Description

Four 2.5V supercaps in series are balanced using the quad supercapacitor auto balancing (SAB) MOSFET ALD810026. ALD810026 has a threshold voltage, \( V_t \), equal to 2.60 volts. When the gate-source voltage, \( V_{GS} \), is equal to \( V_t \), the \( I_{DS} \) ON current for M1/M2/M3/M4 is set at \( 1\mu A \). The \( I_{DS} \) ON current of M1/M2/M3/M4 change exponentially with slight changes in \( V_{GS} \). Each SAB MOSFET \( M_X \) behaves like a voltage sensitive resistor (See sabfet_11101.0). At \( V_{GS} \) voltages below or above \( V_t \), the SAB MOSFET \( I_{DS} \) ON current changes at a rate of approximately 1 decade for every 0.1V change in \( V_{GS} \). When \( V_{GS} \) drops low enough, the \( I_{DS} \) ON current becomes essentially zero. In this example, the \( V_{GS} \) voltage of each SAB MOSFET M1/M2/M3/M4 is set at approximately 2.5V, which has a nominal \( I_{DS} \) ON current of 0.1 \( \mu A \). If the \( V_{GS} \) voltage for the ALD810026 falls below 2.0V, the \( I_{DS} \) current decreases to pA range, which is near zero compared to \( 1\mu A \).

The voltages across M1/M2/M3/M4 automatically self-adjust to accommodate different leakage currents for C1/C2/C3/C4. \( V_1 \), \( V_2 \) and \( V_3 \) settle to approximately \( \frac{3}{4} \) (V+), \( \frac{1}{2} \) (V+) and \( \frac{1}{4} \) (V+) respectively, depending upon relative leakage currents of each supercap. With V+ equal to 10V, \( V_1 \) is 7.5V, \( V_2 \) is 5.0V, and \( V_3 \) is 2.5V. The currents through M1/M2/M3/M4 automatically compensate for different supercap voltages. A higher supercap voltage results in a higher corresponding \( V_{GS} \) voltage of \( M_X \) connected across it, at a higher \( I_{DS} \) ON current, which opposes the tendency for the higher supercap voltage to increase. A lower supercap voltage results in lower \( I_{DS} \) ON currents in the corresponding SAB MOSFET until \( I_{DS} \) ON \( \approx \) 0. In equilibrium, the total leakage current across both M1/M2/M3/M4 and C1/C2/C3/C4 network is approximately equal to the highest leakage current of any one of C1/C2/C3/C4.

For full schematic diagram and notes, please register and login at aldinc.com