SAM DAVIS, Editor-in-Chief, PET

Mobile Electronic Products Employ Integrated Power Management

Design trends for mobile products show that continuous growth will require more connectivity and functionality, which will require flexible, mixed-signal, and intelligent power-controlled ICs.

A new paradigm is evolving for the design and manufacture of mobile electronics equipment. Development lifecycles are now to 3 to 6 months, with a prime product life of 9 to 18 months. Manufacturers will constantly need to add features that enable their products to be more competitive. This will challenge design engineers to deliver:

Better audio fidelity

•More integration

•Longer battery life

•Smaller form factor

•Easier user interface

•Modular platform approach

These challenges will require more design flexibility, with programmable power management and added intelligence.

One answer to this evolving paradigm is IDT's P95020 that includes high-fidelity audio subsystem, clock generation, resistive touch controller, backlight LED driver, Li+/Polymer battery charger, multi-channel DC-to-DC converters and a high resolution analog-to-digital converter (ADC). The P95020 (*Fig. 1*) offers functions intended for use with multimedia applications. All functional blocks can be accessed via I²C and programmable regulators satisfy the dynamic voltage adjustments required by most application processors.

All P95020 subsystem modules are configured, monitored and controlled by either the on-chip microcontroller or by an external controller (application processor) over an I²C interface. The external application processor can monitor and control functions within the P95020 even when the internal microcontroller is enabled. The registers for the various sub-functions allow access from more than one controller through an arbitration mechanism implemented in hardware.

Operational programmability and flexibility are key features of the P95020. Its embedded microcontroller requires only moderate speed because it only sets the IC's operating parameters and provides general housekeeping and I/O processing tasks, while offloading these tasks from the applicationís host processor. The application processor can do all the "heavy lifting," without being bothered by housekeeping chores.

The P95020 is the first of a new generation of standardized application-specific controllers that incorporates a general purpose microcontroller, a high fidelity audio CODEC including headphone outputs and a 2.5W Class D audio amplifier, full power management functionality, a touch screen controller and a real-time clock, all of which are required by portable consumer devices such as cellular phone handsets, portable gaming devices, digital media players, portable navigational devices, etc. *Fig. 2* shows a block diagram of the P95020. Among its features are:

•General purpose microcontroller that controls the device power-on/power-off sequencing and provides general system housekeeping.

•Two I²C Interfaces, a master for communicating with an external EEPROM and a

Fig. 1. Programmable power regulation blocks and an on-chip power management enable the P95020 to improve system performance and extend battery life.

slave for communicating with the host processor.

- High fidelity audio CODEC which includes a mixer along with headphone outputs and the 2.5 W Class D audio speaker amplifier comprise a total audio solution for portable applications.
- Switch-mode EnergyPath™ Battery Charger operates with its own high efficiency buck regulator to transmit the 2.5 W available from a USB port to the system with minimal wasted power. It can also handle up to 2A from a wall charger.
- Power management features along with switch-mode converters and LDOs are sufficient to provide power for even the most complex hand-held devices.
- White LED module for LCD backlighting.
- Integrated touch screen controller allows adding touch screen capability to devices at significantly reduced cost.
- High quality, low power real time clock.

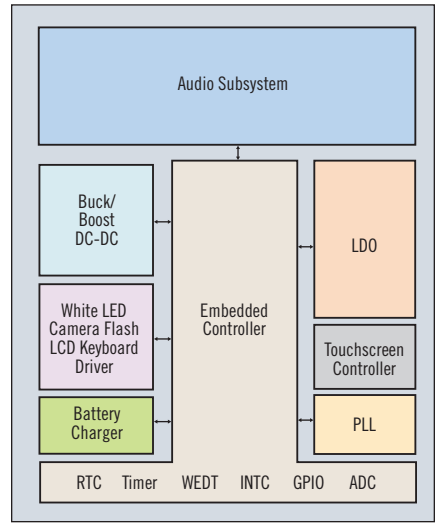

Fig. 2. The P95020 consists of seven functional modules surrounding the embedded controller.

