Contents Supplement

Conversions

TEMPERATURE

Fahrenheit

Thermometric scale with fixed points marked 32°F for freezing point and 212°F for boiling of water.

Celsius

International thermometric scale with fixed points marked 0°C for freezing point and 100°C for boiling of water.

(Fahrenheit – 32) x .555 = Celsius

(Celsius x 1.8) + 32 = Fahrenheit

°C	°F
–40	–40
–30	–22
–25	–13
–20	–4
–10	+14
0	+32
+50	+122
+55	+131
+70	+158
+85	+185
+100	+212

LINEAR DIMENSIONS

Formulas for Conversions

millimeter x .03937 = inch

inch x 25.4 = millimeter

Fraction	Inch	Millimeter	Fraction	Inch	Millimeter
	.100	2.54		.394	10.0
	.150	3.81	15/32	.469	11.9
	.197	5.0		.472	12.0
	.236	6.0	1/2	.500	12.7
1/4	.250	6.35			

FORCE

Formulas for Conversions

ounce•force	x	.2780139	=	newton
pound-force	x	4.4482220	=	newton
kilogram-force	x	9.8066500	=	newton
newton	x	.1019716	=	kilogram-force
newton	x	.2248089	=	pound-force
newton	x	3.5969420	=	ounce•force

TORQUE

Formulas for Conversions

kg/cm	x	2.2046	x	.3937	=	lb/in
newton•meter	x	.7375621	=	pound-foot		
newton•meter	x	.1019716	=	kilogram-meter		
newton•meter	x	141.6119	=	ounce-inch		
newton•meter	x	8.8507	=	pound-inch		
pound-foot	x	1.355818	=	newton•meter		

PLATING THICKNESS

Micron

One millionth of a meter;

a micrometer

1 micron	=	1 thousandth of 1 millimeter
1 micron ÷ .0254	=	39.37 millionths of an inch
Example: 3 microns ÷ .0254	=	118.11 millionths of an inch

WEIGHT

1 gram	=	.03527 ounce	1 ounce	=	31.10348 grams
1 kilogram	=	35.27 ounces	1 ounce	=	.03110348 kilogram
1 kilogram	=	2.2 pounds	1 pound	=	.4539 kilogram

Electrical Ratings

RERATING CURRENT FOR SWITCHES WITH 125V AC RATINGS

Generally, most switch applications can be classified into one of the below load categories. Switch capacities can be mathematically rerated when the application calls for a category or voltage other than the switch standard general specification ratings, meaning original current ratings at 125V AC. NKK has not conducted life tests at these rerated voltages and currents so it is important to contact the factory in such cases. The candidate switch should be tested in the actual application in which it is intended to function.

Factors for Calculating Rerated Current at Various Loads

New Voltage Rating	Resistive Load Multiply by:	Inductive Load Multiply by:	Lamp Load Multiply by:	Motor Load Multiply by:	Capacitive Load Multiply by:
125VAC	1	0.50 ~ 0.66 (PF 0.6)	0.20 ~ 0.25	0.33	0.25
250VAC	0.50 ~ 0.66	0.25 ~ 0.33 (PF 0.6)	0.10 ~ 0.16	0.16 ~ 0.22	0.12 ~ 0.16
12VDC	1	0.75 ~ 1	0.20 ~ 0.25	0.33	0.25
30VDC	0.50 ~ 1	0.25 ~ 0.50	0.10 ~ 0.25	0.16 ~ 0.33	0.12 ~ 0.25
48VDC	0.25 ~ 0.33	0.20 ~ 0.25	0.05 ~ 0.08	0.08 ~ 0.11	0.06 ~ 0.08
125VDC	0.05	0.02 ~ 0.03	N/A	N/A	N/A

Sample Calculation for Model M2012SS1W01
with 6A @ 125VAC resistive rating.
To use at 48V DC inductive, multiply
6A x 0.25 = 1.5A @ 48VDC

Sample Calculation for Model JWL22RCA
with 16A @ 125/250VAC resistive rating.
To use at 30V DC motor load, multiply
16A x 0.33 = 5.28A @ 30VDC

Resistive Load

Resistive loads can be purely resistive or of the tungsten-heater load type. A resistive load that has no heating element is the easiest for a switch to handle, and the switch's rating is based on this type of load. A resistive load is one in which 100% of the load is composed of resistive devices. The power factor is high (PF = 1) and contact erosion is low. Consequently, the switch's electrical life can be anticipated with some certainty.

Lamp Load

When a switch closes on a resistive lamp load, the switch sees a short circuit because the cold resistance of the lamp filament is near zero. The surge current as the switch closes can be many times the steady state current. As the lamp filament heats up to operating temperature, the resistance of the filament increases and the current decreases to the lamp's steady state.

Motor

Motor loads present yet another brutal environment for switch contacts. Closing the switch contact on a motor start-up load causes very large current surges of about 3 to 8 times the running current. When the switch is opened and the current decreases, the magnetic field of the inductor collapses and an electromotive force is induced. The polarity of the induced voltage is such as to oppose any change in current flow. This induced voltage aids the source voltage in striking an arc and maintaining it as the contacts separate.

Inductive Load

Non-motor inductive loads, such as those seen in switching power supplies, have inrush currents that greatly exceed the normal operating currents of the equipment. This inrush current can easily reach 8 to 10 times the steady state current. As a switch on an inductive load is opened, the inductor, or transformer, induces a counter option "voltage" in the circuit. This voltage opposes any change in the circuit current and can reach hundreds of volts. This extremely high voltage can restrike the arc as the switch contacts open resulting in severely eroded or welded contacts.

Capacitive

With such loads as DC power supplies, welding machines, and strobe charging units the inrush current is even more damaging than with inductive loads. To the switch a capacitive load appears as a dead short as the switch closes. In the first few milliseconds the inrush current can sometimes reach 100 times the steady state current of the circuit. Even worse for the switch, this inrush occurs before the contact bounce has subsided. This produces severe arcing and massive contact erosion. Often the contacts weld upon closure preventing the switch from ever opening. In an emergency the operator of the equipment would know he could not open the circuit.

INDUCTIVE LOADS

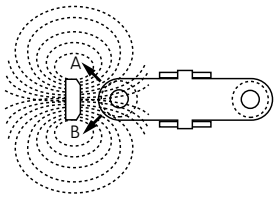
In AC circuits the voltage and current are varying in a sinusoidal pattern; both the voltage and current cross the zero reference 120 times per second for 60Hz. Therefore, the chances of closing or opening a switch when the voltage and current are at their maximum in AC circuits is remote.

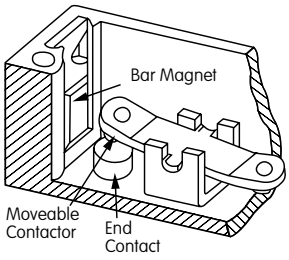
In DC circuits the voltage and current do not vary and are always at their rated levels. Compared to AC circuits with the same voltage and current, DC circuits handle 1.414 times the power. Therefore, when opening or closing a switch on a DC load, the arc developed is more severe, more energetic, and lasts longer causing more contact erosion and a shorter switch life. A switch intended for a DC circuit should have its AC capacity rerated for DC. See previous page for rerating current.

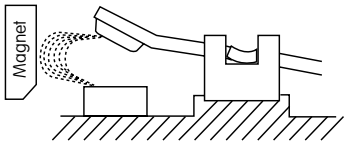
DESIGN FOR INDUCTIVE DC LOAD MODELS S800D & SW3800D

Bar magnets are placed at each end of high capacity switches, and their magnetic field opposes the field created by the arcing current, thereby extinguishing the arc and protecting the contacts.

Positive (+) must be connected to end terminals and negative (–) to common terminals.







TV RATINGS

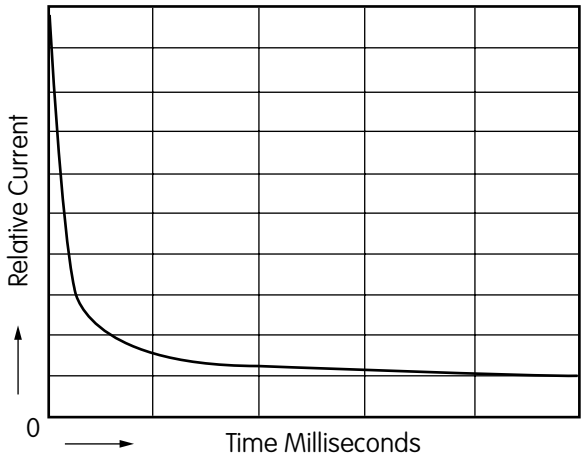
The TV5 and TV8 ratings are tested and assigned by the Underwriters Laboratory. The switches are intended to be used as "Power ON" devices in equipment where a high tungsten inrush current is anticipated, such as tungsten-filament lamp loads or entertainment equipment like sound systems and monitors.

An example is the TV8 test which consists of an overload test and an endurance test. The overload test consists of a switch closing on a minimum inrush current of 163 amps with 50 consecutive operations at a rate of 10 cycles per minute. The test must be conducted without any failures. In the endurance test the current is reduced to 117 amps, and the same switch is subjected to another 25,000 operations.

The JWL is a product example that has been tested and meets the TV8 rating.

In addition to the electrical testing, the switch enclosure (housing) must comply with the requirements for classifying materials as UL94V-0. The insulation material must have arc-tracking characteristics with a minimum arcing time of 180 seconds when tested in accordance with the Standard Test Methods for High-Voltage, Low-Current Arc Resistance of Solid Electrical Insulation.

The JWM and JWL switches are rugged, dependable, and well suited to high inrush circuits.

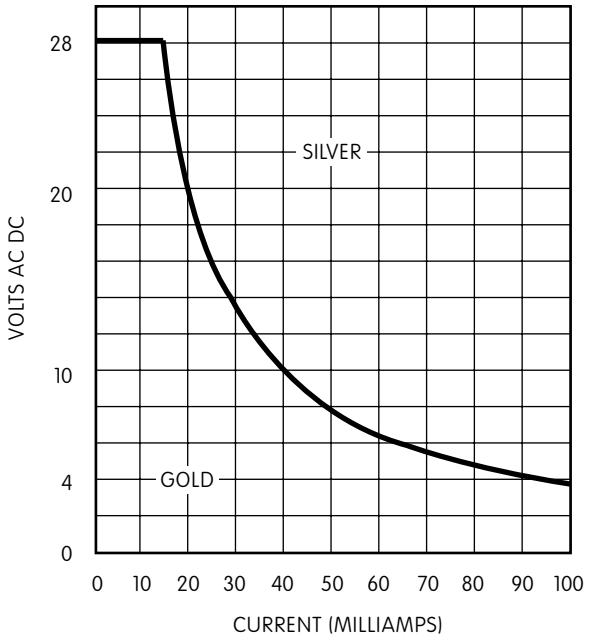


Typical Tungsten Inrush Curve

Electrical Ratings

OPERATING RANGE

Three contact materials are commonly used in NKK switches: gold, silver, and gold over silver. These materials give the options of low level, power level, plus combined power and low level ratings.



