RX-8035 / 4035

Solution for RTC power supply switch circuit problems

[Preface]

Generally, a real-time clock updates the calendar data and time data continuously by the crystal oscillation. To maintain and safeguard this data, a data holding circuit is used in case of a main power shut off or a power failure to seamlessly and timely switch from the main power supply to the battery backup.

Currently, there are 2 general methods to implement the data holding circuit. The first is to use a specified power management LSI, but this is expensive and takes up more space on the board. The second and more popular solution is to implement a simple low cost diode-OR circuit [Fig. 1]. However, this circuit has some technical issues which is hard to control. This white paper will explain these technical issues and propose our new RTC that resolves these issues.

[1] Problem 1: Battery Power Loss

With a diode, there are two characteristics that have to be considered. The first is the forward direction voltage drop characteristic (VF), and the second is the reverse leak current characteristic (IR).

Generally, VF is about 0.6V across the diode so if the main power supply is 3.0V, the actual voltage is only about 2.4V. This voltage drop causes less charge voltage when used to charge a rechargeable battery or an electric double layer capacitor which as a result shortens the battery back-up time.

A schottky barrier diode is a solution for this VF issue due to its low voltage drop, but it has a large IR value which allows The current to flow from the battery towards the main power supply when it is turned off (down to 0V). This again contributes to a shorten battery back-up time. This reverse leak current is illustrated on [Fig. 2]. Furthermore, the IR characteristic has a high temperature dependence [Table 1].

For these reasons, every engineer considers the temperature specification range of their product and select diodes which have best balance of VF and IR that matches their system's overall conditions, but it is not easy to find that balance.

[2] Problem 2: Clock Data Destructive Risk

Due to the VF characteristics of a diode, a potential difference may occur at the power supply voltage of the CPU and RTC. If the CPU accesses the RTC in this state, the input voltage from CPU may exceed the input voltage max. range of RTC. In this case, the internal register bit value may change irregularly, typical in a CMOS semiconductor type product. In addition, it may impact the I/F input, output enable (OE) input voltage and pull-up voltage of the CMOS clock output. Usually, a CMOS semiconductor's input max. voltage is only Vdd+0.3V, so a potential difference of 2.4V at the RTC versus 3.0V at the CPU may cause the risks mentioned above [Fig. 1]. To avoid these risks, a schottky diode with low VF is used, but one faces the reverse leak current issue.

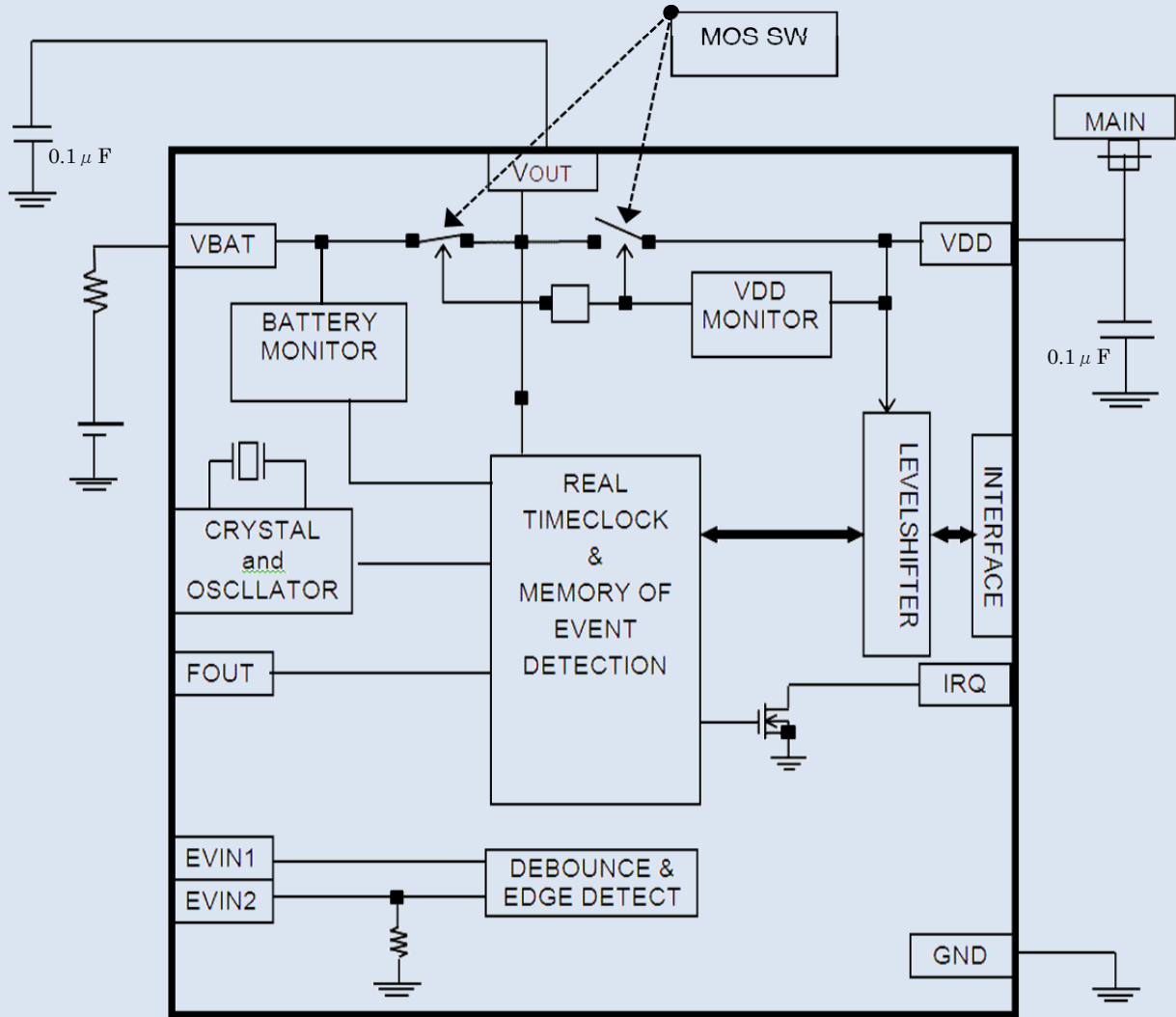[Fig.1] Power supply switch circuit of Diode-OR circuit