There are two primary functional modes for operation: external processor only or simultaneous internal and external processor operation. In the external processor control mode, the external processor can access all internal registers via the I²C interface and receive interrupts via an interrupt pin, and the internal microcontroller can be powered down or its clock can be gated off.

With the combined internal and external processor mode the P95020's microcontroller will function autonomously or semi-autonomously based on the content of the on-board or external ROM. The external application processor may or may not perform additional control functions through the I²C bus interface. Individual time-based or event-based interrupts generated inside the P95020 may be routed internally or externally to be handled separately. All I²C registers can be simul-

taneously accessed by either the external application processor or the internal microcontroller. Access to the I^2C registers is arbitrated via on-chip hardware arbitration.

CHARGER MODULE

The charger module consists of a switch-mode battery charger, a precision reference and an ideal diode, as shown in *Fig. 3*. It also generates the VSYS power-on-reset when the system is powered up or when a battery or power adapter is attached. The charger consists of three power sources:

- VBUS: Wall Adapter or USB provided power
- VBAT: Battery on VBAT will either deliver power to VSYS through the ideal diode or be charged from VSYS via the charger.
- VSYS: Output voltage of the Switch Mode Pre-Regulator and Input Voltage of the Battery Charger.

Charger operation is hardware autonomous with software redundancy and configuration. On power-up it is configured for a generic charging algorithm by default, which is mask defined. Input current limiting selection is set by current limit configuration register on power-up. After power-up the current limit can be set for either a 500mA or 1.5A.

The charger's pre-regulator is a buck converter that can provide currents up to 2A. It monitors the external input voltage and, when this voltage is high enough, regulates VSYS to 3.6v or (VBAT+0.3V) whichever is greater. Under-voltage lockout (UVLO) will stop the regulator from running if the input voltage gets too low. This module produces the status of whether the adapter input (VBUS) is ready/powered so the system will be aware of the power source of the whole system, and can adjust the operating parameters accordingly.

LED POWER MODULE

The LED power module is a current mode PWM boost converter that provides power to one or two strings of white or colored LEDs used in LCD displays and keyboard backlighting (*Fig. 4*). The converter also includes two regulated current sink drivers with internal FETs, providing two outputs each containing the same number of LEDs up to 25 mA each or a single (combined) output up to 50 mA total. Safe operation is ensured by a user-programmable over-current limiting function and by output over-voltage pro-

tection operation at a user-selectable switching frequency of either 1MHz or 500kHz.

BOOST5 MODULE

The BOOST5 is a synchronous, fixed frequency boost converter, delivering high power to the Class D Audio Power

