

Switch User Manual

Page

Manual Switches Z4

Voltage • Circuit Design • Spark Quenching • Circuit Wiring • Load Types • Motor Forward-Reverse

Selecting Switches Based on Usage Environments Z7

Environments • Rubber Products • Caps • LEDs

Types of Actuators Z9

Toggles & Paddles • Pushbuttons

Operating Characteristics Z10

Alternate Action • Momentary Action • Latchdown • Two Switches

Manual Switch Operation Z11

Switch Mounting & Installation Z11

Bushing Mounting • Thick Panels • Mounting Torque • Screw Mounting • Snap-in Mounting • Printed Circuit Board Mounting • Terminal Numbers

Types of Terminals Z13

Solder Lug • Screw Lug • Straight PC • Vertical PC • Right Angle PC • Wirewrap • Solder Lug/Quick Connect • Soldering Conditions • Soldering Profiles

SmartSwitch Programmable Switches Z14

OLED Pushbutton • OLED Rocker • LCD 64 x 32 Pushbutton • LCD 36 x 24 Pushbutton

Tilt Switches Z17

Touch Screens Z18

Membranes Z20

Custom & Specialty Products Z22

Accessories • Legends & Mounting • Custom Solutions

Quality First Z23

Certifications • Standards • Product Development • Premium Materials • Applications

IEC Standard of Protection Z25

IP Ratings Table • NKK's Test Methods

Testing Facilities & Equipment Z26

Toggles

Rockers

Pushbuttons

PB

Illuminated

Programmable

Keylocks

Rotaries

Slides

Tactiles

Tilt

Touch

Indicators

Accessories

Supplement

Z

NKK SWITCHES USER MANUAL

MANUAL SWITCHES

Maximum Applied Voltage

Just as there are limits on a switch's electrical capacity, there are also limits on the voltage used. The maximum working voltage for a switch is generally the maximum rated voltage noted in the specifications for each series. If the switch is to be used at a higher voltage than the recommendation, it is advised to first consult with an NKK sales representative.

Circuit Design Considerations

- If the switch is to be used in an extremely critical device or application, consider extra security precautions such as a fail-safe function.
- Consider safety circuits (ground, etc.) for the switch.
- A switch's contact reliability is increased when two contact points are connected in parallel.
- When using micro-load circuits, use switches for micro-currents.

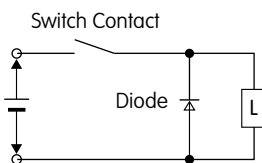
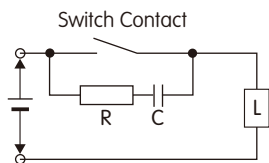
Spark Quenching Circuit

Spark quenching, or arc suppression, protects contacts against abnormal voltage and current when opening/closing a switch on an inductive load.

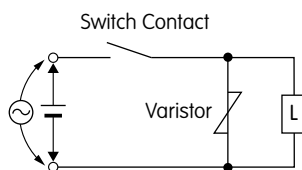
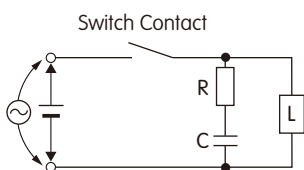
- Aids in noise prevention and absorption using a signal circuit
- Reduced contact erosion on DC circuits

It is recommended to include an appropriate spark quenching circuit. Spark quenching can be achieved by connecting CR elements, diodes, varistors, or a combination of these in parallel to the contact or load, which may also significantly increase durability.

For DC



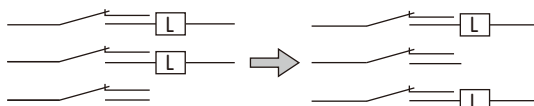
For AC/DC

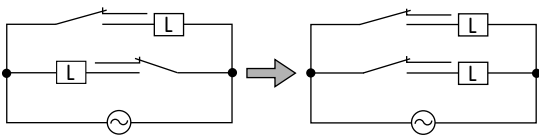


Circuit Wiring Examples

Preventing Short Circuits Between Poles

When there may be danger of an arcing short circuit between poles, put an extra pole in the center or use with an in-phase circuit. This way, the middle pole is used as a buffer.



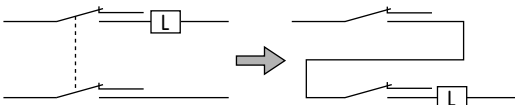


The switch mechanism should be in the same phase.

• Load with High Voltage Between Contacts

In the case of an arc connection caused by counter-electromotive force during an interruption, such as by an inductive load, a double pole switch may be used and contacts connected in series (see diagram below). This increases the contact interval and shortens the arc interruption time, reducing contact erosion and improving conditions. However, when a double pole switch is connected in parallel and used as a single pole, there is a time lag in operation between the two poles, so the throw/interruption capacity cannot be doubled.

