Programmable Power Management for Small Networks

Modern electronic systems require a large number of rails for DSP, Core, RF PA, IO and Memory. A case in point is Smaller Communications Networks such as Small Cells, Picocells and Femtocells.

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Exar offers universal PMICs that offer multi-rail DC/DC converters in a small package. These converters are synchronized to minimize board noise and EMI. PMICs offer a host of advanced features from precisely programmable control loop parameters and fault monitoring and reporting to high power conversion efficiency and rail sequencing.

System solution

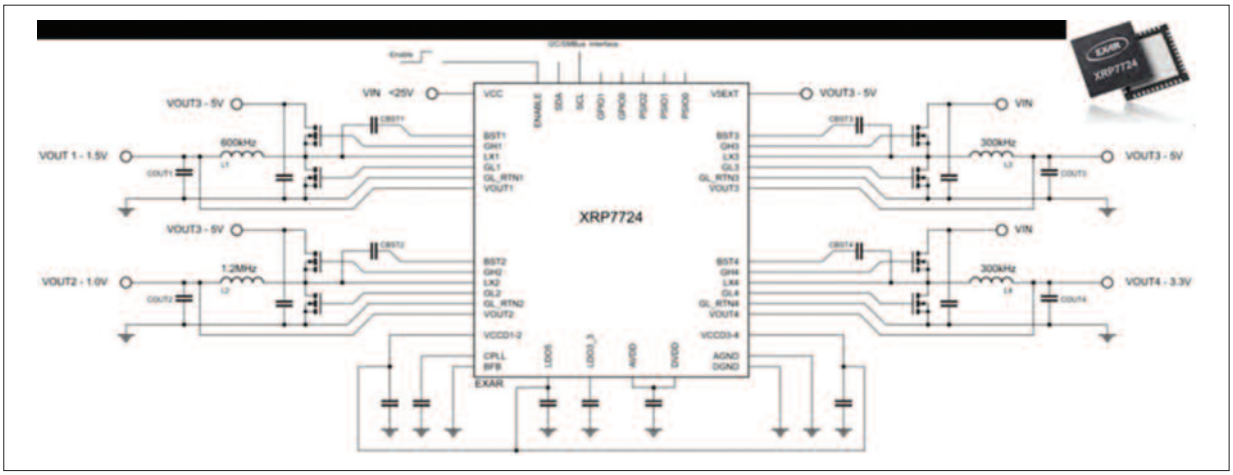
To address all of the above requirements in one elegant and complete solution, the universal PMIC P/N XRP7724 that packs four complete and independent PWM controllers in a TQFN package measuring 7mm x7 mm that feature a patented light load mode for low power dissipation and high efficiency at low output currents (see Figure 1). It provides a number of critical safety features, such as Over-Current Protection (OCP), Over-Voltage Protection (OVP), Over Temperature Protection (OTP) plus input Under Voltage Lockout (UVLO). In addition, a number of key health monitoring features such as warning level flags for the safety functions, Power Good (PGOOD), etc., plus full monitoring of system voltages and currents. The above are all programmable and/or readable from the SMBus and many are steerable to the GPIOs for hardware monitoring by the system controller.

Functional overview

Within the Quad Synchronous Buck controllers integrated MOSFET Drivers with 17 ns and 11 ns rise and fall times will help achieve very low switching losses resulting in higher efficiency allowing the system PCB to operate at lower temperature and hence higher reliability. Figure 2 shows very high efficiency at both low and high end of the load current due to the utilization of light load mode at low output current and PWM at higher loads.

Patented Over-Sampling (OVS) mode guarantees fast transient responses under demanding load conditions. In OVS mode the output voltage is sampled four times per switching cycle. If the voltage goes outside the set high or low limits, the OVS control electronics can immediately modify the pulse width of the GH or GL drivers to respond accordingly, without having to wait for the next cycle to start.