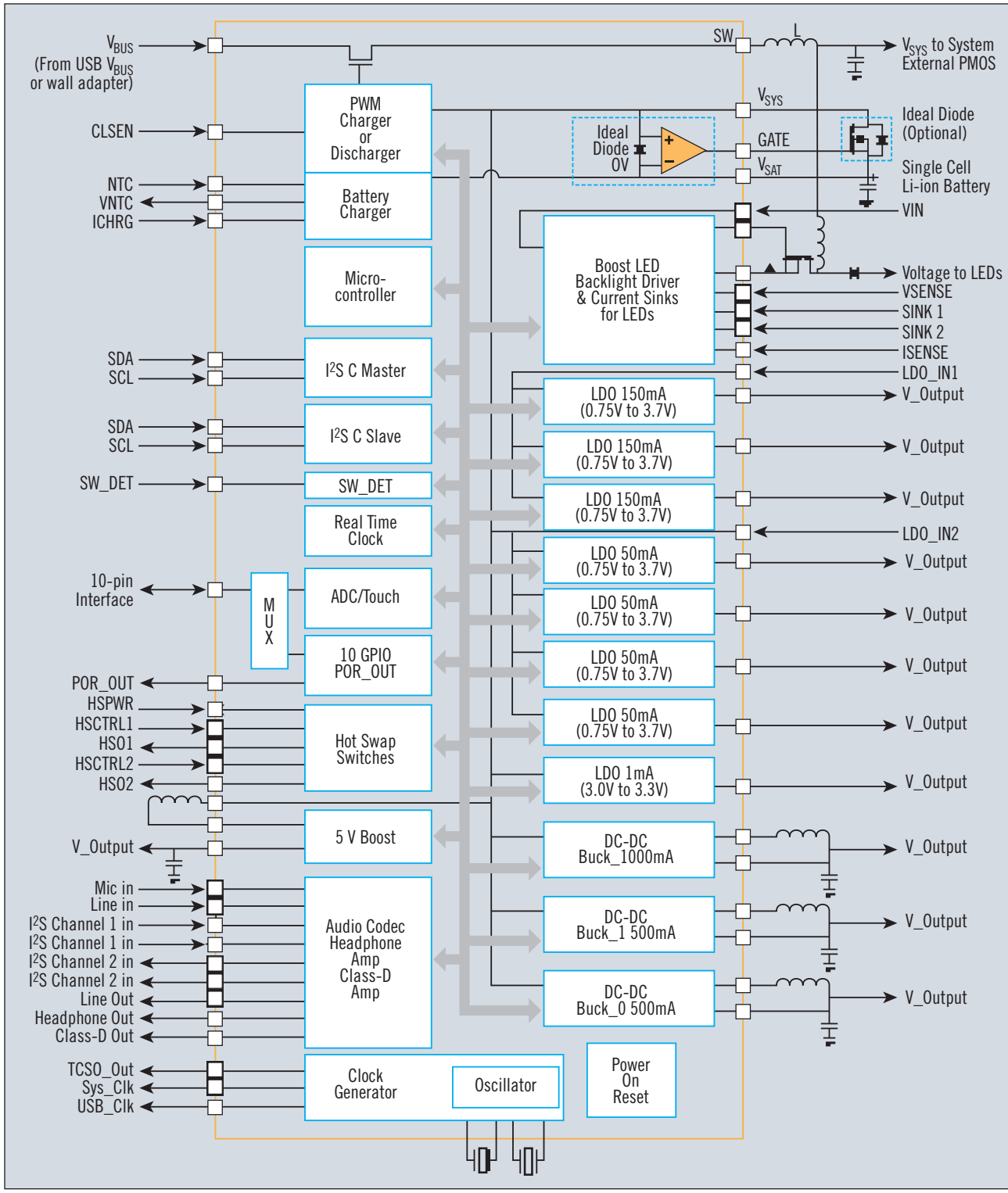

Fig. 3. Charger module software supports several charging algorithms and the hardware includes a switch-mode battery charger, precision reference and an ideal diode.