Low Level ~ 0.4VA maximum @ 28V AC or DC maximum

Gold plated contacts are recommended for dry circuits, which are defined as very low energy. In circuits where the voltage is below 28 volts DC and current is below 100 milliamps (dry circuits), no arc develops as the contacts open or close. So, the tarnish remains. Eventually without the arc, the contacts become so encrusted that the switch is unable to close the circuit due to the high contact resistance.

The solution to this is plating the contacts with gold, which does not tarnish, thus assuring the full electrical life of the switch.

Power Level ~ 100mA to 10 amps @ 125V AC

Silver contacts are recommended for electrical levels above 0.4VA. Although silver tarnishes, it is a good conductor and this electrical energy is sufficient to break through the tarnish to give reliable performance. The oxidation which coats the contact surfaces with a hard layer of insulative contamination is removed by arcing. In circuits where the voltage is above about 12 volts DC and the current above .5 amps, an arc develops during opening or closing of the contacts. This arc keeps the oxidation cleaned off.

Power or Low Level

Gold over silver contacts are used in applications requiring both dry and power circuits. NKK's gold over silver contacts have dual ratings as further described below.

DUAL RATINGS

The dual rated option is suitable where identical switches are used in both a logic and a power level circuit within the same application.

Dual rated switches enable the user to install the same switch in both a logic level (dry circuit) and a power level circuit. However, once a code "A" rated contact switch has been used at a power level, it cannot then be used at a logic level.

There may be advantages to stocking only a single switch for use in both a logic level and a power level circuit. Our dual rated contact material option allows this advantage. However, once a dual rated contact material switch has been used at a power level it cannot then be used at a logic level.

The gold over silver contact material provides a reliable, tarnish free, contact surface for logic level switching. When this same contact material switch is used in power level circuit, the gold plating is removed by contact arcing. If an attempt is then made to use this same switch in a logic level circuit (where no arcing occurs). The low current condition cannot provide adequate contact wiping or cleaning.

RERATING

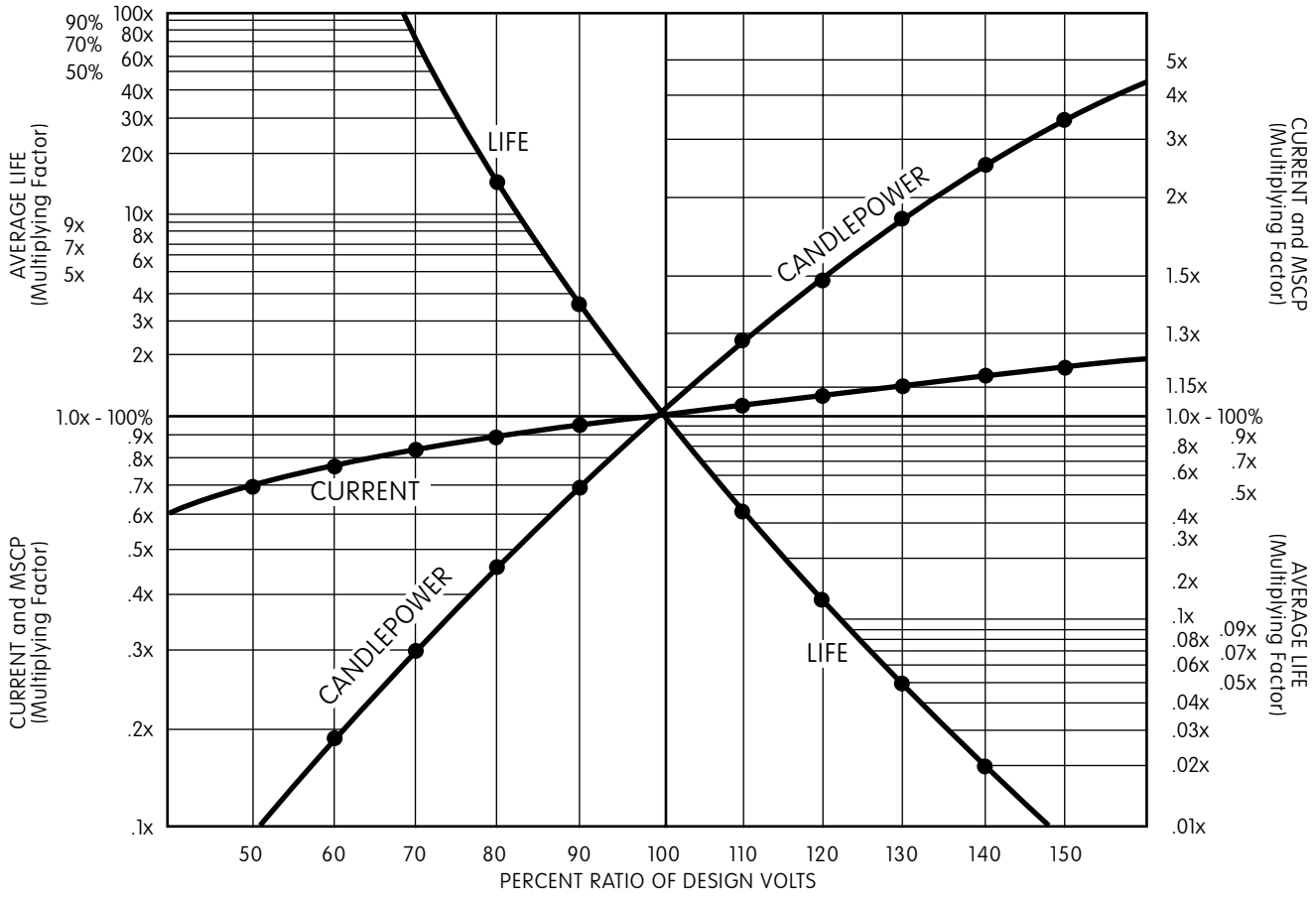
When a lamp is to be operated at a voltage other than the rated or design voltage, the rerated lamp specifications should be calculated to determine suitability for the user's application. The following formulas assist in predicting the rerated effect on luminous intensity, endurance and current. Results are most reliable for applied voltages close to the rated voltage.

$$\text{Rerated MSCP} = \text{Rated MSCP} \times \left[\frac{\text{Applied Voltage}}{\text{Rated Voltage}} \right]$$

$$\text{Rerated Life} = \text{Rated Life} \times \left[\frac{\text{Rated Voltage}}{\text{Applied Voltage}} \right]$$

$$\text{Rerated Current} = \text{Rated Current} \times \left[\frac{\text{Applied Voltage}}{\text{Rated Voltage}} \right]$$

For your convenience, the graph below illustrates the way current, candlepower, and life performance vary with percent changes in applied voltage. The graphed values are typical for miniature and subminiature lamps with the average life based on rated voltages at 60 cycles AC, in room temperature, and under static conditions.



Source: General Instrument Chicago Miniature Brand Incandescent and Neon Lamps, Catalog No. 8400-Rev 1, (Chicago, Illinois: General Instrument Corporation), page 3.

Lamps & LEDs

APPLICATION CONSIDERATIONS

LEDs

Light emitting diodes (LEDs) operate at relatively low current and DC voltage levels and have comparatively unlimited service life. Their characteristics do not change significantly with age, and they are not easily damaged by shock or vibration. A variety of NKK's switches and indicators are offered with red, green, yellow, amber, blue, white, or bicolor (red/green) LEDs.

Most of the LEDs used in our products require a ballast resistor connected in series with the LED. In addition, we offer 5-, 12-, and 24-volt lamps with internal resistors in the YB series.

Incandescent Lamps

Lamp life is determined in a laboratory environment where conditions are near perfect. Actual applications, unlike the test environment, involve many factors which can greatly affect the values listed in lamp specifications. Of all the operating characteristics, lamp life is the least predictable. The lamp filament must deteriorate to produce illumination, and actual life is a function of this unpredictable rate of deterioration. Thus, exact life performance cannot be determined for any incandescent lamp under any set of conditions.

Lamps perform at their maximum when used at their rated AC voltages or below. There are many known conditions or factors that affect lamp life. Using the lamp in abusive environments such as high ambient temperatures, high shock and/or vibration, constant illumination, and DC voltage accelerates deterioration of the tungsten filament.

Neon Lamps

Neon lamps are low-current, long-life sources limited by the high ionization voltage of neon (≥80 volts) for use in line voltage circuits. A series resistor is required in all neon lamps for current limiting. Larger lamps often include an integral resistor sized for a specific voltage.

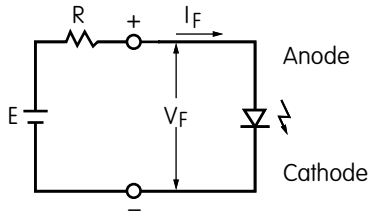
Neon lamps glow with a low intensity, amber light. Bright light and vivid colors are not obtainable with neon lamps. Their typical 1.5mA current drain, better than 25,000-hour service life, and good resistance to shock and vibration make them an excellent alternative in many line voltage applications. For best visibility they should be used with clear lenses and diffusers. Other suitable colors are red, orange, yellow, or white.

LED & Lamp Part Numbers for Each Series

PN	Type	Series	PN	Type	Series	PN	Type	Series
AT070	LED	EB M MB24	AT618	LED	EB M MB24	AT630	LED	HB
AT602	Incand.	LW MLW	AT621	LED	YB	AT631	LED	KB LB YB YB2
AT602N	Neon	LW MLW	AT622	LED	MLW	AT632	LED	KB LB YB YB2
AT607	Incand.	LB	AT624	LED	HB	AT633	LED	HB
AT607N	Neon	LB	AT625	LED	KB LB YB YB2	AT634	LED	KB YB YB2
AT611	Incand.	KB YB	AT627	LED	LB	AT635	LED	KB LB
AT615	Neon	KB	AT628	LED	YB YB2	AT636	LED	KB YB YB2
AT617	LED	EB M MB24	AT629	LED	HB			

BALLAST RESISTOR CALCULATIONS & RECOMMENDATIONS

If the source voltage is greater than the rated voltage of a lamp or LED, a ballast resistor must be connected in series with the lamp. The following circuit diagram and formula will assist in calculating the value of the required ballast 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)

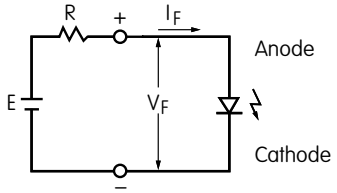
Watt recommendations provide a margin to reduce heat rise and increase life.