Power supply designers are often faced with limited PCB real estate allocation for the power system forcing them to use all the tools in their arsenal to shrink the size



ABOVE Figure 1: **XRP7724 offers four complete PWM controllers**

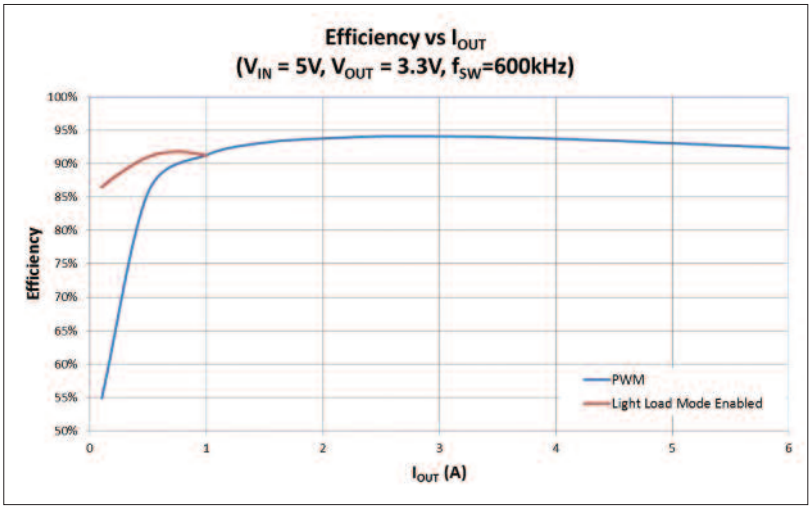


Figure 2: **Efficiency at 5 V input to 3.3 V output**

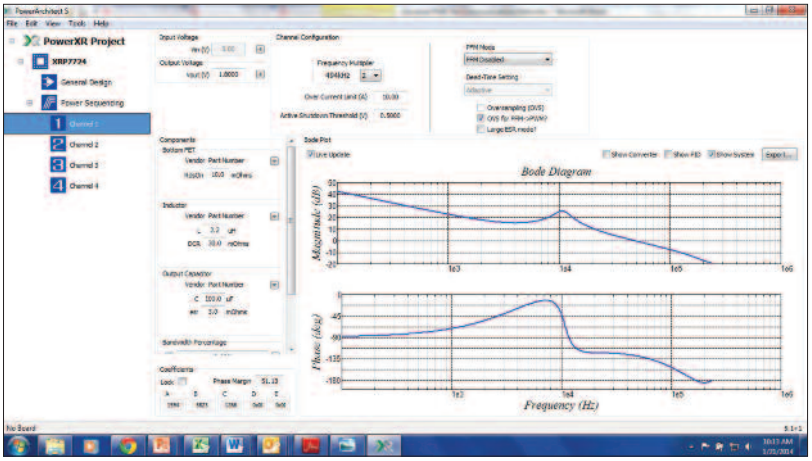


Figure 3: Final PA5.1 screen showing all the selected and calculated parameters

of any converter. To that end, this device allows for setting the switching frequency independently for each channel using Digital PWM 105kHz-1.23MHz Operations with guaranteed synchronous operation between all four channels. Furthermore, since the choice of the switching frequency affects the EMI spectrum of complex system with multiple of rails hence, the final choice will support the design objectives in efficiency, size and EMI.

For maximum flexibility and to allow the system designer total control over the implementation and performance, a sophisticated design tool PowerArchitect™ 5.1 is available. This GUI-based wizard helps with the power train components selection like the output inductors and capacitors as well as the control loop design. XRP7724 offers a programmable 5 coefficient PID control and depending on the user's choice of switching frequency, output voltage and current a Bode Plot will be generated. The user can either accepts it or the PID parameters can be modifed to suit the exact requirements.

Figure 3 depicts the final screen with the selected switching frequency, output filter inductance and capacitance. Also shown are, the PID coefficients, Bode plot, phase margin and the control loop bandwidth for channel 1. All the related parameters are under the user's control to fine tune or completely change. This is the ideal environment for "What if?" scenarios where the response is a mouse click away.