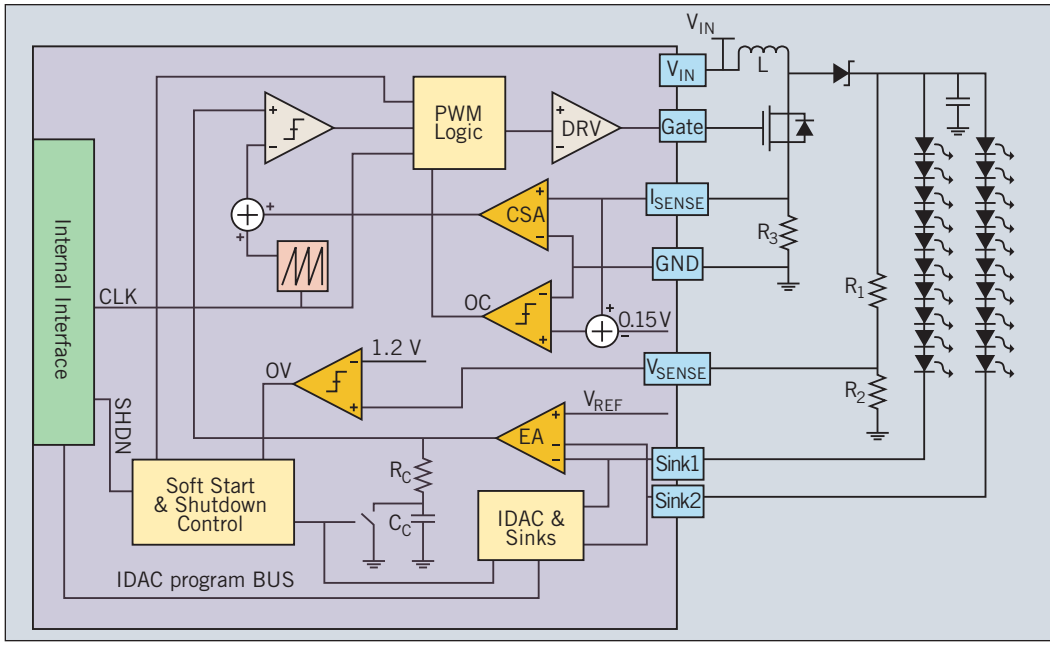

Fig. 4. The LED module's power converter is fully compensated and requires no additional external components for stable operation at a user-selectable switching frequency of either 1MHz or 500kHz.

Amplifier and LDOs requiring input voltages greater than the system voltage.

A switching frequency of 1.0MHz minimizes solution footprint by allowing the use of small, low profile inductors. The current mode PWM is internally compensated, reducing external part count.

As shown in *Fig. 5*, there is a direct path from VIN through the external inductor (L) into the BOOST5_SWn pins, through SR1 to the BOOST5_OUT pin, which directly charges the output capacitor (COUT) to ~VIN. During startup, the converter continues charging to the programmed output voltage using soft start. During soft-start, the BOOST5 limits the peak inductor current for the first 500 µs. The voltage value in the output voltage register may be changed during soft-start.

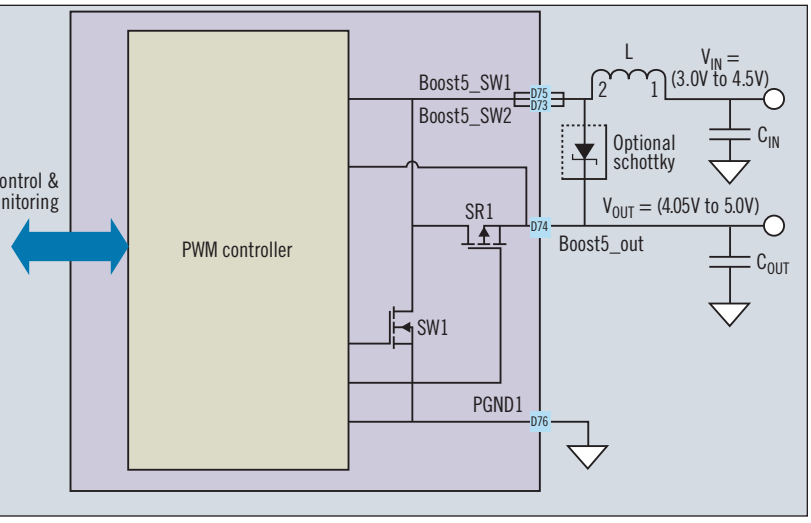

Fig. 5. The BOOST5 module contains an internal NMOS switch and PMOS synchronous rectifier. It can supply 5.0V at 700mA

During normal operation, the BOOST5 converter provides cycle-by-cycle current limiting. If the output voltage drops below VIN, current limiting is no longer possible. A Schottky diode should be used if the converter output voltage is 4.5V or greater. The Schottky diode carries the output current for the time it takes for the synchronous rectifier to turn on.

The P95020 includes two types of LDOs for external use: normal LDOs (NMLDO) and one low-power, always on LDO (LPLDO). Features include:

- Four external use LDOs with current output up to 50mA
- Output voltage adjustable in 25mV steps from 0.75V to 3.7V
- Three external use LDOs with current output up to 150mA
- Initialization and power sequencing controlled by an external host processor or the embedded microcontroller
- Output voltage adjustable in 25mV steps from 0.75V to 3.7V
- One user-selectable (3.0V or 3.3V), always-on low-power LDO
- 10mA maximum output current

The P95020 also includes LDOs that are used by other functional blocks within the device. The LDOs used by the audio module are powered by a dedicated power input.