FORWARD VOLTAGE	FORWARD CURRENT	SOURCE VOLTAGE E																	
V_F	I_F	5V		6V		9V		12V		14V		16V		18V		22V		24V		28V	
V	mA	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W
1.65	25	130	1/4	180	1/2	300	1/2	430	1	510	1	560	1	680	2	820	2	910	2	1.1K	2
1.70	30	110	1/2	150	1/2	240	1	360	1	430	1	470	2	560	2	680	2	750	2	910	3
1.75	40	82	1/2	110	1/2	180	1	270	1	300	2	360	2	430	2	510	3	560	3	680	3
1.77	20	160	1/4	220	1/4	360	1/2	510	1/2	620	3/4	750	3/4	820	1	1.0K	1	1.1K	1	1.3K	1.5
1.80	48	68	1/2	91	1/2	150	1	220	2	240	2	300	2	330	2	430	3	470	3	560	3
1.85	20	160	1/4	220	1/4	360	1/2	510	1	620	1	750	1	820	1	1.0K	1	1.2K	2	1.5K	2
1.90	8	390	1/8	510	1/8	910	1/4	1.2K	1/4	1.5K	1/4	1.8K	1/4	2.0K	1/2	2.4K	1/2	2.7K	1/2	3.3K	1/2
	15	220	1/8	270	1/4	470	1/2	680	1/2	820	1/2	1.0K	1	1.1K	1	1.5K	1	1.5K	1	1.8K	2
	16	200	1/4	220	1/4	430	1/2	620	1/2	750	1	910	1	1.0K	1	1.2K	1	1.3K	1	1.6K	1
	20	150	1/4	200	1/4	360	1/2	510	1/2	620	3/4	750	1	820	1	1.0K	1	1.1K	1	1.3K	2
	26	120	1/4	160	1/2	300	1/2	390	1	470	1	560	1	620	1	820	2	910	2	1.1K	2
1.95	15	220	1/8	270	1/4	470	1/2	680	1/2	820	1/2	1.0K	1	1.1K	1	1.5K	1	1.5K	1	1.8K	2
	20	150	1/4	200	1/4	360	1/2	510	1/2	620	3/4	680	3/4	820	1	1.0K	1	1.1K	1	1.3K	2
	24	130	1/4	160	1/2	300	1/2	430	1	510	1	560	1	680	2	820	2	910	2	1.1K	2
1.96	16	200	1/4	240	1/4	430	1/2	620	1/2	750	1/2	910	1	1.0K	1	1.3K	1	1.3K	1	1.6K	1
2.00	15	200	1/8	270	1/4	470	1/2	680	1/2	820	1	910	1	1.1K	1	1.3K	1	1.5K	1	1.8K	1
	20	150	1/4	200	1/4	360	1/2	510	1	620	1	750	1	820	1	1.0K	1	1.1K	2	1.3K	2
	24	120	1/4	160	1/2	300	1/2	430	1	510	1	560	1	680	2	820	2	910	2	1.1K	2
	25	120	1/4	160	1/2	270	1/2	390	1	470	1	560	1	620	2	820	2	910	2	1.1K	2
	26	120	1/4	160	1/2	270	1/2	390	1	470	1	560	1	620	1	820	2	910	2	1.0K	2
	48	62	1/2	82	1/2	150	1	200	1	240	1	300	2	330	2	430	3	470	3	560	3
2.07	16	180	1/8	240	1/4	430	1/2	620	1/2	750	1/2	910	3/4	1.0K	3/4	1.3K	1	1.3K	1	1.6K	1
2.10	15	200	1/8	270	1/4	470	1/2	680	1/2	820	1/2	1K	1	1.1K	1	1.3K	1	1.5K	1	1.8K	1
	20	150	1/4	200	1/4	360	1/2	510	1	620	1	680	1	820	1	1.0K	1	1.1K	1	1.3K	1
	24	120	1/4	160	1/2	300	1/2	430	1	510	1	560	1	680	2	820	2	910	2	1.1K	2
	25	120	1/4	160	1/2	270	1/2	390	1	470	1	560	1	620	2	820	2	910	2	1.1K	2
	30	100	1/4	130	1/2	240	1	330	1	390	1	470	2	510	2	680	2	750	2	910	2
	40	75	1/2	100	1/2	180	1	270	1.5	300	1.5	360	1.5	430	2	510	2	560	3	680	3
	45	68	1/2	91	1/2	160	1	220	2	270	2	330	2	360	2	430	3	510	3	620	3
2.15	16	180	1/8	240	1/4	430	1/2	620	1/2	750	1/2	910	3/4	1.1K	3/4	1.2K	1	1.3K	1	1.6K	1
	20	150	1/4	200	1/4	360	1/2	510	1	620	1	680	1	820	1	1.0K	1	1.1K	1	1.3K	1
2.16	16	180	1/8	240	1/4	430	1/2	620	1/2	750	1/2	910	3/4	1.0K	3/4	1.2K	1	1.3K	1	1.6K	1

Ballast Resistors

BALLAST RESISTOR CALCULATIONS & RECOMMENDATIONS

If the source voltage is greater than the rated voltage of a lamp or LED, a ballast resistor must be connected in series with the lamp. The following circuit diagram and formula will assist in calculating the value of the required ballast 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)

Watt recommendations provide a margin to reduce heat rise and increase life.

FORWARD		SOURCE VOLTAGE E																	
VOLTAGE	CURRENT	5V		6V		9V		12V		14V		16V		18V		22V		24V		28V	
V_F	I_F	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W	Ω	W
V	**mA**																				
2.20	20	150	1/4	200	1/4	360	1/2	510	1	620	1	750	1	820	1	1.0K	1	1.1K	2	1.3K	2
	26	110	1/4	160	1/2	270	1/2	390	1	470	1	560	1	620	1	820	2	910	2	1.0K	2
	30	91	1/2	130	1/2	220	1	330	1	390	1	470	2	510	2	680	2	750	2	820	3
2.25	20	150	1/4	200	1/4	360	1/2	510	1	620	1	750	1	820	1	1.0K	1	1.1K	2	1.3K	2
2.27	20	150	1/4	200	1/4	330	1/2	510	1/2	620	3/4	750	3/4	820	1	1.0K	1	1.0K	1	1.2K	1
2.30	20	130	1/4	180	1/4	330	1/2	510	1/2	620	3/4	680	3/4	820	1	1.0K	1	1.0K	1	1.2K	1
2.35	40	68	1/4	91	1/2	160	1	240	1	300	2	330	2	390	2	510	3	560	3	620	3
2.80	20	110	1/4	160	1/4	330	1/2	470	1/2	560	1	680	1	750	1	1.0K	1	1.1K	1	1.3K	1
3.20	20	91	1/8	150	1/4	300	1/2	470	1/2	560	1/2	680	3/4	750	3/4	1.0K	1	1.0K	1	1.2K	1
3.30	20	91	1/8	150	1/4	300	1/2	430	1/2	560	1/2	680	3/4	750	3/4	1.0K	1	1.0K	1	1.2K	1
3.40	20	82	1/8	130	1/4	300	1/2	430	1/2	560	1/2	680	3/4	750	3/4	1.0K	1	1.0K	1	1.2K	1
3.50	20	75	1/4	120	1/8	270	1/4	430	1/2	560	1	620	1	750	1	1.0K	1	1.1K	2	1.3K	2
3.60	20	68	1/4	120	1/8	270	1/4	430	1/2	560	1	620	1	750	1	1.0K	1	1.1K	2	1.3K	2
	30	47	1/8	82	1/4	180	1/2	270	1	360	1	430	1	470	2	620	2	680	2	820	2
3.80	26	47	1/8	91	1/4	200	1/2	300	1/2	390	1	470	1	560	1	750	1.5	820	1.5	1.0K	2
	30	39	1/8	75	1/4	180	1/2	270	1	330	1	430	1	470	2	620	2	680	2	820	2
3.90	30	36	1/8	68	1/4	180	1/2	270	1	330	1	390	1	470	2	620	2	680	2	820	2
4.00	26	39	1/8	82	1/4	200	1/2	330	1/2	390	1	470	1	560	1	750	1.5	820	1.5	1.0K	2
	30	33	1/8	68	1/4	130	1/2	270	1	330	1	390	1	470	2	620	2	680	2	820	2
4.20	20	39	1/8	91	1/8	240	1/4	390	1/2	510	1	620	1	680	1	910	1	1.0K	1	1.2K	1
	30	27	1/8	62	1/4	160	1/2	270	1	330	1	390	1	470	2	620	2	680	2	820	2
4.30	20	36	1/8	82	1/8	240	1/4	390	1/2	470	1/2	560	1	680	1	910	1	1.0K	1	1.2K	1
4.40	26	24	1/8	62	1/4	180	1/2	300	1/2	390	1	470	1	560	1	680	1.5	750	1.5	910	1.5
5.00	25	—	—	47	1/8	160	1/2	300	1	360	1	470	1.5	560	1.5	680	2	820	2	1.0k	2.5
5.50	12.5	—	—	82	1/8	330	1/2	160	1	560	1/4	910	1/2	1.1K	1	1.5K	1	1.6K	1	1.8K	1
	25	—	—	43	1/8	160	1/4	300	1/2	360	1/2	470	1	560	1	680	1	820	1.5	1.0K	1.5
	45	—	—	24	1/8	91	1/2	160	1	200	1	270	1.5	300	1.5	390	2	430	3	560	3
	52	—	—	20	1/8	82	1/2	150	1	180	1.5	220	1.5	270	3	330	3	390	3	470	3
12.00	12.5	—	—	—	—	—	—	—	—	160	1/8	330	1/8	510	1/4	820	1/2	1K	1/2	1.3K	1
	15	—	—	—	—	—	—	—	—	150	1/8	270	1/8	400	1/4	680	1/2	820	1/2	1.5K	1
	20	—	—	—	—	—	—	—	—	100	1/8	200	1/4	300	1/2	510	1	620	1	820	1
	26	—	—	—	—	—	—	—	—	82	1/8	160	1/4	240	1	390	1	470	1	620	1
24.00	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	400	1/8
	13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	330	1/2

