

# How Illuminated Switches Work Product Training Module

# Introduction

## Purpose



- To “illuminate” the customer regarding illuminated switches and their functions, and to display the wide variety of illuminated switches that NKK offers

## Objective

- Introduce the various types of illumination
- Describe how isolated lamp terminals offer more flexibility to the customer
- Explain how resistors are used with illuminated switches
- Present the various types of illuminated actuations
- Discuss applications by product grouping
- Present the UB2 alternating legends
- Description of custom legend capabilities

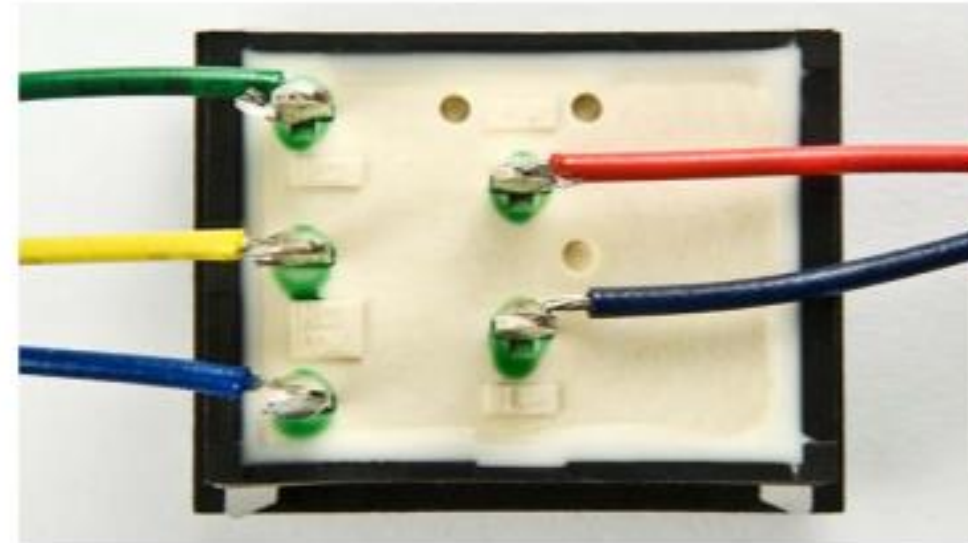


## Types of Illumination

Illumination Type	Benefits	Disadvantages
 <p><b>LED</b></p>	<ul style="list-style-type: none"> <li>• Long Life</li> <li>• Low Current &amp; DC Voltage Levels</li> <li>• Not easily damaged by shock</li> <li>• Variety of colors</li> <li>• Bright &amp; Super Bright options</li> <li>• Bicolor &amp; RGB available in some lines</li> </ul>	<ul style="list-style-type: none"> <li>• High initial costs</li> <li>• Ballast resistor required</li> </ul>
 <p><b>Incandescent</b></p>	<ul style="list-style-type: none"> <li>• Lower initial costs</li> <li>• Brightness</li> </ul>	<ul style="list-style-type: none"> <li>• Short life</li> <li>• Sensitive to shock &amp; vibration</li> <li>• High heat dissipation</li> </ul>
 <p><b>Neon</b></p>	<ul style="list-style-type: none"> <li>• Not long life</li> <li>• Not easily damaged by shock or vibration</li> </ul>	<ul style="list-style-type: none"> <li>• Low intensity</li> <li>• Resistor required</li> </ul>

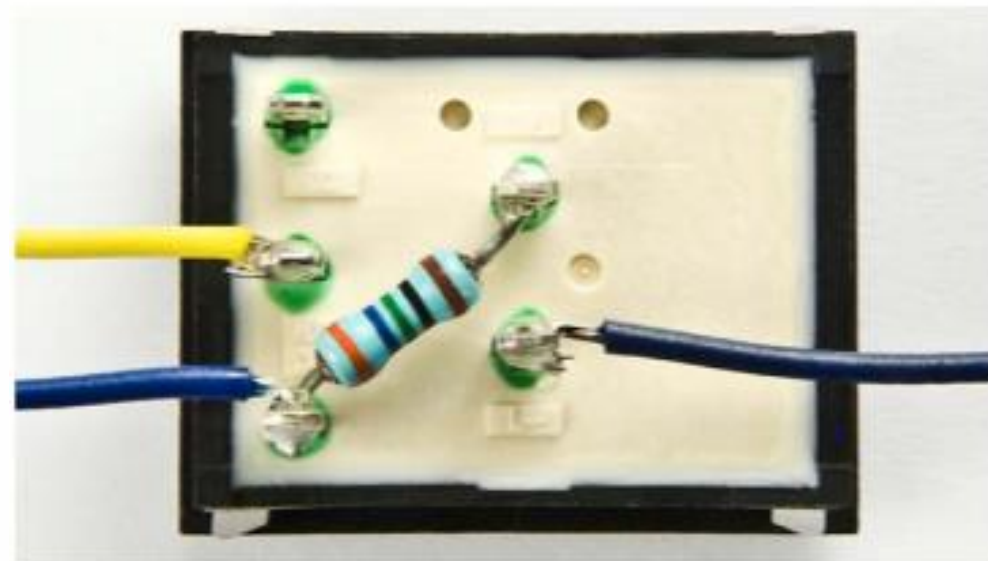
## Isolated Circuits from External Source

- All of NKK's illuminated switches come with isolated circuits for the lamps.
- In this example, the red and dark blue wires are soldered to an external source. This source will send the current that illuminates the lamp.
- The source current will depend upon the lamp specifications.



