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APPLICATION NOTE 1803

Simple Circuit Provides +5V Gate Bias from -48V Input

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Abstract: In this design idea a small circuit with six components derives 5V gate bias from the -48V rail widely used in telecom applications. The MAX6138 shunt voltage reference and the MAX1683charge pump are featured in the design.

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A small and simple circuit (**Figure 1**) derives +5V from the -48V rail widely used in telecom applications. Useful for gate bias and other purposes, the 5V supply delivers up to 5mA. A shunt reference (U1) defines -5V as ground reference for a charge pump (U2), and the charge pump doubles this 5V difference (between system ground and charge pump ground) to produce +5V with respect to the system ground.

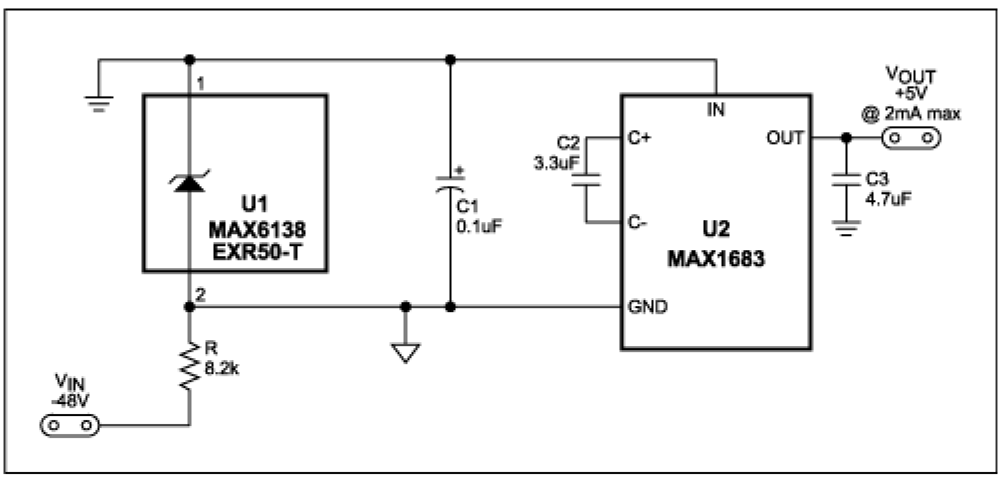

Figure 1. This small circuit (six components) produces 5V at 5mA from a -48V input.

The shunt reference maintains 5V across its terminals by regulating its own current (I_S), which in turn is determined by the value of R. Current through R (I_R) is fairly constant, and varies only with the input voltage. I_R, the sum of the charge-pump and shunt-reference currents ($I_R = I_{CP} + I_S$), has maximum and minimum values set by the shunt reference.

The shunt reference sinks up to 15mA, and requires 60µA minimum to maintain regulation. Maximum I_R

is determined by the maximum input voltage. To prevent excessive current in the shunt reference with no load on the charge-pump output, use the maximum input voltage (-48V -10% = -52.8V) when calculating the minimum value of R. The maximum reference sink current (15mA) plus the charge pump's no-load operating current (230µA) equals the maximum I_R value (15.23mA). Thus,

$$R_{MIN} = (V_{IN(MAX)} - V_{REF})/I_{R(MAX)} = (52.8V - 5V)/0.01523A = 3.14k\Omega.$$

Choose the next-highest standard 1% value, which is 3.16kΩ.

Guaranteed output current for the charge pump is calculated at the minimum line voltage: -48V + 10% = -43.2V. The charge pump's maximum input current is:

$$I_{CP} = (V_{IN(MIN)} - V_{REF})/R - I_{SH(MIN)} = (43.2V - 5V)/3.16k\Omega - 90\mu A = 12mA,$$

where 90µA is the minimum recommended operating current for the shunt reference. Assuming 90% efficiency in the charge pump, the output current is

$$I_{OUT} = (I_{CP}/2) \times 0.9 = (12mA/2) \times 0.9 = 5.4mA.$$

Charge-pump input current is halved, because output voltage is twice the input voltage. Power is dissipated via the shunt reference under no-load conditions, so be sure that R can handle the resulting wattage. A 1W resistor suffices in this case.

Related Parts		
MAX1683	Switched-Capacitor Voltage Doublers	Free Samples
MAX6138	0.1%, 25ppm, SC70 Shunt Voltage Reference with Multiple Reverse Breakdown Voltages	Free Samples

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