PROCESSING RECOMMENDATION GUIDE

Series & Type	PCB		SMT		Cleaning	
	Wave Solder	Manual Solder	IR Reflow	Vapor Phase	Auto-matic	Manual
A Rockers	x	x			x	
A Toggles	x	x			x	
AB Pushbuttons	x	x			x	
AS Slides	x	x				x
B Illuminated Toggles	x	x			x	
B Toggles	x	x			x	
BB Pushbuttons	x	x			x	
CB Tactiles	x	x			x	
CB3 SMT Tactiles		x	x		x	
CS Slides	x	x				x
D2 Toggles	x					x
DB Pushbuttons	x	x				x
DSA Tilt	x	x				x
DSB Tilt	x	x			x	
EB Pushbuttons (PCB)	x	x				x
FR01 DIP Rotaries	x	x				x
FR02 SMT DIP Rotaries		x	x			x
FS Slides	x	x				x
G Illuminated Toggles	x	x			x	
G Rockers	x	x			x	
G Toggles	x	x			x	
G3B SMT Pushbuttons		x	x		x	
G3T SMT Toggles		x	x		x	
GB Illuminated Plunger	x	x			x	
GB Pushbuttons	x	x			x	
GB2 Pushbuttons	x	x				x
GW Illum. Paddles	x	x				x
GW Rockers/Paddles	x	x				x
HB2 Illum. Pushbuttons	x	x				x
HP02 Tactiles	x	x				x
HP03 SMT Tactiles		x	x			x
IS LCD PB & Display	x	x				x
IS OLED PB & Display	x	x				x
JB Illuminated Tactiles	x	x			x	

Series & Type	PCB		SMT		Cleaning	
	Wave Solder	Manual Solder	IR Reflow	Vapor Phase	Auto-matic	Manual
JB Tactiles	x	x			x	
JF Illuminated Tactiles	x	x			x	
JF Tactiles	x	x			x	
JL Illuminated Tactiles	x	x				x
JS DIP Slides	x	x				x
JS SMT DIP Slides		x	x			x
KP Illum. Pushbuttons	x	x				x
M Rockers (PCB)	x	x				x
M Toggles (PCB)	x	x				x
M2B Pushbuttons	x	x			x	
M2T Rockers	x	x			x	
M2T Toggles	x	x			x	
M2100 Illum Act's (PCB)	x	x				x
MB2000 PBs (PCB)	x	x				x
MB2400 PBs (PCB)	x	x				x
MB2500 PBs (PCB)	x	x				x
MRA Rotaries	x	x			x	
MRB Rotaries	x	x			x	
MRF Rotaries	x	x			x	
MRK Rotaries	x	x			x	
MS Illuminated Slides	x	x				x
MS Slides	x	x				x
ND Rotaries	x	x			x	
ND3 SMT Rotaries		x	x		x	
NP01 Pushbuttons	x	x				x
P Rockers (PCB)	x	x				x
P Toggles (PCB)	x	x				x
SK Keylocks (PCB)	x	x			x	
SM Slides	x	x				x
SS Illuminated Slides	x	x				x
SS Slides	x	x				x
SS3 SMT Slides		x	x			x
UB Pushbuttons (PCB)	x	x				x
UB2 Pushbuttons (PCB)	x	x				x

Processing Data

PROCESS SEALED SWITCHES

NKK, a pioneer in the development of process sealed switches, is ahead of its time as a manufacturer. These process sealed switches are increasingly in demand because of the advancements in automated PC board processing. NKK's expansive family of process compatible devices includes toggles, rockers, pushbuttons, tactiles, rotaries, keylocks and slides in a variety of sizes.

Over 50 years of quality design experience produced the first process sealed switches to satisfy the process requirements of PC board soldering and cleaning techniques. As the cutaway drawings on our Distinctive Characteristics pages illustrate, our process sealed switches incorporate all the features necessary to accomplish their process compatibility: epoxy sealed terminals, heat resistant resins, interior rubber o-rings, seals, and sleeves, plus ultrasonic welding. The following data has been developed from a comprehensive study of test data, technical literature, and industry practice.

Automated Cleaning Specifications

Temperature Stabilization

To minimize the thermal shock, switches should be allowed to cool to 38°C or to the temperature of the hand or machine cleaning.

Flux

NKK Switches recommends a no-clean (low residue) flux that can be either left on the board or cleaned with a mild organic solvent. A second choice is a synthetic flux that can be effectively removed with an alcohol-based solvent. A water soluble flux is not recommended because of the corrosive nature of the flux residue. The relatively high temperature and energetic cleaning methods needed to ensure complete removal of all flux residues could also be hazardous to the switch.

Flux Removal

Cleaning should take place at a slightly elevated room temperature between 38°C and 52°C. Spray pressure should not exceed 25psi. See table of Flux Removal Conditions below to determine recommended depth of submersion, time and temperature.

Drying

Drying time should be extended to a one-hour bake at 52°C maximum. This step will eliminate any condensation.

Flux Removal Conditions

Series	Depth (mm)	Time (Minutes)	Temperature (°C)
A, B	100	5	—
AB, BB, G, GB, SK-B	50	5	—
CB, CB3, JB, JF, M2B, M2T	50	1	50
G3B, G3T, ND, ND3	100	1	70
MRA, MRB, MRF	50	3	—
SK-E	50	1	60

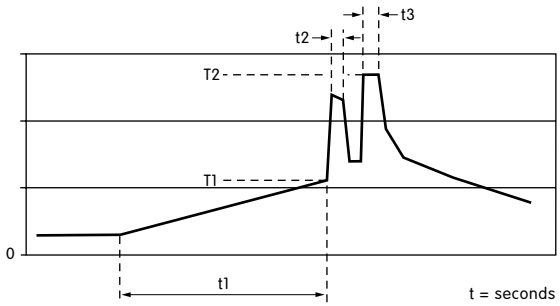
Manual Solder Profiles

Manual Solder Profile	Profile A High Temperature	Profile B Low Temperature
Solder Iron Tip Temperature	390°C	350°C
Time on Terminal	4 seconds	3 seconds
Cycles	2	1

Notes:

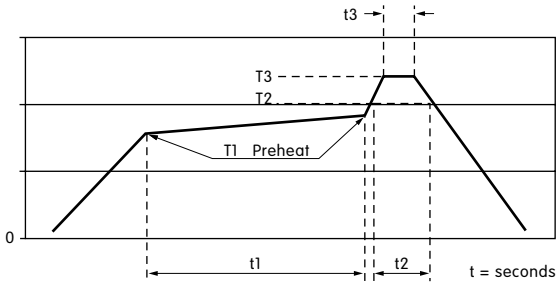
Profiles A and B are for lead-free.
Do not exceed these specifications.

Wave Solder Profiles for Through Hole



Wave Solder Profile	Symbol	Profile A High Temperature	Profile B Low Temperature
Preheat Temperature	T1	110°C	110°C
Preheat Time	t1	40 seconds	30 seconds
Peak Temperature	T2	270°C	270°C
Peak Time	t2 + t3	6 seconds	5 seconds
Thickness of PCB		1.6mm	1.6mm
Cycles		2	2
Comments		PCB with no Lead	PCB with no Lead

Reflow Solder Profiles for SMT



Reflow Solder Profile	Symbol	Profile A High Temperature	Profile B Low Temperature
Preheat Temperature	T1	180°C ~ 200°C	150°C ~ 170°C
Preheat Time	t1	120 seconds	90 seconds
Heating Temperature	T2	230°C	200°C
Heating Time	t2	60 seconds	30 seconds
Peak Temperature (Surface)	T3	250°C	240°C
Peak Time	t3	Not Specified	Not Specified
Thickness of PCB		1.6mm	1.6mm
Cycles		2	2
Comments		PCB with no Lead	PCB with no Lead

Notes:

The Reflow Solder profile above describes the printed circuit board (PCB) surface temperature. Since the PCB surface temperature and the switch surface temperature will vary depending on the height of the switch, the PCB material, and PCB thickness, ensure that the switch surface temperature does not exceed 250°C for high temperature (column A), or 240°C for low temperature (column B). Contact the factory if your conditions are more severe than the above specifications.

Standards & Approvals

Underwriters Laboratories Inc.
Find certifications at www.ul.com
File No. E44145
Class Description:
Switches, Special Use – Component. Switches are supplied without marking unless specified. See General Specifications page of each series for ordering instructions.

Underwriters Laboratories Inc.
Find certifications at www.ul.com
File No. E44145
Class Description:
Switches, Special Use – Certified for Canada. Switches are supplied without marking unless specified. See General Specifications page of each series for ordering instructions.

Canadian Standards Association
Online at www.csa-international.org
File No. 023535_0_000
Class No. 6241-10; Class Description:
C22.2 No. 55: Switches-Snap-Special Use. Switches are supplied without marking unless specified. See General Specifications page of each series for ordering instructions.

UL, cULus recognized & CSA certified only when ordered with marking on the switch.

See details regarding specific options in each switch section.

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
CWSA	6A @ 250V AC	•	•	
CWSB	6A @ 250V AC	•	•	
CWSB (illum.)	9A @ 125V AC	•		•
CWSC (illum.)	9A @ 125V AC	•		
	6A @ 250V AC	•		
CWT12	6A @ 125V AC	•	•	
	3A @ 250V AC	•		
EB2011	3A @ 125V AC	•	•	•
EB2065		•	•	•
EB2061	3A @ 125V AC	•	•	•
EB2085		•	•	•
FB15ANEP2	0.5A @ 125V AC	•	•	
HB15	0.1A @ 30V AC/DC	•	•	
HB16		•	•	
HS16-1	12A @ 125V AC 6A @ 250V AC	•	•	
HS16-2		•	•	
HS16-3		•	•	
HS16-4		•	•	
HS16-5		•	•	
HS16-6		•	•	
JPL	TV8, 125V AC	•	•	
JPM	TV5, 125V AC	•	•	
JWL11	TV8, 16A @ 250V AC 5A @ 72V DC (UL)	•	•	•
JWL12		•	•	•
JWL21		•	•	•
JWL22		•	•	•
JWM11	TV5, 10A @ 250V AC 10A @ 30V DC	•	•	•
JWM12		•	•	•
JWM21		•	•	•
JWM22		•	•	•
JWLW11	16A @ 250V AC	•		
JWLW12		•		
JWLW21		•		
JWLW22		•		
JWMW11	10A @ 250V AC 10A @ 30V DC	•		•
JWMW12		•		•
JWMW21		•		•
JWMW22		•		•
JWS11	6A @ 125/250V AC (illum. & nonilluminated)	•	•	•
JWS21		•	•	•

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
KB15	1A @ 125/250V AC 1A @ 30V DC 0.4VA @ 28V DC	•	•	•
KB16		•	•	•
KB25		•	•	•
KB26		•	•	•
LB15	3A @ 125/250V AC 0.4VA @ 28V DC	•	•	•
LB16		•	•	•
LB25		•	•	•
LB26		•	•	•
LP0125	3A @ 125V AC 3A @ 250V AC 3A @ 30V DC	•	•	
		•	•	
		•	•	
LW3122	10A @ 125V AC 6A @ 250V AC	•	•	
LW3123		•	•	
LW3125		•	•	
LW3128		•	•	
LW3129		•	•	
Toggles				
M2011	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	•	•	•
M2012		•	•	•
M2013		•	•	•
M2015		•	•	•
M2018		•	•	•
M2019		•	•	•
M2021		•	•	•
M2022		•	•	•
M2023		•	•	•
M2024		•	•	•
M2025		•	•	•
M2026		•	•	•
M2027		•	•	•
M2028		•	•	•
M2029		•	•	•
M2032	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	•	•	•
M2033		•	•	•
M2035		•	•	•
M2038		•	•	•
M2039		•	•	•
M2042		•	•	•
M2043		•	•	•
M2044		•	•	•
M2045		•	•	•
M2046		•	•	•
M2047	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	•	•	•
M2048		•	•	•
M2049		•	•	•

See details regarding specific options in each switch section.

