CMPT 433: Embedded Systems

Timer Calculation Worksheet (Answers)

Equation for calculating period of time and timer clock frequency:

$$\text{Period} = \frac{0xFFFF\ FFFF - TLDR + 1}{\text{Timer Clock Frequency}} * 2^N \tag{1}$$

1. **Given an 8-bit timer with a 32Hz clock and no divider, find the maximum timer duration.**

   An 8-bit timer has maximum value $0xFF$.

   To achieve the maximum timer duration, set $TLDR$ to 0.

   The frequency is 32.

   The equation is:

$$\begin{aligned}
\text{Period} &= \frac{0xFF - TLDR + 1}{\text{Timer Clock Frequency}} * 2^N && (2)\\
&= \frac{0xFF - 0 + 1}{32} * 2^0 && (3)\\
&= \frac{2^8}{2^5} && (4)\\
&= 2^3 && (5)\\
&= 8s && (6)
\end{aligned}$$

   Answer: The maximum timer duration is 8s.

2. **Given an 8-bit timer with a 32Hz clock, calculate the necessary divider and TLDR for a 200s period.**

   To change the period to 1s, divide the 32Hz clock by $N = 5$ to multiply the period by $2^5 = 32$.

   The equation is:

$$\text{Period} = \frac{0xFF - TLDR + 1}{\text{Timer Clock Frequency}} * 2^N \tag{7}$$
$$= \frac{2^8 - TLDR}{32} * 2^5 \tag{8}$$
$$= 2^8 - TLDR \tag{9}$$
$$= 256 - TLDR \tag{10}$$
$$TLDR = 256 - 200 \tag{11}$$
$$= 56 \tag{12}$$

   Answer: $N = 0$, $TLDR = 56$

3. **Given a 32-bit timer with a 25MHz clock and no divider, find the maximum timer period.**

   A 32-bit timer has maximum value $0xFFFF\ FFFF$.

   Let $TLDR = 0$ for the maximum amount of time.

   The equation is:

$$\text{Period} = \frac{0xFFFF\ FFFF - TLDR + 1}{\text{Timer Clock Frequency}} * 2^N \tag{13}$$
$$= \frac{0xFFFF\ FFFF - 0 + 1}{25MHz} * 2^0 \tag{14}$$
$$= \frac{2^{32}}{25,000,000} \tag{15}$$
$$\approx 170s \tag{16}$$
$$\approx 2.8min \tag{17}$$

   Answer: The maximum timer duration is about 2.8 minutes.

4. **Given a 32-bit timer with a 25MHz clock, calculate the necessary divider and TLDR for a 2s period.**

   Since the maximum timer period is greater than 2s (see previous question), no divider is necessary. Let $N = 0$.

   The equation is:

$$\text{Period } = 2s = \frac{0xFFFF\ FFFF - TLDR + 1}{\text{Timer Clock Frequency}} * 2^N \tag{18}$$

$$= \frac{2^{32} - TLDR}{25,000,000} * 2^0 \tag{19}$$

$$50,000,000 = 2^{32} - TLDR \tag{20}$$

$$TLDR = 2^{32} - 50,000,000 \tag{21}$$

$$= 0xFD05\ 0F80 \tag{22}$$

$$\tag{23}$$

   Answer: $N = 0$, $TLDR = 0xFD05\ 0F80$

5. **Given the same parameters and TLDR from the previous question but with $N = 2$, how long will the period be?**

   If $N = 2$, the period is multiplied by $2^N = 2^2 = 4$.

   Period $= 2s \times 4 = 8s$

   Answer: The period will be $8s$.