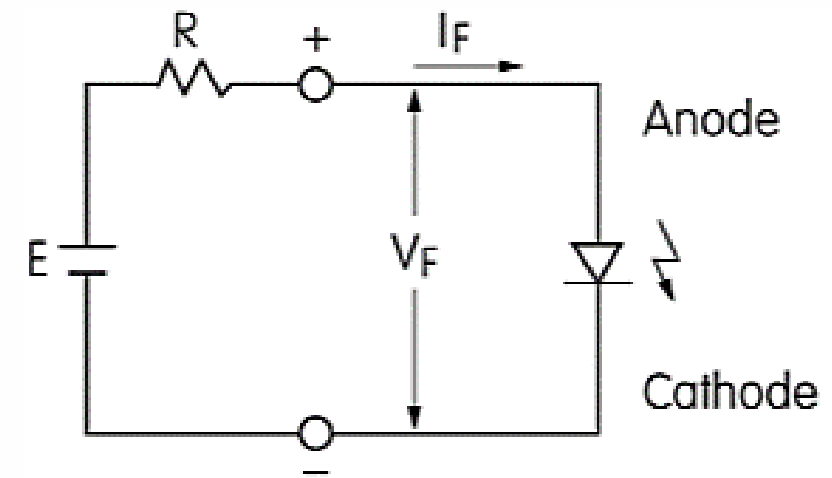
## Isolated Circuits Wire in Line with Switch Actuation

- In this example, a resistor is wired to the positive lamp terminal from the “Normally Open” switch terminal.
- As a result, when the switch is actuated from the “Normally Closed” terminal to the “Normally Open” terminal, the lamp will illuminate.
- The resistor is required to properly power the lamp.



## LED Circuit

- The illumination is created by the LED which has the properties of a diode (Anode “+” and Cathode “-”). Once the Forward Voltage ( $V_F$ ) and Current ( $I_F$ ) is achieved, the LED will illuminate.
- If the voltage is reversed and exceeds the Reversed Voltage ( $V_R$ ) the LED can be damaged.
- The ballast resistor ( $R$ ) is used to create the proper voltage and current through the circuit. An alternative to the ballast resistor is a constant current source circuit.
- The LED is generally used in DC applications. If an AC circuit is to be used, a rectifier circuit along the ballast resistor is required to generate the appropriate DC voltage.



## Ballast Resistor Calculation

- The ballast resistor value is calculated by the formula shown here.
- As an example:
  - Source Voltage = 5.0V
  - Forward Voltage = 1.9V (set by LED)
  - Forward Current = 20mA (set by LED)
  - The resultant ballast resistor = 155Ω
- Additionally, the power rating of this ballast resistor must be considered.
  - With a forward current of 20mA and the voltage across the ballast resistor(5.0V – 1.9V) = 3.1V
  - Power across is then calculated: 3.1V x 20mA = 0.062W
  - For safety purposes, typical power rating of 2X the calculated value is selected
  - The resulting power rating = 0.125W (1/4W resistor)

$$R = \frac{E - V_F}{I_F}$$

Where: R = Resistor Value (Ohms)  
 E = Source Voltage (V)  
 $V_F$  = Forward Voltage (V)  
 $I_F$  = Forward Current (A)



## Ballast Resistor Calculation for LED

- Forward voltages of the LED are different for each LED and color. In switches where bicolor or RGB LEDs are used, different ballast resistor values may be required for each LED.
- The current profile of an LED is that it varies with temperature, so the value of the ballast resistors should be calculated at the appropriate operating temperature.
- This can be calculated with the current reduction rate information supplied.

