DVS for OMAP1510 Using TPS62200

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ABSTRACT

Portable electronics with long battery lives are unquestionably more marketable. Power consumption of the microprocessor can be reduced by lowering the internal clock frequency and/or even more by lowering the core supply voltage. Dynamic voltage scaling (DVS) is used to reduce core supply voltage to minimize power consumption. This application note explains how to implement DVS using a TPS62200 buck converter to power an OMAP1510 processor.

The following relationship describes the power consumption of a TI-DSP based core:

$P_C \sim (V_C)^2 \times f$

where P_C is the core power consumption, V_C is the core voltage, and f is the core clock frequency.

Thus, power consumption can be reduced by lowering the internal clock frequency and/or even more by lowering the core supply voltage. Dynamic voltage scaling (DVS) is used to reduce core supply voltage to minimize power consumption. This application note explains how to implement DVS using a TPS62200 buck converter to power an OMAP1510 processor.

The OMAP1510 processor has two modes of operation, AWAKE mode and low-power DEEP-SLEEP mode. In AWAKE mode, the OMAP1510 processor requires 1.5 V. In DEEP-SLEEP mode, the processor operates at either 1.1 V or 1.5 V. In DEEP-SLEEP mode, with V_{DDx} = 1.1 V, the OMAP1510 processor consumes minimum power. Figure 1 shows a circuit for implementing DVS with the TPS62200 adjustable buck converter, an additional feedback resistor R_X and the digital control signal, called Low Power Mode (LPM), which goes low to indicate the step down from 1.5 V to 1.1 V.

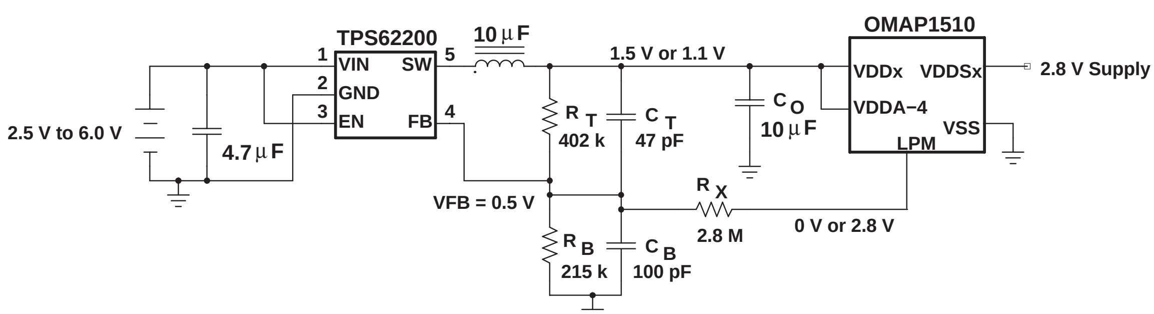

Figure 1. DVS for OMAP1510 Using TPS62200

The control signal, LPM, injects current into the feedback network through R_X, thereby, changing the output voltage. Equations 1 and 2 were written by summing the currents at the feedback node, V_{FB}. Simultaneously solving equations 1 and 2 then substituting back and solving for R_B yields equations 3 and 4. These equations show how to compute the values of the injection resistor, R_X, and bottom feedback resistor, $R_{B,}$ in Figure 10, given R_T = 402 kΩ, V_{O_HI} = 1.5 V, V_{O_LO} = 1.1 V, V_{LPM_HI} = 2.8 V, V_{LPM_LO} = 0 V and V_{FB} = 0.5 V.

$$\frac{V_{FB}}{R_B} + \frac{\left(V_{FB} - V_{O\_HI}\right)}{R_T} + \frac{\left(V_{FB} - V_{LPM\_LO}\right)}{R_X} = 0 \tag{1}$$

$$\frac{V_{FB}}{R_B} + \frac{\left(V_{FB} - V_{O\_LO}\right)}{R_T} + \frac{\left(V_{FB} - V_{LPM\_HI}\right)}{R_X} = 0 \tag{2}$$

$$R_B = -V_{FB} \times R_T \times \frac{\left(-V_{LPM\_HI} + V_{LPM\_LO}\right)}{\left[\left(-V_{O\_HI} + V_{O\_LO} + V_{LPM\_LO} - V_{LPM\_HI}\right) \times V_{FB} - V_{LPM\_LO} \times V_{O\_LO} + V_{LPM\_HI} \times V_{O\_HI}\right]} \tag{3}$$

$$R_X = R_B \times R_T \times \frac{\left(-V_{FB} + V_{LPM\_HI}\right)}{\left(V_{FB} \times R_B + V_{FB} \times R_T - V_{O\_LO} \times R_B\right)} \tag{4}$$

Figure 2 shows a transition between output voltages when the load current has been reduced to 300 µA. The long transition time is due to the slow discharge of the 10-µF output capacitor from 1.5 V to 1.1 V with only 300-µA load current.

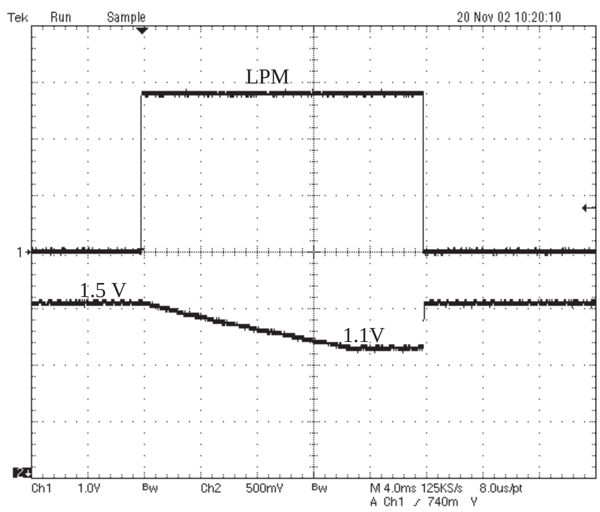

Figure 2. Transition Between Two Output Voltages

The TPS62200 is ideal for providing DVS. It switches between PWM mode, which is more efficient at higher load currents seen in OMAP1510's AWAKE mode, to PFM mode, which is more efficient at the few hundreds of microamps consumed during DEEP-SLEEP mode.

For example, consider a OMAP1510 chip powered by a TPS62200 with a 3.6-V, 1-Ahr Li-Ion battery input, and the following characteristics:

DEEP-SLEEP (TPS62200 in PFM) without DVS:	V_O = 1.5 V at 300 µA Efficiency = 93%
DEEP-SLEEP (TPS62200 in PFM) with DVS:	V_O = 1.1 V at 250 µA Efficiency = 93%
AWAKE (TPS62200 in PFM):	V_O = 1.5 V at 100 mA Efficiency = 96%

Assuming a usage profile of 5% AWAKE and 95% DEEP-SLEEP, using DVS in DEEP-SLEEP mode extends battery life by 9 hours.

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