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
Rockers M2011	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	•	•	•
M2012 M2013 M2015 M2018 M2019	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	• • • • •	• • • • •	• • • • •
M2021	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	•	•	•
M2022 M2023 M2024 M2025 M2026 M2027 M2028 M2029	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	• • • • • • • •	• • • • • • • •	• • • • • • • •
M2032 M2033 M2035 M2038 M2039	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	• • • • •	• • • • •	• • • • •
M2042 M2043 M2045 M2048 M2049	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	• • • • •	• • • • •	• • • • •
M2044 M2046 M2047	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	• • •	• • •	• • •
M2112 M2113	6A @ 125V AC	• •	• •	• •
UL & cULus for M2112 & M2113: Only Synchronous Toggles & Rockers with Solder Lug or Straight PC				
M2112 M2113	6A @ 125V AC			• •
CSA for M2112 & M2113: Only Synchronous Toggles & Rockers				
M2B15 M2B25	1A @ 125V AC 1A @ 30V DC 0.4VA @ 28V DC	• •	• •	• •
M2T12 M2T13 M2T15 M2T18 M2T19	6A @ 125V AC 3A @ 250V AC 4A @ 30V DC	• • • • •	• • • • •	• • • • •
M2T12 M2T13 M2T15 M2T18 M2T19	0.4VA @ 28V DC	• • • • •	• • • • •	

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
M2T22 M2T23 M2T25 M2T28 M2T29	6A @ 125V AC 3A @ 250V AC 4A @ 30V DC	• • • • •	• • • • •	• • • • •
M2T22 M2T23 M2T25 M2T28 M2T29	0.4VA @ 28V DC	• • • • •	• • • • •	
MB2011 MB2065 MB2061 MB2085 MB2181 MB2185	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC	• • • • • •	• • • • • •	• • • • •
MB2411 MB2461	3A @ 125V AC 0.4VA @ 28V DC	• •	• •	• •
MB2511 MB2521	3A @ 125V AC 0.4VA @ 28V DC	• •	• •	• •
MLW3012 MLW3013 MLW3015 MLW3018 MLW3019	5A @ 125V AC 3A @ 250V AC	• • • • •	• • • • •	
MLW3022 MLW3023 MLW3025 MLW3028 MLW3029 MLW3020	5A @ 125V AC 3A @ 250V AC	• • • • • •	• • • • • •	• • • • •
MRT22 MRT23	10A @ 125V AC 5A @ 125V AC	• •	• •	
MS12 MS13 MS22 MS23	6A @ 125V AC 3A @ 250V AC (nonilluminated)	• • • •	• • • •	
MS12 MS13 MS20 MS22 MS23	6A @ 125V AC 3A @ 250V AC 0.4VA @ 28V DC (nonilluminated)			• • • • •
P2011 P2012 P2013 P2021 P2022 P2023	10A @ 125V AC 6A @ 250V AC	• • • • • •	• • • • • •	• • • • • •
S1A S2A S3A	10A @ 125V AC 5A @ 250V AC	• • •	• • •	
S1A S2A S3A	15A @ 125V AC 6A @ 250V AC			• • •

Standards & Approvals

See details regarding specific options in each switch section.

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
S6A S6AL	20A @ 125V AC 10A @ 250V AC	• •	• •	• •
S7A	20A @ 125V AC 10A @ 250V AC			•
S31 S31F	18A @ 125V AC 9A @ 250V AC	• •	• •	
S31 S31F	25A @ 125V AC 9A @ 250V AC			• •
S32 S32F	18A @ 125V AC 9A @ 250V AC	• •	• •	
S32 S32F	25A @ 125V AC 9A @ 250V AC			• •
S33 S33F	18A @ 125V AC 9A @ 250V AC	• •	• •	
S33 S33F	25A @ 125V AC 9A @ 250V AC			• •
S31T S32T S33T	15A @ 125V AC 6A @ 250V AC	• • •	• • •	• • •
S35 S38 S39	15A @ 125V AC 6A @ 250V AC	• • •	• • •	• • •
S41 S41F S41R	18A @ 125V AC 9A @ 250V AC	• • •	• • •	
S41 S42 S43	25A @ 125V AC 9A @ 250V AC			• • •
S41T S42T S43T	15A @ 125V AC 6A @ 250V AC	• • •	• • •	• • •
S42 S42F S42R	18A @ 125V AC 9A @ 250V AC	• • •	• • •	
S42	25A @ 125V AC 9A @ 250V AC			•
S43 S43F S43R	18A @ 125V AC 9A @ 250V AC	• • •	• • •	
S43	25A @ 125V AC 9A @ 250V AC			•
S45 S48 S48R S49 S49R	15A @ 125V AC 6A @ 250V AC	• • • • •	• • • • •	
S114 S116	5A @ 125V AC 2A @ 250V AC			• •

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
S301 S302 S303	15A @ 125V AC 6A @ 250V AC	• • •	• • •	• • •
S301F	15A @ 125V AC 6A @ 250V AC	•	•	•
S301T S302T S303T	15A @ 125V AC 6A @ 250V AC	• • •	• • •	• • •
S305 S305T S308 S308T S309 S309T	15A @ 125V AC 6A @ 250V AC		• • • 	• • • • • •
S331	25A @ 125V AC 9A @ 250V AC	•	•	•
S331F	25A @ 125V AC 25A @ 250V AC	•	•	
S331R	25A @ 125V AC 9A @ 250V AC	•	•	
S331T	15A @ 125V AC 15A @ 250V AC	•	•	
S332	25A @ 125V AC 9A @ 250V AC			•
S332 S332F S332R	25A @ 125V AC 15A @ 250V AC	• • •	• • •	
S332T	15A @ 125V AC 15A @ 250V AC	•	•	
S333	25A @ 125V AC 9A @ 250V AC			•
S333 S333F S333R	25A @ 125V AC 15A @ 250V AC	• • •	• • •	
S333T	15A @ 125V AC 15A @ 250V AC	•	•	
S335	15A @ 125V AC 6A @ 250V AC	•	•	•
S335F	25A @ 125V AC 15A @ 250V AC	•	•	
S335T	15A @ 125V AC 6A @ 250V AC	•	•	
S338 S338R S338T	15A @ 125V AC 6A @ 250V AC	• • •	• • •	
S339 S339R S339T	15A @ 125V AC 6A @ 250V AC	• • •	• • •	

See details regarding specific options in each switch section.

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
S821 S822 S823	30A @ 125V AC 30A @ 250V AC	• • •	• • •	• • •
S821D S822D S823D	30A @ 30V DC 15A @ 125V DC	• • •	• • •	• • •
S831 S832 S833	30A @ 125V AC 30A @ 250V AC	• • •	• • •	• • •
S831D S832D S833D	30A @ 30V DC 15A @ 125V DC	• • •	• • •	• • •
SB25	15A @ 125V AC 9A @ 250V AC	•	•	•
SB61A	10A @ 125V AC 5A @ 250V AC	•	•	
SB221NC SB221TNC	3A @ 125V AC 1.5A @ 250V AC	• •	• •	• •
SB221NO SB221TNO	3A @ 125V AC 1.5A @ 250V AC			• •
SB265	6A @ 125V AC 3A @ 250V AC	•	•	•
SB4011NC SB4011NO	3A @ 125V AC 2A @ 250V AC	• •	• •	• •
Low Security SK12AA SK12BA SK13DA SK13EA	3A @ 125V AC 1A @ 250V AC	 • • • •	 • • • •	 • • • •
Medium Security SK12AD SK12BD SK13ED	3A @ 125V AC	 • • •	 • • •	

Basic NKK Part No.	Rating Amps@Volts	UL	cULus	CSA
SW3001A SW3002A SW3003A	15A @ 125V AC 6A @ 250V AC 15A @ 30V DC 10A @ 125V AC (Inductive)	• • •		
SW3001A SW3002A SW3003A	15A @ 125V AC 6A @ 250V AC			• • •
SW3006A	20A @ 125V AC 10A @ 250V AC	•	•	•
SW3007A	15A @ 125V AC 6A @ 250V AC			•
SW3821 SW3822 SW3823	30A @ 125V AC 30A @ 250V AC	• • •	• • •	• • •
SW3821D SW3822D SW3823D	30A @ 30V DC 15A @ 125V DC	• • •	• • •	• • •
SW3831 SW3832 SW3833	30A @ 125V AC 30A @ 250V AC	• • •	• • •	• • •
SW3831D SW3832D SW3833D	30A @ 30V DC 15A @ 125V DC	• • •	• • •	• • •
UB15 UB16 UB25 UB26	5A @ 125V AC 5A @ 250V AC 0.014A @ 28V DC	• • • •	• • • •	
UB15 UB16 UB25 UB26	5A @ 125V AC 5A @ 250V AC 0.4VA @ 28V DC 5A @ 30V DC			• • • •
UB215 UB216 UB225 UB226	5A @ 125V AC 5A @ 250V AC 0.014A @ 28V DC	• • • •	• • • •	
WR11 WR12 WR13 WR15 WR18 WR19	15A @ 125V AC 15A @ 250V AC 15A @ 30V DC (Solder Lug & Screw Lug only)	• • • • • •	• • • • • •	
YB15 YB16 YB25 YB26	3A @ 125/250V AC 0.4VA @ 28V AC/DC (Solder Lug only)	• • • •	• • • •	• • • •
YB15 YB16 YB25 YB26	3A @ 125/250V AC 0.4VA @ 28V AC/DC	• • • •	• • • •	• • • •
YB215 YB216 YB225 YB226	3A @ 125/250V AC 0.4VA @ 28V AC/DC	• • • •	• • • •	

Standards & Approvals

VDE (Verband Deutscher Elektrotechniker/Germany)

VDE Approved

Models	Approved Ratings	File or License Numbers	Marking on Case
JPL	8A/128A @ 250V AC 16A (8A) @ 250V AC	097579	Standard
JPM	5A/80A @ 250V AC 10A (6A) @ 250V AC	113494	Standard
JWL	8A/128A @ 250V AC 16A (8A) @ 250V AC	115637	Standard
JWM	5A/80A @ 250V AC 10A (6A) @ 250V AC	115637	Standard

VDE Approved

Models	Approved Ratings	File or License Numbers	Marking on Case
JWS	5A (3A) @ 125/250V AC	119153	Standard
P	10A (6A) @ 125V AC 6A (6A) @ 250V AC	119174	Standard
SW3006A	20A @ 125V AC 10A @ 250V AC	119189	On Request
WR	15A (8A) @ 250V AC	126501	On Request

ISO (International Organization for Standardization)

ISO 9001

ISO 9000 is a set of international standards on quality management and quality assurance. It is not a set of product specifications but requirements for building a quality system with documented and repeatable procedures.