The maximum voltage and current should not exceed the switch’s rated values.



Precautions on Load Types and Their Impact

Most of NKK’s switch rating labels are AC ratings and display current values for resistive loads at 125 – 250V AC. For other types of loads, use in accordance with Electrical Capacity by Load Type. Using a switch in excess of recommended values can cause erosion and shortened life.

• Resistive Load

This is a load for resistance only with a power factor of 1 ($\cos \varnothing = 1$). It is the basic load that expresses a switch’s characteristics. There are few loads that are strictly resistance only; most include some inductive or capacitive load. For actual use, 80% or less of the rated current is appropriate.

• Inductive Load

Inductive loads are in motors, transistors, solenoids, etc. Arcing occurs due to large counter-electromotive voltage at interruption, and compared to a resistive load, contact erosion is greater. (The lower the load’s power factor, the greater the counter-electromotive voltage.)

• Lamp Load

Joule heat can be caused by overcurrent and occurs when it is 10 – 15 times the rated current. It flows through a cold filament when the switch is thrown, and heat caused by arcing can result in contacts that melt and adhere.

• Motor Load

When a motor starts, there is an inrush current 3 – 8 times greater than the rated current, so contact erosion is greater. Careful consideration should be given to the motor type and start-up current.

Motor	Start-up Type	Start-up Current (Full Load Current)	Application
3-Phase Motor	Cage	50 - 800%	Machine Tools
Single-Phase Motor	Split-Phase-Start	500 - 600%	Fans, Pumps
	Condenser-Start	400 - 500%	Compressors
	Repulsion-Start	300 - 0%	Compressors, Deep Well Pumps
	Shading Coil	400 - 500%	Ceiling Fans

Take adequate precautions for the startup current when using switches in universal motors, condenser motors, DC motors or specialty motors, etc.

Toggles
Rocker
Pushbuttons
Illuminated PB
Programmable
Keylocks
Rotaries
Slides
Tactiles
Tilt
Touch
Indicators
Accessories
Supplement Z

Motor Forward-Reverse Switches

- Use Switches with OFF in Center

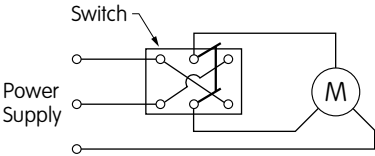
When there is a low power factor load due to deterioration in the simultaneity between poles, short circuits between poles can occur when an arc and another contact circuit comes ON. For switches with two or more poles, use a switch with OFF in the center: ON - OFF - ON or (ON) OFF (ON)

- Stop the Motor, Reverse the Rotation

If rotation is reversed while the motor is revolving, current flows through at about twice the start-up speed (current equivalent to inertia torque during rotation + start-up current). The switch’s electrical capacity needs to be sufficiently high.

- Reversing Rotation with a DPDT Switch

Use wiring in order to prevent burnout caused by short circuiting, as shown in following example.



- Condenser Load

When using condenser loads, there is an extremely large inrush current when the switch is turned ON. Use the switch after measuring the transient value at the actual load and confirming whether it is within the rated current.

- DC Load

With DC loads, there is no point at which voltage and current are zero like AC, so large arcs occur even with small loads. At 50V or higher, the arc duration time is much longer, and interruption failure may occur. Contact NKK Switches if using a switch in a DC circuit that is not labeled DC in the electrical capacity section.

Generally, when using a switch at 30V DC or less, it can be used up to a current value suitable for 125V AC.

Connecting the minus side to the COMMON terminals can help reduce contact damage caused by arcing.

Electrical Capacity By Load Type

Controllable current ratio by load with rated electrical capacity (resistive load at 125V AC) set at 1.

Voltage	Electrical Capacity	
	Resistive Load	Inductive Load Power Factor = 0.6
125V AC	1	1/2 - 2/3
250V AC	1/2 - 2/3	1/4 - 1/3
12V DC	1	3/4 - 1
30V DC	1/2 - 1	1/4 - 1/2
48V DC	1/4 - 1/3	1/5 - 1/4
125V DC	1/20	1/40 - 1/30

Load	Electrical Capacity
Resistive Load	1
Inductive Load Power Factor = 0.6	1/2 - 2/3
Lamp Load	1/5 - 1/4
Motor Load	1/3

SELECTING SWITCHES BASED ON USAGE ENVIRONMENTS

• Water, Oil and Dust

When using switches in locations with exposure to water or oil, or where dust may accumulate, use waterproof or airtight models. Switches do not have waterproof, oil-resistant or explosion-proof structures unless specifically indicated. When switches are used in areas with poor ambient air conditions and are without adequate protection, they are susceptible to contact failure.

