface allows the VS8801A to provide digitized information for real time system monitoring and control.

To improve adaptivity for different types of portable products, the VS8801A incorporates patented Slew-Rate Control (SRC) and Amplitude-Modulation Control (AMC) technologies, allowing the “smart” response to transient events and guarantees operation conditions of loads.

The VS8801A is a multi voltage power supply system especially designed for portable applications using a standard 3.3V to 5.5V battery. The device is intended to supply all components and circuits of a portable system which require different supply voltage rails such as 15V, 3.3V, 2.5V, 1.8V, 1.1V including a White-LED array back-light and a -10V for some particular uses (if any). Addition to 8 PWM controller channels, the VS8801A also consists of 3 additional LDOs with separated outputs (3.3V, 2.5V and 1.8V well-regulated) which makes it adaptable for a large range of portable products from present to



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foreseeable future. All these power-controllers are integrated onto a single chip to achieve lowest power dissipation thus being able to power the application even at critical ambient temperatures.

Four step-down controllers deliver suitable PWM pulses, which through Power-MOSFETs and small electrolytic filter capacitors, can supply well-regulated and low-ripple voltages of 1.1V, 1.8V, 2.5V, 3.3V to external circuits with a maximum current capability of 600mA for each channel.

Two step-up controllers deliver suitable PWM pulses, which through Power-MOSFETs, Schottky-diodes and small electrolytic filter capacitors, can supply well-regulated and low-ripple voltages of 15V, 10V, 5V to external circuits with a maximum current capability of 20mA for each channel.

The step-up controller for White-LED, delivers PWM signals, which through Power-MOSFETs and small electrolytic filter capacitors, can supply an adjustable maximum 28V / 20 mA to White-LED array back-light load.

One buck-boost controller delivers PWM signal, which through Power-MOSFETs and small electrolytic filter capacitors, can supply a well-regulated and low-ripple voltage of -10V.

Three low drop linear post-regulators offer 3.3V, 2.5V, or 1.8V of output voltages depending on the configuration of the device with maximum current capabilities of 50mA.

In addition the inputs of eight voltage channels are connected to the Li-Ion standard battery with output from 3.3V to 5.5V bus voltage. Their outputs follow the main linear regulator (LDO1, LDO2 and LDO3) with high accuracy are able to drive a current of 50mA each. Each channel can be turned on and off individually by a 16 bit serial peripheral interface (I²C/SPI). Through this interface also the status information of each tracker can be read out.

The supervision of the DSP is managed by the I²C/SPI-triggered window watchdog.

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