AN-1192 Power Duty Cycle Controller to Prolong Battery Life, with MCU Programmable Duty Cycle

Some battery powered products, particularly Internet of Things (IoT) sensor transceivers, are best powered intermittently, to prolong battery life. For example, say a transceiver only needs to check for a signal once per second. Based on this period, a duty cycle controller turns on power to the transceiver and controlling MCU. Once the MCU has determined that the transceiver has completed its work, it triggers the duty cycle controller to restart by turning off the power to the downstream circuit.

Existing Technology

This duty cycle configuration is currently achieved by using multiple connected devices, such as TI’s TPS61291, TPL5111, or CD4541, as well as associated passive components.

GreenPAK™ Technology

The ability to modify the delay period between each cycle is advantageous, as it allows the application to modify the duty cycle for the best battery life by taking into account external factors (e.g. time of day, season, temperature, traffic volumes, etc.).

Figure 1. Example of a setup using purpose-made discrete devices to achieve power duty cycling

Figure 2. Example of the GreenPAK SLG46116V/SLG46117V based replacement, with a smaller footprint, fewer supporting passive components, and optionally enhanced duty cycle control with MCU modifiable interval
Implementation

The circuit is implemented using a SPI interface to set and change the time interval. When the external circuit is not powered, it is expected that the input pins would have high impedance or be held at logic LOW.

It is left to the user to implement a hardwired version if the time interval is constant or a parallel interface version if preferred.
circuit loses power.

To program the selection of the time period, with SPIEN driven HIGH, the logic level at pin D is clocked into DFF0 on the rising edge of CLK. Data already in DFF0 is clocked into DFF1. This sets upSEL0 and SEL1. As most MCUs have a minimum SPI data frame size larger than two bits, it should be noted that only the last two clocked bits are retained (so you should only set up the last two bits transmitted when implementing the SPI interface on the MCU). SPIEN should remain LOW or at high impedance (it is internally pulled LOW) when the SPI interface is not in use.

At first power up, DFF0 and DFF1 have default values of 0, which results in the shortest delay. Additionally, DFF2 has an initial polarity of HIGH, turning on the P-FET switch. At this time, the desired delay should be programmed. Afterwards, the programmed delay interval will be retained until a power loss to the GreenPAK chip, or until the delay is reprogrammed.

The shown delay times can be modified to any allowable delay period by reconfiguring the Counter data (and/or Clock) for each CNT/DLY module and/or the OSC module.

![Diagram](image)

Figure 5. Predefined delays can be changed by modifying the configuration

If the SPIEN function is not required, the 2-L2 gate can be removed, and the CLK can drive DFF0 and DFF1 directly. In this case, CLK should be held LOW or be at high impedance when not clocking data.

<table>
<thead>
<tr>
<th>Last 2 bits L to R</th>
<th>SEL0</th>
<th>SEL1</th>
<th>Selected</th>
<th>Delay (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>0</td>
<td>0</td>
<td>CNT0/DL0, CNT2/DLY2, 3L-2</td>
<td>100</td>
</tr>
<tr>
<td>01</td>
<td>1</td>
<td>0</td>
<td>CNT1/DLY1, CNT3/DLY3, 3L-2</td>
<td>500</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>1</td>
<td>CNT0/DL0, CNT2/DLY2, 3L-3</td>
<td>1000</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>1</td>
<td>CNT1/DLY1, CNT3/DLY3, 3L-3</td>
<td>5000</td>
</tr>
</tbody>
</table>

Table 1. Programmed bits, intermediate selections, and results

The SPI input has been tested at a clock speed of 8MHz, and works in SPI mode 0, 1, and 3.
Figure 6. Demonstration of changing delay from 100 ms to 1 s

Figure 7. Showing the sleep pulse (yellow) to end the cycle

Arduino Code
These tests and demonstrations were completed using the following Arduino test code:
Function | SLG46117V pin | Arduino pin
---|---|---
SPI Data | 2 | 11
SPI Clock | 3 | 13
SPI Enable | 1 | 7
Power Down | 4 | 5
Sleep | 10 | 6

Table 2. SLG46117V Arduino interconnections used in demonstration

**Conclusion**

In this app note we created a variable-length power duty cycle controller to help prolong the battery life of a system. It allows a microcontroller to decide how long to power down and when to wake back up. Since GreenPAK IC's quiescent current is less than a typical microcontroller's quiescent current, using the GreenPAK as a dedicated wake/sleep device will help the system operate for a longer period of time before the battery runs out.
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Corporate Headquarters
TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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