Description

Two 5.0V supercaps in series are balanced using two MOSFETs each of the quad supercapacitor auto balancing (SAB) MOSFET ALD810025. The ALD810025 quad SAB MOSFET has a threshold voltage, $V_t$, equal to 2.5 volts. When the gate-source voltage, $V_{GS}$, is equal to $V_t$, the $I_{DS}$ ON current for each SAB MOSFET M1/M2/M3/M4 is set at 1µA. The $I_{DS}$ ON current of M1/M2/M3/M4 change exponentially with slight changes in $V_{GS}$. Each SAB MOSFET MX 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. For example, if the $V_{GS}$ voltage for the ALD810025 falls below 1.9V, the $I_{DS}$ current decreases to pA range, which is near zero compared to 1µA.

The voltages across M1/M2 automatically self-adjust to accommodate different leakage currents for the supercap C1 and the voltages across M3/M4 automatically self-adjust to accommodate different leakage currents for the supercap C2. $V_1$ settles to approximately ½ ($V_+$), depending upon relative leakage currents of each supercap in the stack. With $V_+$ equal to 10V, $V_1$ is 5.0V. Since there are two SAB MOSFETs in series for each supercap, the voltages across M1/M2 automatically compensate the C1 voltage, and the voltages across M3/M4 automatically compensate the C2 voltage. A higher supercap voltage results in a higher corresponding $V_{GS}$ voltage of MX 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 ≈ 0. In equilibrium, the total leakage current across both M1/M2/M3/M4 and C1/C2 of each network is approximately equal to the highest leakage current of any one of C1/C2.

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