NKK has received the certificate of registration for the ISO 9001 standard, which is for business operations that design, produce, install, and service products.

ISO 14001

ISO 14000 is a new series of voluntary international standards governing environmental management. ISO 14001 is the first of some 20 standards to be developed.

NKK, being a corporation mindful of environmental concerns, has obtained a certificate of registration for ISO 14001. This standard seeks to balance socio-economic and business needs with support of environmental protection and pollution prevention within reach of businesses large and small.

IP Code for Degrees of Protection Provided by Enclosures

The IP code is part of the IEC60529 (International Organization for Standardization) standard recommending the degree of protection of enclosures for low-voltage switch gear; specifically, concerned with protection of persons against contact with live or moving parts and the prevention of ingress of solid foreign bodies and liquid.

The IP code is an industrial specification used internationally and is similar to the NEMA standard.

IP60 dust tight but not protected from water.

IP65 dust tight and protected against water jets.

IP67 dust tight and protected against effects of temporary immersion.

PLASTICS

Specific Name	Acronym or Abbreviation	Generic Name
Acrylonitrile butadiene styrene	ABS	Shatterproof thermoplastic composed of styrene and acrylic resin; ABS provides resilience, shiny appearance, and stable base for metal plating
Carbon blended polyamide		Polyamide blended with carbon for antistatic property
Carbon composite polyacetal		Polyacetal
Diallyl phthalate	DAP	Diallyl phthalate; a thermosetting resin
Ethylene Propylene Terpolymer	EPT	Ozone resistant plastic
Glass fiber reinforced diallyl phthalate	GFR DAP	Diallyl phthalate
Glass fiber reinforced polyamide	GFR PA	Polyamide
Glass fiber reinforced polybutylene terephthalate	GFR PBT	Polyester
Liquid crystal polymer	LCP	Liquid crystal polymer
Nitrile butadiene rubber	NBR	NBR; mainly used where oil-proof is required
Phenolic resin		Phenol plus aldehydes; used extensively as thermosetting plastic
Polyacetal		Polyacetal
Polyamide	PA	Nylon 6/6; Polyamide; always a nylon resin
Polybutylene terephthalate	PBT	Polyester
Polycarbonate	PC	Lexan; Polycarbonate; damaged by tricholoethylene solvent and so changes to polyamide
Polyethylene	PE	Polyethylene
Polyphenylene sulfide	PPS	Polyphenylene sulfide
Polyoxymethylene	POM	Polyoxymethylene
Polypropylene	PP	Polypropylene; more elastic than polycarbonate
Polyvinyl chloride	PVC	Polyvinyl chloride; loses pliability below 0°C (32°F)
Resin		Polymer
Silicone		Silicone

ELEMENTS

Ag	silver	**Cr**	chromium	**Pb**	lead
Al	aluminum	**Cu**	copper	**Sn**	tin
Au	gold	**Ni**	nickel	**Zn**	zinc

Terms & Acronyms

A

AC Alternating Current; electric current that continually reverses direction at a fixed frequency

alloy A metal created by combining two or more different metals to obtain a desired physical property

alternate action Commonly describing pushbutton switches; remaining in a given circuit condition after removal of actuating force; when actuating force is applied a second time, the opposite circuit is engaged; also known as push-push switching action; may or may not be latchdown

ambient temperature range Operating temperature range

angle of throw Used with rockers and toggles to indicate total travel arc measured in degrees

annealed Relieved of mechanical stress through the application of heat and gradual cooling; for example, annealed copper is less brittle

ANSI American National Standards Institute; a standard-setting agency of the United States which approves the design and/or performance of electrical/electronic components that are distributed in the world market

arcing The flow of electric current between opening or closing switch contacts

AWG American Wire Gauge. Sizes may be determined by measuring the diameter of the conductor (the bare wire) with the insulation removed.

B

bifurcated contact A two-pronged, wiping movable contact

bounce The repeated rebounding of the movable contact during the transfer from one throw to the next; measured in milliseconds

brass An alloy of zinc and copper

break before make Interrupting one circuit of a pole before completing another of the same pole (nonshorting contact)

C

capacitive load A load in which the initial current on make is higher than steady state; upon break it is less than steady state. Current leads voltage in capacitive loads

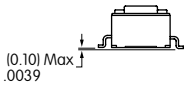
clad The joining of two dissimilar materials by welding or bonding

cleaning Automated cleaning for process sealed devices, manual cleaning for unsealed devices. Cleaning is needed to remove flux from terminals and PC boards

contact resistance The resistance across a pair of closed contacts which is in series with the load; this resistance increases with the age of the switch at a rate varied by environment, frequence of use, voltage, and load conditions; measured in milliohms

convection reflow Automated soldering of surface mount devices by running the PC board with the attached components through a soldering convection oven

coplanarity The profile of the surface tolerance establishes a tolerance zone defined by two parallel planes some distance apart within which all considered surfaces must lie



HP03 Series

All other SMTs

creepage	The unwanted flow of electrical current from one conductive part to another
CSA	Canadian Standards Association
cULus	Underwriters Laboratories Inc. - indicates compliance with both Canada and US requirements
cycle	The complete sequence of indexing through all successive switch positions and returning to the original position

D

DC	Direct Current; electric current that flows only in one direction
detent	A mechanical positioning device for stopping actuator travel at each successive electrical circuit; for example, a spring-operated ball and groove
dielectric strength	The ability of an insulating material to withstand high voltage without electrical degradation
differential travel	The distance an actuator moves between the point where contacts snap over and where they snap back, or where a contact makes and then breaks
DIP	Dual Inline Package, indicating .100" center-to-center terminal spacing and .300" row-to-row spacing
double break	Having two pairs of contacts (shorting bar) that open the circuit at two places; having this added contact material improves heat dissipation and increases life; desirable in DC circuit applications
DP	Double Pole; see pole
dry circuit	A low energy circuit condition where no arcing occurs during contact switching; for example, 0.4VA maximum @ 28V AC/DC maximum; see logic level
DSP	National Defense Standards of Japan; NKK file numbers C 6310B & C 6313
DT	Double Throw; see throw
dust cover	Protects switch in an environment where small particles and dust exist; switch is operable with dust cover in place

E

environmentally sealed	Protected for use in harsh environments

F

flash plating	A very thin or "instant plating" of usually less than 10 microinches in thickness
flow soldering	Automated soldering of through-hole devices on PC boards, also known as wave soldering
flux	Chemical used for cleaning metal surfaces so that solder will flow out on the metal; fluxes change a passive, contaminated metal surface into an active, clean, solderable surface

G

gull wing	A type of surface mount terminal which extends from side of switch and has an L-shaped bend at the end

Terms & Acronyms

H

horsepower Horsepower, a unit of work, is often found as a rating on electrical motors. One horsepower is equal to 746 watts.

I

inductive load A load in which the initial current on make is lower than steady state and upon break is greater than steady state. The long arcing time, due to stored energy in the inductor at the time of breaking, is severe on the switch contacts

IEC International Electrotechnical Commission
3 Rue de Varembe
P. O. Box 131
1211 Geneva 20, Switzerland

IECQ IEC's Quality Assessment System for Electronic Components, created in 1983 to facilitate national and international trade in certified electronic components; a worldwide certification system which provides a method whereby electronic components made and handled by approved manufacturers and distributors can be used anywhere without further testing.

infrared reflow A method of mass soldering surface mount devices with some form of infrared (IR) thermal radiation, such as a lamp IR system where PCB and components are heated largely by radiant energy from IR lamps

inrush The initial, transitory high-level of current through contacts upon making (closing); can cause severe degradation of contacts; applicable to resistive and capacitive loads

insulation resistance The electrical resistance between two normally insulated parts; measured at a specific high potential; usually greater than 1 megohm

IP Ingress Protection (IP) rating system for definition of level of water and dust protection

ISO ISO, International Standards Organization, is a network of the national standards institutes of 146 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system

isolated lamp circuit Independent of switching circuit; lamp is operated on a circuit separate from the switch circuit

J

JEITA Japan Electronics and Information Technology Industries Association

JETL Japan Electrical Testing Laboratory

JIS Japan Industrial Standard; Japan Industrial Standards Committee (JISC)
Agency of Industrial Science and Technology

L

lamp load (tungsten) Most notably characterized by the high inrush current at make (approximately 10 to 16 times the steady state)

latchdown One type of alternate action in which the pushbutton is mechanically fastened in the down position; the pushbutton is at "normal" position for one circuit and latched down position for the other circuit condition

LED Light Emitting Diode; provides illumination with advantages of long life and low power consumption

logic level An application in which power levels do not cause arcing, melting, or softening of contacts; also referred to as dry circuit or low energy; specified 0.4VA maximum @ 28V AC/DC maximum; typically requiring gold contacts for reliability

low level — Devices that are used in a low level circuit (low voltage and low current) have not been tested by UL and/or CSA. When used as intended in a low level circuit, the results do not produce hazardous energy.

luminous intensity — The luminous intensity is the luminous flux emitted from a point per unit solid angle into a particular direction. Standard unit of luminous intensity is Candela (cd), also expressed as Lumen per Steradian (lm/sr).