I²C communication

The SMBus Compliant - I²C interface is a valuable tool to enable communication with a System Controller or other Power Management devices for optimized system function. This is achieved through a number of functionalities.

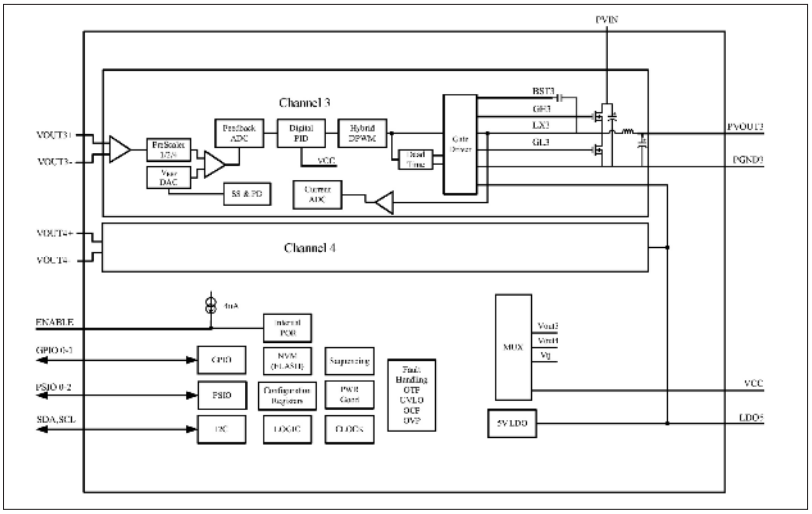
Measurements of per channel input and output voltages and output current allows the controller to gauge the system power demand at any time and implement fine tuning on the fly adjustments to individual rails. This includes voltage margining i.e. incrementally ramp up or down the output voltage for optimum performance like in the case of CPU sleep mode.

Measurement of part temperature is a most valuable reading from the reliability and continuous operation point of view. The system controller can implement software routines to manage power consumption on an overall system basis by allowing consecutive sequencing of power demand when possible rather than simultaneous demand.

At times of low activities, a standby and sleep modes may be implemented by enable and/or disable individual rails or by voltage margining bringing the power consumption to a minimum and reducing the overall demand on the system. Additionally reporting of fault conditions: over voltage, over current and over temperature the system controller can on a dynamic basis adjust all fault limits as well as disabling/enabling faults.

The XRP7724 has two internal Low Dropout (LDO) linear regulators that generate 5.0 V at 130 mA and 3.3 V at 50 mA for both internal and external use.

BELOW Figure 4: Block diagram of XRP9710 power module



Building block for power modules

The XRP7724 has been used as the quad controller in Exar's XRP9710/11 family of power modules.

The XRP9710 (see Figure 4) and XRP9711 are multi-output, synchronous step-down, programmable power modules that offer high power density and low profile at 2.75 mm with 5 – 22 V inputs. Both devices provide two fully integrated regulators with MOSFETs, inductors, and internal input and output capacitors in a compact 12x12x2.75mm package that support loads up to 6 A each. The XRP9711 also offers two controller outputs that are each capable of driving loads up to 30 A, making it the first module to offer two fully integrated channels and two controller outputs.

These new power modules offer full control via the I²C interface allowing for advanced local- and remote-reconfiguration, full performance monitoring and reporting, as well as fault handling. The output voltages can be programmed from 0.6 V up to 5.5 V without requiring any external components. The XRP9710 and XRP9711 come also with the newly released PowerArchitect 5.1 design tool.

Conclusion

XRP7724 is an advanced quad channel Power Management IC (PMIC) that is designed to address all the major requirements of the modern power delivery systems in telecommunications products like Small Cells, Picocells and Femtocells. They are the ideal choice for this application with their quad channel synchronous buck controllers with PWM/light load mode modulation for high efficiency to its comprehensive fault detection and reporting and very small footprints which all translate to high reliability and uncompromising performance