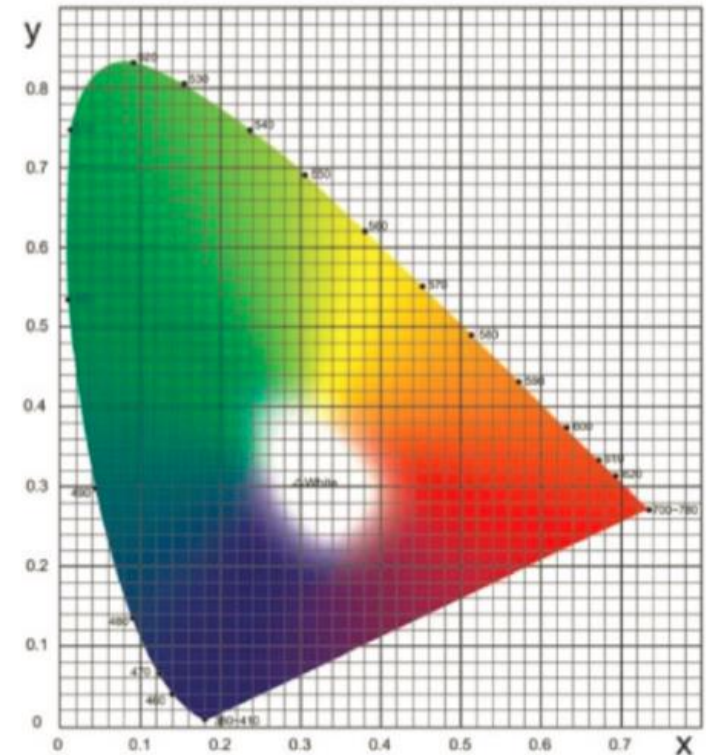
AT635 LED Specifications				
Colors		Red	Amber	Green
Forward Peak Current	$I_{FM}$	30mA	30mA	30mA
Continuous Forward Current	$I_F$	20mA	20mA	20mA
Forward Voltage	$V_F$	1.9V	2.0V	2.1V
Reverse Peak Voltage	$V_{RM}$	5V	5V	5V
Current Reduction Rate Above 25°C	$\Delta I_F$	0.42mA/°C		
Ambient Temperature Range		-25° ~ +50°C		





## LED Colors & Chromaticity

- LED Illuminated switches are available in:
  - **Single Color:** Red, Green, Amber, Blue, White (see “White” note below)
  - **Bicolor:** Red/Green (produces Amber when both are illuminated)
  - **RGB:** Red/Green/Blue; theoretically, all colors can be created by combining these, except for Black
  - **White:** Blue LED with Yellow fluorescent (analog White) Generated by RGB (digital White)
- LED colors are shown in the Chromaticity Graph by their respective X-Y coordinates.



# Illuminated Pushbuttons



# Alternating Legends

## UB2 Pushbuttons



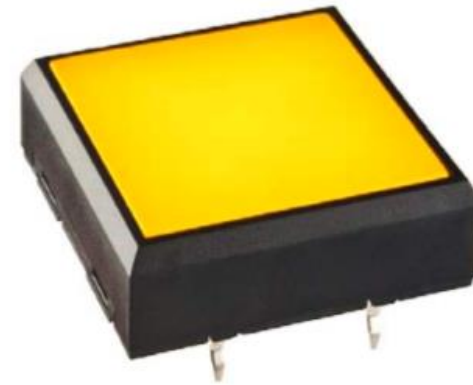
## Illuminated Tactiles



**JB Series**



**JF Series**



**JL Series**

## Illuminated Toggles



**M2100 Series**



**B Series**



**G Series**



**TL Series**

## Illuminated Rockers



**GW Series**



**CWSB Series**



**M2100 Series**



**MLW Series**



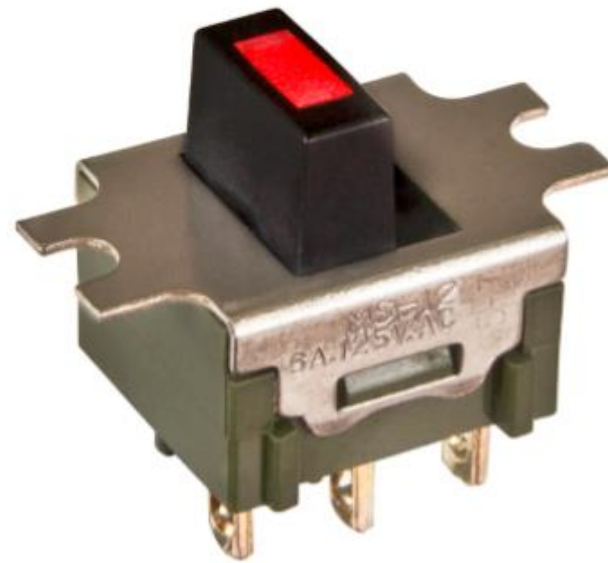
**LW Series**



## Illuminated Slides



**SS Series**



**MS Series**

# Applications



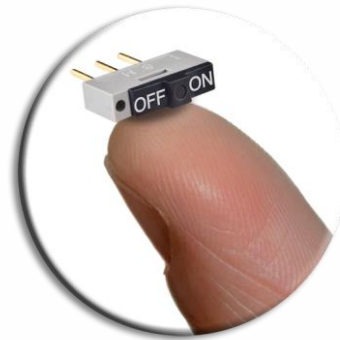


# Custom Switch Solutions & Value Added Capabilities

NKK Switches has the flexibility, expertise and skills to help Engineers design custom switch solutions for today's most innovation applications.

## Custom Printing:

- Laser Etching
- Screen Printing
- Pad Printing



## Custom Assembly:

- Cables & Harnesses
- Electronic
- Electro-Mechanical
- Mechanical



# Questions?

Please visit our website [www.nkkswitches.com](http://www.nkkswitches.com)  
Or email our team at [engineering@nkkswitches.com](mailto:engineering@nkkswitches.com)