Voltage drop

Main power supply 3V

2.4 V

RTC

3.0 V

CPU

←3V Battery
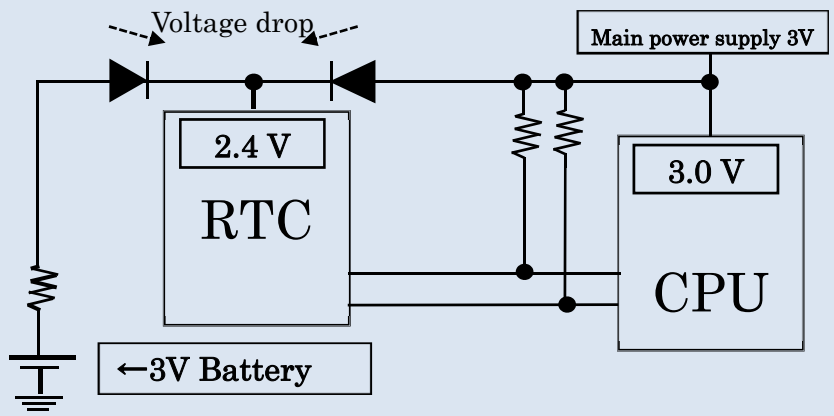
[Fig.2] Leak electric current (dashed line) at Main power supply off

Main power supply OFF

0.0 V

RTC

CPU
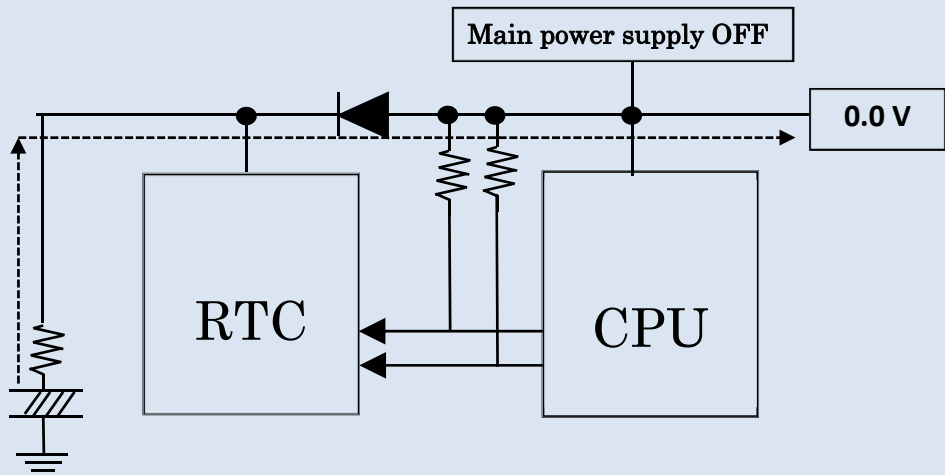
[Table 1] Example of IR characteristic vs. Temperature

Schottky barrier diode Reverse leak electric current (IR) characteristic at 3.0V		
Temperature	25℃	75℃
A company	0.2 μ A	6 μ A
B company	2 μ A	40 μ A

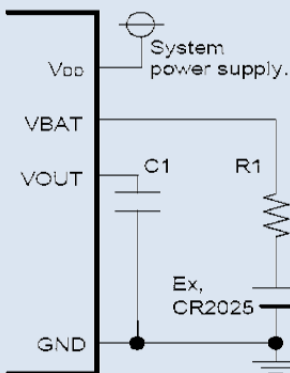[3] SOLUTION: RX-8035/4035 has <u>internal</u> power switch circuit

Epson's RX-8035/4035 is a real-time clock with a power supply switch circuit built internally. It uses a PMOS SW instead of a TR or usual diode, which can control VF <0.12V and IR <30nA in a stationary state. With such low VF <u>and</u> low IR compared to the diode solutions, it helps to minimizes clock data risks and provides extended battery backup time. In addition, the RX-8035/4035 frees up board space as it only requires two 0.1uF bypass capacitors for VDD and VOUT terminal.
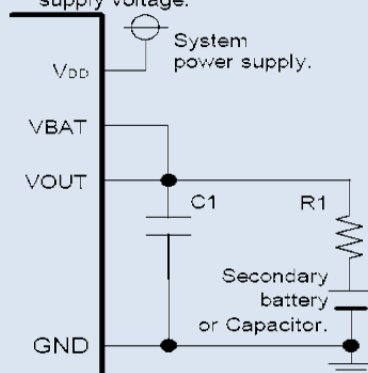
[Connection circuitry of RX-8035/4035]

A main power supply and a battery, a rechargeable battery or an electric double layer capacitor