Application Brief
TPUL Family Overview

Albert Xu

What is the TPUL family?

The TPUL family is created to replace our existing portfolio of monostable multi-vibrators (MMVs). An MMV is a pulse generator that is controlled by an external reistor and capacitor. The pulse width is determined by the equation t_w= K × R × C, where K is a constant that is determined by the device. The TPUL family has devices with a K factor of 1 or 1000. K = 1 devices can replace the current MMV portfolio, while K = 1000 devices allow designs with much longer pulse widths.

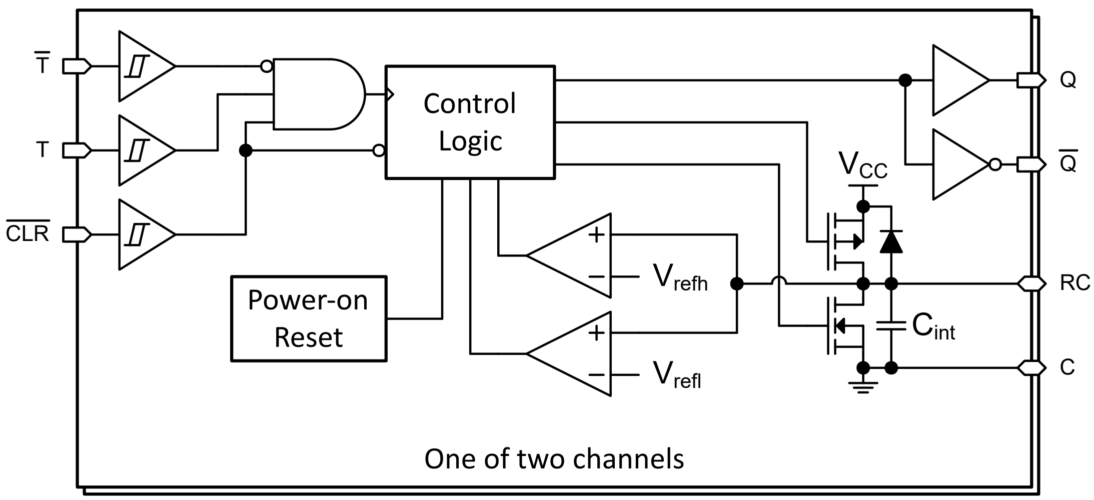

Figure 1. Functional Block Diagram for TPUL2T123

Table 1. Function Table

INPUTS			OUTPUTS	
$\overline{CLR}$	$\overline{T}$	T	Q	$\overline{Q}$
L	X	X	L	H
H	H	X	L	H
H	X	L	L	H
H	L	↑	⎍	⊔
H	↓	H	⎍	⊔
↑	L	H	⎍	⊔

How Does an MMV Function?

MMVs can be designed to be triggered on a rising or falling edge using the 3 control signals T, $\overline{T}$, and $\overline{CLR}$. Refer to Table 1. When a pulse is triggered, the nFET connected to R/C and C is turned on and the capacitor is discharged. This causes the output (Q) to switch HIGH, which generates the output pulse. An internal comparator monitors the capacitor discharge voltage for 63.2% Vcc or one time constant, R×C. The output switches off after reaching this level. To get ready for the next trigger, the capacitor charges back up to Vcc. The pFET shown in the diagram is used to help charge the capacitor voltage quickly

Copyright © 2025 Texas Instruments Incorporated

Which K Factor to Choose?

In our existing MMV portfolio and TPUL K = 1 devices, a realistic max pulse width is 10 seconds. In the new TPUL K = 1000 devices, the max pulse width increases to over 1 hour. A higher K constant, also allows the footprint to be dramatically decreased due to capacitors being the largest component in systems. Figure 2 shows a K = 1 and K = 1000 device with external components designed for the same pulse width of 10 seconds. The left (K = 1) needs to use a large aluminum capacitor while the right (K = 1000) can use a surface mount capacitor.

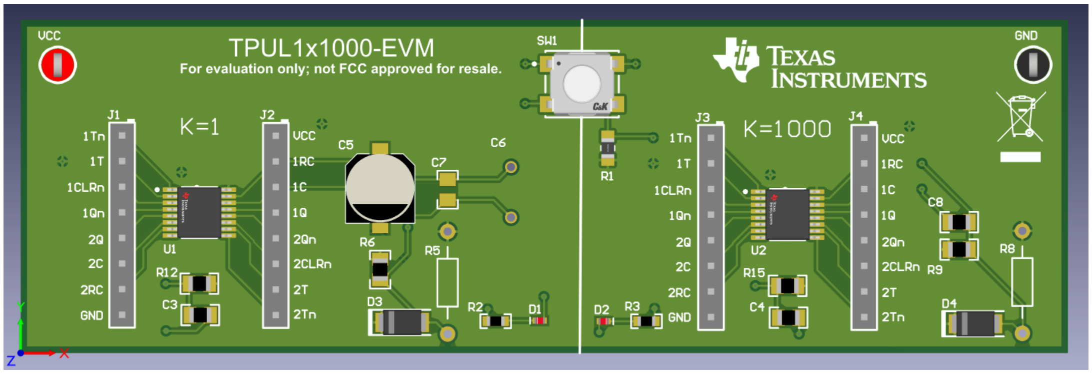

Figure 2. TPUL1x1000-EVM

Component Selection

Resistor and capacitors have to be selected based on the aforementioned pulse width equation, $t_w = K \times R \times C$. There are many benefits in selecting a value for the capacitor first. Capacitors are generally the more expensive component compared to resistors, especially when calculated values are not a common value. In addition, as shown in Figure 2, capacitor size can increase very quickly. By choosing a capacitor value and then calculating the resistor value, allows the design to have a smaller footprint and can potentially save money when compared to calculating the capacitor value.

Assume a design for a pulse width of 10 seconds. A widely available capacitor that can be used in this example is 1 uF. After plugging the K and C values into the equation, the resistor value calculated is around 10 kΩ. There is also a quick reference table for common R and C values in *TPUL2T323 Dual Retriggerable Extended RC-Timed Monostable Multivibrators*, data sheet.

Error Calculation

The last thing to note is that MMVs are not used for precise time lengths. Because the output pulse width is dependent on an external RC circuit, timings can vary greatly from design to design. While resistor values stay relatively consistent through operation, capacitors vary greatly due to temperature, operating voltage, and manufacturing differences. For a quick and easy calculation, a simple equation can be used: $e_{\Delta two} = e_R + e_C + \Delta two$, where e_R is resistor error, $e_C$is capacitance error and Δtwo is the TPUL device error given in the data sheet. Capcitors often have manufacturing tolerance and temperature variation which can be summed up for e_C.

A more accurate equation, $e_{\Delta two} = e_R + e_C + \Delta two(1 + e_R + e_C + e_R e_C)$ can be used when needed. To compare the two equations, take $e_R = 0.1\%$, $e_C = 20\%$ (5% manufacturing and 15% temperature variation), and Δtwo= 5%. The simple equation gives an error of 25.1%, while the accurate equation gives an error of 26.126%.

Trademarks

All trademarks are the property of their respective owners.

Copyright © 2025 Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2025, Texas Instruments Incorporated