M

maintained action — Remaining in a given circuit condition until actuated to the opposite circuit condition where it is again maintained; opposite momentary action

make before break — Completing one circuit of a pole before interrupting another of the same pole (shorting contact)

MITI — Ministry of Industry & Trade Institute (Japan)

momentary action — Mechanically returning from a temporary circuit condition to the normal circuit condition as soon as the actuating force is removed

motor load — Most electric motors are designed to run at 50% to 100% of rated load. Maximum efficiency is usually near 75% of rated load. Thus, a 10-horsepower (hp) motor has an acceptable load range of 5 to 10 hp; peak efficiency is at 7.5 hp. A motor's efficiency tends to decrease dramatically below about 50% load.

MSCP — Mean Spherical Candle Power; a unit of measure of light intensity

N

NC — Normally Closed contacts; circuit is closed when actuator is in relaxed or normal position

NEMA — National Electrical Manufacturers Association, an agency of the United States setting standards for products distributed worldwide; applied to switches in their degrees of protection against the intrusion of liquids, dust, and other contaminants

Newton — The unit of measure for operating force abbreviated N; see the conversion tables in the previous section

NO — Normally Open contacts; circuit is open when actuator is in relaxed or normal position; applies to momentary or alternate action switches

nominal — The result of the calculated actual value range

nonshorting contacts — Contacts which break before make

nonswitching rating — The power carrying capability of a switch after contact closure and at the end of contact bounce; usually much higher than the switching rating

O

opaque — Condition that prevents the passage of light

overtravel — The distance an actuator moves beyond the point at which electrical contacts transfer

P

panel seal — Liquid is prevented from reaching the switch contacts from the front of the panel if the panel is subjected to spills or splashing

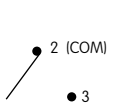
PCB — Printed Circuit Board; thin copper traces on a plastic laminate providing low cost, low current mass wiring

Terms & Acronyms

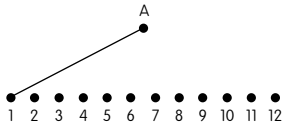
PF Power Factor; a means of determining contact capability when used with inductive loads relative to the standard resistive load rating; for example, if PF = 1.0 the inductive load is 100% of the resistive load, or if PF = 0.6 the inductive load is 60% of the resistive load

photo interrupter Light source being interrupted and thus changing the status of an electrical circuit

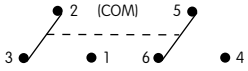
pole A single common electrical input having one or more outputs



Single Pole (with 1 output)



Single Pole (with 12 outputs)



Double Pole (with 2 outputs)

position The mechanical detents of a switch actuator

PPS Polyphenylene sulfide; a thermoplastic resin which is chemical and flame resistant

pretravel The distance an actuator moves before a change in the electrical condition is made

process compatible Capable of subjection to automated cleaning procedures after wave soldering; often noted as "washable"

process sealed Sealed to withstand the entire automated processing including the final cleaning

protective guard Prevents accidental actuation; switch is not operable when protective guard is in place

push-push Also known as alternate action; is not latchdown

R

RCJ Reliability Center for Electronic Components of Japan, member of EXACT (International Exchange of Authenticated Electronic Component Performance Test Data)

resistive load The easiest load to switch because current and voltage are in a steady state on make and drop instantly to zero on break; produces minimal arcing which maximizes contact life

RMS Root Mean Square

RoHS Restriction of Hazardous Substances in Electrical and Electronic Equipment directive restricting the use of lead, cadmium, mercury, hexavalent chromium and PBB/PBDE flame retardant materials in electrical and electronic products sold in Europe beginning July 1, 2006

S

SEMKO Svenska Elektriska Materielkontrollanstalten of Sweden

SEV Schweizerischer Elektrotechnischer Verein of Switzerland

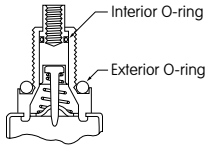
shorting contacts Contacts which make before break

silicone rubber Rubber made from silicone elastomers and noted for its retention of flexibility, resilience, and tensile strength over a wide temperature range

SIP Single Inline Package, indicating .100" center-to-center terminal spacing with terminals aligned in one row

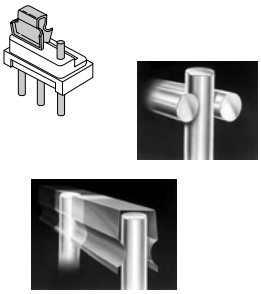
snap action The abrupt transfer of contacts from one position to another; this action is relatively independent of the speed of actuator travel

splashproof Prevents entry of liquids at front panel generally by means of one or two internal o-rings, as illustrated here



SPST Single Pole Single Throw; see pole, also throw

STC Sliding Twin Contact, a mechanism with two movable contact surfaces which pinch the stationary contacts. The STC contact mechanism provides smooth, positive detent actuation, unparalleled logic-level reliability, and more contact stability than conventional mechanisms. Continued reliability is assured since the gold-plated contacts are wiped clean with each actuation. Furthermore, if one side of the twin contacts should fail to conduct, the other side functions as a backup or a fail-safe path for the current. The combination of rounded movable and stationary contacts provides the smooth contact feel not found previously in sliding contact type mechanisms.



surface mount SMD or SMT Component terminals are soldered to pads on the surface of the PC boards as opposed to using holes for mounting; terminal shapes vary – gull wing, J-bend, and others

synchronous lamp circuit Lamp is operated on a circuit in phase with the switch; the switch contains a separate circuit to open or close the lamp circuit simultaneously with the switching circuit

T

tactile feedback The switching action felt by an operator

tamperproof Designed to prevent tampering or provide evidence of tampering; impervious to tampering

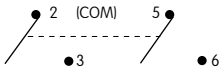
tamper resistant Designed to make tampering difficult or resistive

thermal shock The state of a component that is undergoing an excessive temperature change, particularly in reference to movement from one process to another in soldering and cleaning

thermoplastic A plastic which is flexible and easily molded when heated and which becomes hard and regid when cooled

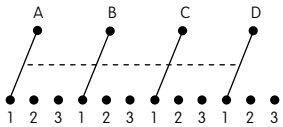
thermoset A plastic which becomes hard and rigid when heated or cured

throw The number of electrical circuits within a pole



Single Throw (with 2 poles)

Double Throw (with 1 pole)



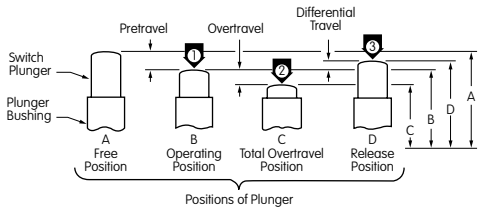
Three Throw (with 4 poles)

total travel Sum of pretravel and overtravel; full distance an actuator moves from relaxed position past the point of electrical contact and to the end of travel

translucent Transmitting and diffusing light so that objects beyond cannot be seen clearly

transparent Transmitting light without appreciably scattering so that objects lying beyond are entirely visible

travel The distance the actuator moves to effect the change of electrical circuits; see also differential travel, pretravel, overtravel, and total travel



Terms & Acronyms

two circuit Circuit in which one circuit is completed in one position and another separate circuit is completed in the other position

U

UL Underwriters Laboratories Inc.; many of NKK's switches are UL Recognized

undercoating A coating used for preparation of a surface for plating or used to prevent corrosion when the finish plating develops pinholes; thickness of an undercoating is determined by its purpose

V

vapor phase A process well-suited to soldering surface mount devices; it combines infrared preheating with condensation heating for reflow, advantageous for eliminating overheating of components and PCB

VDE Verband Deutscher Elektrotechniker of Germany

W

watertight Impermeable to water except when subjected to immersion; not waterproof

wavelength The color of visable light is measured by its wavelength. The Greek symbol "lambda"is used to represent wavelength, the unit of measure is nm.

wave soldering A method of soldering in which a wave of molten solder contacts surfaces as the PC board with components is conveyed through the process; wave width, travel speed, dwell time, etc. are varied to achieve desired results

WEEE Waste Electrical and Electronic Equipment
Directive aims at prevention of WEEE and its reuse, recycling and recovery, so as to reduce the disposal of this type of waste. The directive sets targets for the separate collection of WEEE, along with standards for treatment and targets for recycling and recovery.

wiping action Sliding of contacts over one another resulting in cleaning of the surfaces

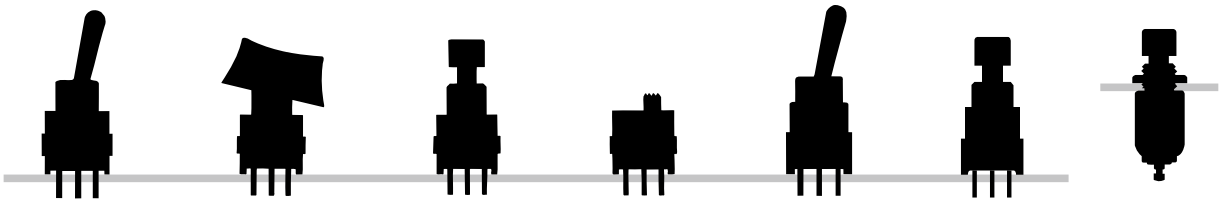
FEDERAL SUPPLY CODE

NKK Switches has been assigned the
FSC Number 63426
and is classified as a
Commercial and Governmental Entity (CAGE)
by the Defense Logistics Agency
in Battle Creek, Michigan.

