AN922
APPLICATION NOTE

Using a Super Cap to Back-up The M41T56, M41T00 and M41T11

The M41T56, M41T00 and M41T11 TIMEKEEPER devices, from STMicroelectronics, are used by applications designers who need a single chip device that offers fast SRAM storage and an integrated Real Time Clock (the M41T00 provides the Real Time Clock only). Many of their designs switch in a battery to maintain the data, and to keep the clock running, when the external power supply falls below specification (or even becomes completely absent). When the battery is depleted, though, the designer or user can be faced with the issues of replacement and disposal (though see *AN1011*).

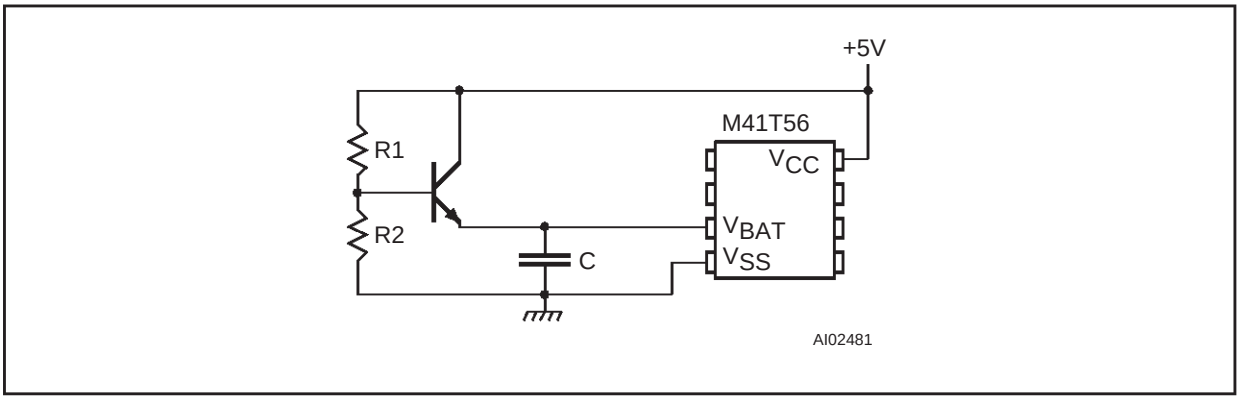
This document describes a more maintenance-free way to sustain the data and clock in systems that only experience short breaks in the power supply (on the order of days). A super cap can be used as a type of secondary cell (a rechargeable battery) and can therefore provide an alternative solution to using a primary cell. Figure 1 (for the M41T56) and Figure 2 (for the M41T00 and M41T11) show two typical circuit arrangements. (Since the super cap is limited to a certain maximum charging current, a series limiting resistor may also be required. Please consult the data sheet of the super cap.)

In this document, the reliability, leakage current, and charging cycle limitations of the super cap have not been taken into account. Please consult the data sheet of the super cap for details.

CALCULATING THE VALUES OF THE CIRCUIT COMPONENTS FOR THE M41T56

The minimum voltage for this device is 2.6 V, and the maximum supply voltage is 3.5 V. (Charging the capacitor above 3.5 V will result in a higher V_{PFD} trip point, and can thereby cause inadvertent deselection of the device at nominal V_{CC} values). This gives the maximum delta voltage swing across the capacitor (0.9 V). In this circuit the voltage divider provides a bias on the transistor, so limiting the maximum voltage charge on the capacitor to be V_{BASE} - V_{BE}. Thus V_{BASE}=maximum supply voltage + V_{BE}. V_{BE} is typically 0.6 V, so giving a value of 4.2 V for V_{BASE}. The resistor divider can be calculated according to the ratio of V_{CC} to V_{BASE}.

Figure 1. External Connections to the M41T56



Recommended starting values for R1 and R2 are R1=22 kΩ and R2=100 kΩ. Since the battery current, I_{BAT}, is limited to maximum value of 500 nA, the capacitance and the duration of "power out time" can be calculated using the formula I=C.ΔV/Δt (where I=500 nA, ΔV=0.9 V, C=capacitance in Farads, and Δt = "power out time" in seconds). Using a 100,000 µF capacitor, for example, the equation would be 500 nA = 0.1 F x 0.9 V/Δt. Solving for Δt, the maximum power down time is about 180,000 seconds. This is approximately one and a half days.

CALCULATING THE VALUES OF THE CIRCUIT COMPONENTS FOR THE M41T11 AND M41T00

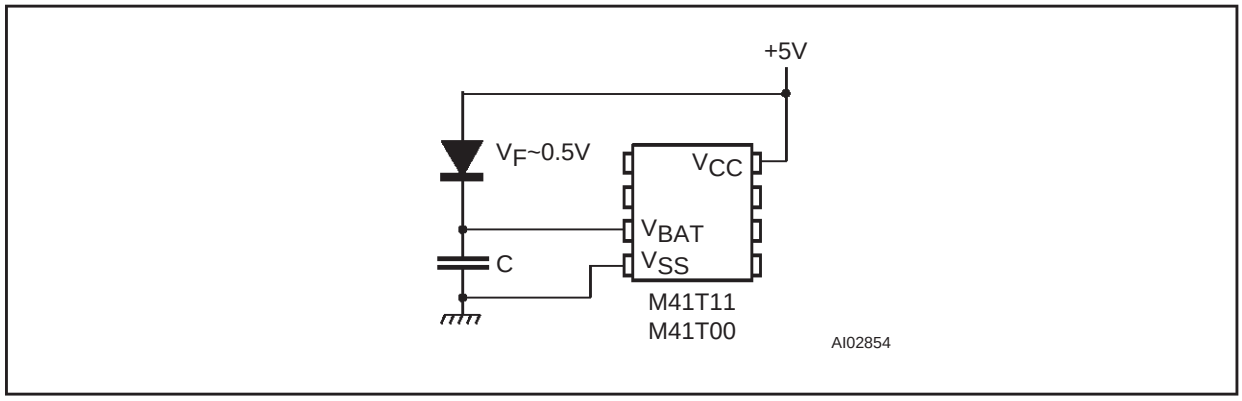
The minimum operating voltage for these devices is 2.0 V, with a typical V_{BAT} voltage of V_{CC} - V_F (diode). The deselect and switch-over point (V_{SO}) for the M41T00 and M41T11 is V_{BAT} - 0.5 V (typical). Therefore, the typical delta voltage swing across the capacitor is:

$\Delta V = V_{CC} - [V_F + V_{SO}(offset)] - V_{CC}(min)$

$= 5.0\ V - [0.5\ V + 0.5\ V] - 2.0V$

$= 2.0\ V$

Figure 2. External Connections to the M41T00 and M41T11



Since the battery current (I_{BAT}) is limited to maximum value of 1.0 µA, the capacitance and the duration of "power out time" can be calculated using the formula I = C.ΔV/Δt (where I=1.0 µA, ΔV=2.0 V, C = capacitance in Farads, and Δt = "power out time" in seconds). Using a 100,000 µF capacitor, for example, the equation would be 1.0 µA = 0.1 F x 2.0 V/Δt. Solving for Δt, the maximum power down time is about 200,000 seconds. This is 55.6 hours or 2.3 days.

If you have any questions or suggestions concerning the matters raised in this document, please send them to the following electronic mail addresses:

apps.nvram@st.com (for application support)
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Please remember to include your name, company, location, telephone number and fax number.