• Micro-current Use and Ambient Gas

When switches are used at the level where arcing does not occur when opened/closed, contact voltage and current are relatively low. In environments with excessive hydrogen sulfide, chlorine gas and water vapor, oxidation or sulfurization may occur. Silver-based contacts can turn black, increasing contact resistance. It is then necessary to use a special switch for micro-currents that has gold ground on the contact area or has been coated with gold plating. Also, when a switch is operated infrequently (several times a year), it is recommended to use the type with a sliding contact mechanism, such as A, B, G, or D2 Series.

• Rubber Products

Generally, synthetic rubber is used in panel sealed switches or waterproof caps for panel sealing. Depending on the type of rubber, these may not always be suitable for the usage environment.

The following table shows key characteristics for various rubber types, and there are differences depending on composition or shape. Usually, even when performance is a strength, results are not always obtainable, depending on the usage environment and method. It is advisable to select products based on adequate assessments.

Abbreviation		NBR	Si	EPR (EPM, EPDM, EPT)	CR
Name		Nitrile Butadiene Rubber	Silicon Rubber	Ethylene-Propylene Rubber	Chloroprene Rubber
Heat Resistance		▲	◎	○	▲
Cold Resistance		▲	◎	○	○
Fatigue Resistance		○	✕ - ▲	○	○
Abrasion Resistance		○ - ◎	✕	○	◎
Weather Resistance		✕ - ▲	○ - ◎	◎	◎
Ozone Resistance		✕ - ▲	○	◎	○
* Oil Resistance	Fuel Oil	○ - ◎	✕	✕	✕
	Lubricants	○ - ◎	▲ - ○	✕	▲ - ○

* Oil resistance differs depending on the type of rubber

◎ Superior ○ Good ▲ Acceptable ✕ Unacceptable

• Operating Frequency

If the switch is opened/closed infrequently (only several times a year), confirm reliability and consult with an NKK representative. Also, switches can be supplied without grease as a way to curb the impact of grease solidifying on contacts. This occurs when a switch is not operated for a lengthy period of time.

• Protection to Prevent Accidental Operation

When safety is at risk due to inadvertent operation, it is recommended to use switches with locking levers. Typical examples to implement this precaution include small control rooms or control panels in transportation, production systems, medical devices, or exposure to vibration or shock.

Switch User Manual

Toggles

- **Ambient Temperature Range**

The ambient temperature range is guaranteed in an evaluation based on product specifications, but it is not certified that the switch can be used perpetually at that temperature.

Rockers

- **High Temperature Environments**

When switches are used near extremely strong heat-generating elements, current flows through the switch, causing it to become hotter than the ambient environment. This may result in the deterioration of the insulation, curtailing the life of the switch. It is best that they not be used near heat-generating elements.

Pushbuttons

NBR rubber parts will not only harden in high temperature environments, but the elasticity also deteriorates. In some cases, silicone rubber may be the solution.

Illuminated PB

- **Low Temperature Environments**

In an extremely low temperature environment, a switch's components' strength will decline, grease on movable parts may freeze, or the switch may no longer function normally. Cracks may also form in components of the device.

Programmable

- **Environments with High Humidity**

When a switch is used in an extremely high humidity environment, leakage current may increase. This may cause current malfunction due to insulation deterioration.

Keylocks

- **High Altitude or Low Atmospheric Pressure**

When atmospheric pressure declines, the dielectric strength of the air and insulation decreases. Discharge damage can occur and the arc length increases when opening/closing contacts. This results in reduced contact lifespan. Prevention of damage would be reduced voltage and current.

Rotaries

- **Storage and Transport Precautions**

If switches sustain shocks by being dropped, in transit, etc., internal components may become loose or damaged. There may be damage even if not visible, and adequate precautions should be taken to confirm the switch is not impaired.

Slides

When products with silver contacts are stored for long periods of time, the terminals may be affected by the ambient environment and experience sulfuration. Steps to prevent sulfuration during storage include avoiding high temperature, high humidity, airtight sealing, and not placing devices near objects that generate sulfur content. If sulfuration does occur, it can be removed with a silver polishing cloth.

Tactiles

- **Caps: Mounting, Cleaning, Legends**

When adhering a cap to a pushbutton switch, use a two-component adhesive and hold cap down until dry. Using a single component adhesive, when the cap is up, may allow the adhesive to flow into the switch and cause malfunction.

Tilt

Use caution when handling caps for illuminated switches and others with a clip that fits to the switch. Handle carefully so that clip does not become bent or damaged and result in a loose, improper fit.

Touch

Contaminants such as dirt on plastic actuators should be wiped with a dry cloth. If needed, wipe with a cloth and small amount of neutral detergent, then wipe with a dry cloth. It is not recommended to use alcohol, thinner, or other organic solvents, as they may remove printed legends or harm materials in the cap.

