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APPLICATION NOTE 1053

VDDQ Supply for Server DDR Memory Using PWM Step-Down Controller

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Abstract: DDR memory has become extremely popular in servers and personal computers due to its fast data transfer rate and cost. The DDR memory requires main memory supply also known as VDD and a tracking termination supply VTT. The MAX1917 is a versatile quick PWM step-down controller capable of sinking and sourcing up to 25A of current. This application note illustrates the use of MAX1917 as the VDD supply for DDR memory in servers.

The MAX1917 is a PWM controller that generates the termination voltage supply (VTT) for DDR memories. In such applications, the output voltage, VTT, tracks the DDR memory supply voltage, V_{DD}, which is fed to the DDR pin.

The MAX1917 also can be used to generate the VDDQ supply voltage, from either a 5V or 12V input source, by connecting its reference voltage to the DDR pin. **Figure 1** shows the schematics for 12A output current.



Figure 1. The MAX1917 for VDDQ supply voltage application.

The MAX1917 could be used for other non-tracking applications with output voltage from 1.0V and up,

such as processor core voltages and DSP core voltages. One of the advantages of the MAX1917 is the fast transient response (responding within one switching cycle for a step load change). Therefore, it is suitable for high-speed applications. Another feature of the following application circuit is that the switching frequency can be set from 200kHz to 1MHz by changing the value of R6. Such a feature optimizes the external component selections.

Table 1 lists the component information.

Table	1.	Bill	of	Materials	for	2.5V/15A	Application
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Comp.	Description	Vendors
C1	$1.0\mu\text{F}/25\text{V}$ ceramic cap, TMK316BJ105ML, 20m Ω max esr.	Taiyo Yuden
C2	$4X330\mu$ F/25V aluminum caps, ZA series, $26m\Omega$ max esr.	Rubycon
C3	4.7μ F/10V ceramic cap, JMK212BJ475MG, 20m Ω esr max.	Taiyo Yuden
C4	0.47µF/10V ceramic capacitor, LMK107BJ474MA	Taiyo Yuden
C5	$10\mu\text{F/6.3V}$ ceramic capacitor, JMK316BJ106ML, $20m\Omega$ max esr.	Taiyo Yuden
C6	3X560µF, 4SP560M, 14m Ω max esr each capacitor.	Sanyo
C7	0.22µF/10V ceramic capacitor, LMK107BJ224MA	Taiyo Yuden
D1	30V/100mA Schottky diode, CMPSH-3	Central Semi.
L1	0.75µH/24A, CDEP149-0R7NC, (esr, 1.2mΩ max)	Sumida
Q1	IRF7822	IR
Q2	2XIRF7822	IR
Q3	2N7002K	Siliconix
R1	400k, 1%	
R2	5.1k, 5%	
R3	20k, 5%	
R4	15k, 0.1%	
R5	10k, 0.1%	
R6*	1.78k. 1%	

*See equation (2).

Set the Output Voltage

According to the schematic shown in Figure 1, the feedback reference voltage is set to 1.0V. The output voltage can be adjusted from 1.0V and up. The following equation determines the output voltage:

$$V_0 = (1 + \frac{R4}{R5}) \cdot 1.0 V.$$
 (1)

Set the Switching Frequency

The switching frequency of the MAX1917/8 can be set to either 300kHz or 550kHz by leaving the FSEL pin floating or connecting it to ground. However, the switching frequency can be set anywhere between 300kHz to 1MHz by adding one resistor (R6). The actual switching frequency is given by,

$$f_{\rm S} = \frac{V_{\rm O}}{1.82} \cdot \frac{R6}{R2 + R6} \cdot 10^3 \, \text{kHz.}$$
 (2)

For the above equation to be true, the FSEL pin should be grounded. The corresponding off time is given by,

$$T_{OIf} = \frac{1}{f_S} - \frac{1.82}{V_{IN}} \cdot \left(1 + \frac{R2}{R6}\right) \mu s.$$
(3)

The switching frequency is independent of the input voltage. However, the off time depends on the input voltage. The MAX1917 has a minimum off time of 350ns typical and 400ns max. Therefore, one should be very careful when choosing the switching frequency at low input voltage (5V input) to make sure that the required off time from Equation 3 is at least 1.4 times of the minimum off time to meet the transient response requirements.

Figure 2 shows the converter efficiencies as a function of load current for 5V and 12V inputs respectively. It is evident that the converter exhibits very high efficiencies for load current less than 12A. The figures below (**Figure 3a** and **3b**) show the output ripple voltage and the low side MOSFET drain to source voltage waveforms for 5V and 12V inputs respectively. The output ripple voltage is maintained less than 25mV for 5V input and less than 50mV for 12V input. Large output inductor, (for example 1.5μ H, Sumida CEP125-1R5-H), should be used to keep the ripple voltage less than 1% of the output voltage at 12V input.



Figure 2. Efficiency vs output load current.







Figure 3b. Output ripple voltage and low side MOSFET Vds waveforms at 12V input.

Related Parts		
MAX1917	Tracking, Sinking and Sourcing, Synchronous Buck Controller for DDR Memory and Termination Supplies	Free Samples

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