Product Overview

Ultra-Miniature & Subminiature

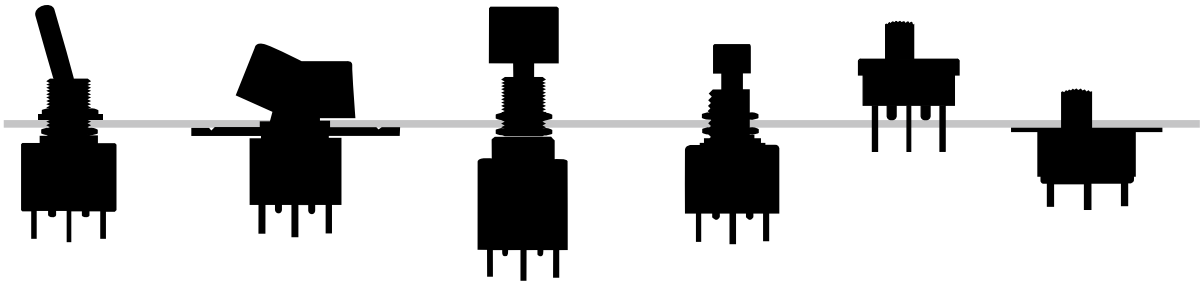
Toggles
Rockers
Pushbuttons
Slides



A Toggles | A Rockers | A Pushbuttons | A Slides | B Toggles | B Pushbuttons | FB Pushbuttons

Miniature

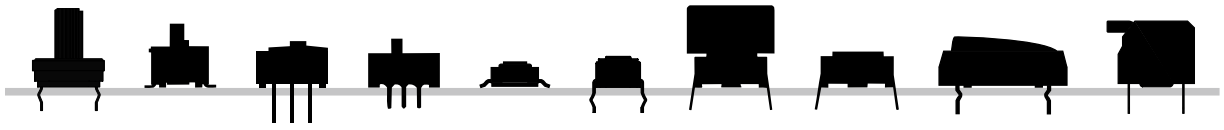
Toggles
Rockers
Pushbuttons
Slides



M Toggles | M Rockers | MB2000 | MB2400 | CS Slides | MS Slides

Specialty

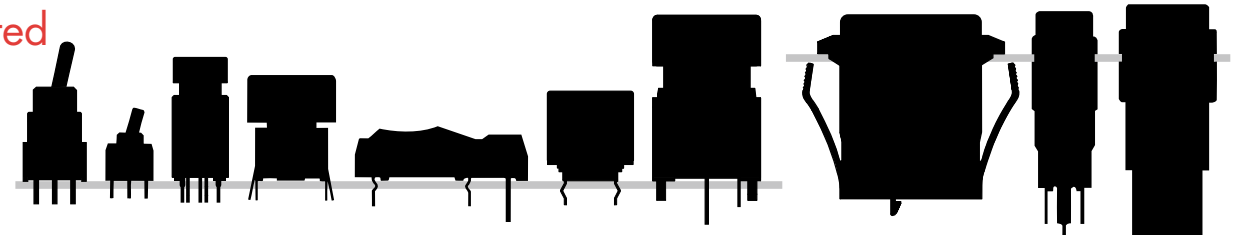
Rotaries
DIP Rotaries
Tactiles
Slides
Keylocks
Tilt Switches



FR01 FR02 | ND ND3 | SM | SS SS3 | CB CB3 | HP02 HP03 | JB | JB | JF | JS

Illuminated

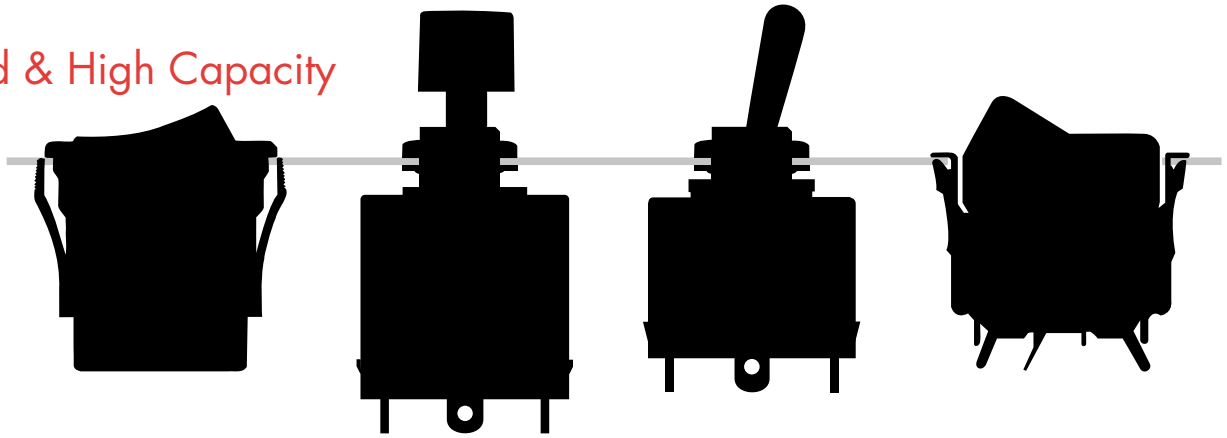
Toggles
Rockers
Pushbuttons
Tactiles
Slides



B Toggles | G GB GW | HB2 | JB | JF | NP01 | KP | FP | HB | KB

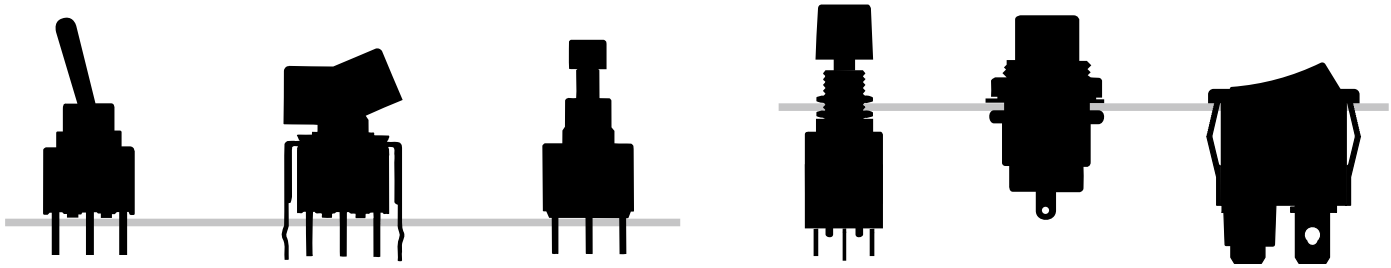
Standard & High Capacity

Toggles
Rockers
Pushbuttons
Rotaries

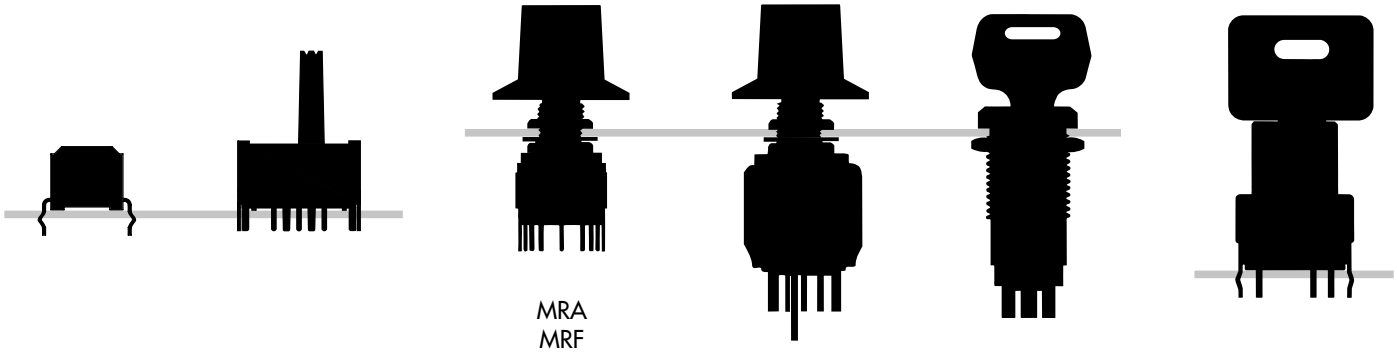


JW, JP | WB | WT, WR | LW

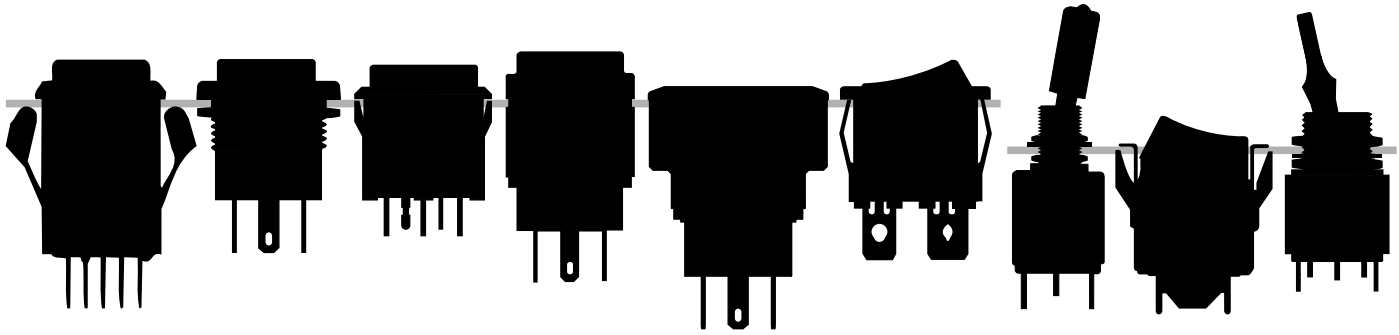
G Toggles G Rockers GB G3T G3B GW GB2



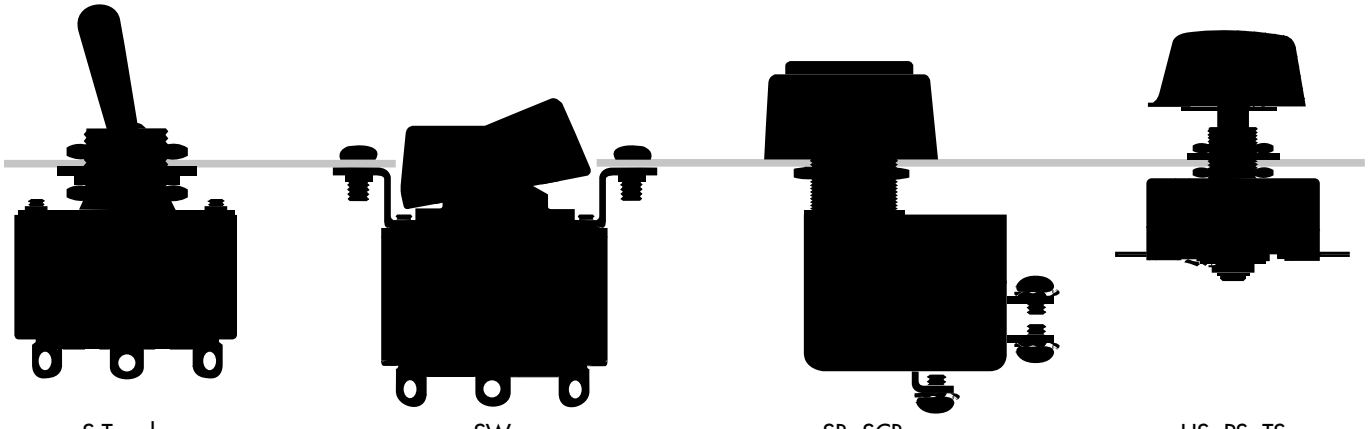
M2T Toggles M2T Rockers M2B EB SB40 CW



DS Tilt FS MRA MRF MRK MRX, MRY, MRT CK, SK SK



LB LP UB, UB2 YB YB2 CW M2100 MLW TL



S Toggles SW SB, SCB HS, PS, TS

Index by Model Number

Index by Model Number

Index by Model Number

Index by Model Number

Notes