Indicators

When printing on cap, be certain that it will not harm the cap's materials.

- **LED Colors in Illuminated Switches**

Color variances may occur due to the nature of LEDs, even when using the typical forward current. Confirm and make adjustments accordingly to the current value for each color. If illuminating with two colors simultaneously, the color variance may be greater.

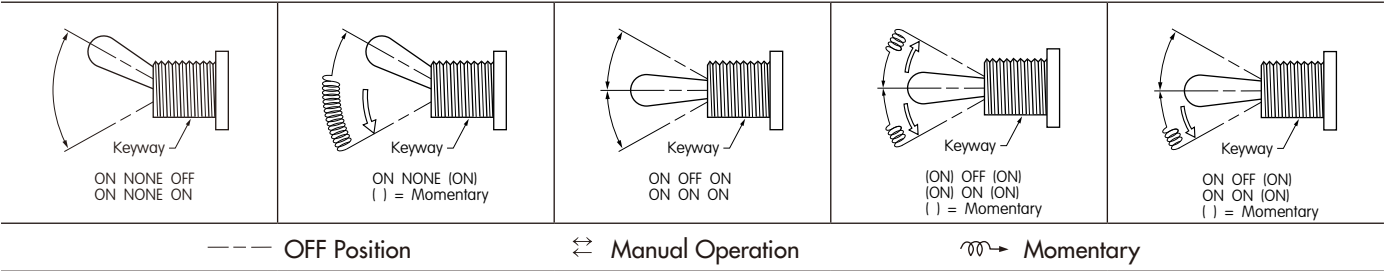
Accessories

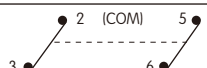
Supplement

Z

TYPES OF ACTUATORS

• Toggle and Paddle Actuators



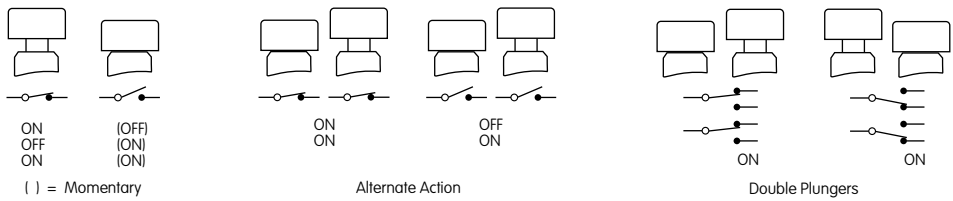
POLES & CIRCUITS								
M Toggles		Toggle Position () = Momentary			Connected Terminals			Throw & Schematics
Pole	Model	Down 	Center 	Up 	Down 	Center 	Up 	Note: Terminal numbers are not actually on the switch.
SP	M2011	ON	NONE	OFF	2-3	OPEN	OPEN	SPST 
SP	M2012 M2013 M2015 M2018 M2019	ON ON ON (ON) ON	NONE OFF NONE OFF OFF	ON ON (ON) (ON) (ON)	2-3	OPEN	2-1	SPDT 
DP	M2021	ON	NONE	OFF	2-3 5-6	OPEN	OPEN	DPST 
DP	M2022 M2023 M2025 M2028 M2029	ON ON ON (ON) ON	NONE OFF NONE OFF OFF	ON ON (ON) (ON) (ON)	2-3 5-6	OPEN	2-1 5-4	DPDT 
3P	M2032 M2033 M2035 M2038 M2039	ON ON ON (ON) ON	NONE OFF NONE OFF OFF	ON ON (ON) (ON) (ON)	2-3 5-6 8-9	OPEN	2-1 5-4 8-7	3PDT 
4P	M2042 M2043 M2045 M2048 M2049	ON ON ON (ON) ON	NONE OFF NONE OFF OFF	ON ON (ON) (ON) (ON)	2-3 5-6 8-9 11-12	OPEN	2-1 5-4 8-7 11-10	4PDT 

The Pole & Circuit table above, using M2000 Toggles as an example, shows operating characteristics in relation to switch model number. The first five characters in the number, for example, M2011, explains amount of poles, toggle position, and connected terminals.

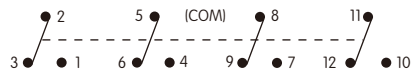
• Pushbutton Actuators

Types of pushbutton actuators:

Momentary, Alternate Action and Double Plunger



Toggles
Rocker
Pushbuttons
Illuminated PB
Programmable
Keylocks
Rotaries
Slides
Tactiles
Tilt
Touch
Indicators
Accessories
Supplement

POLES & CIRCUITS						
MB2000 Pushbuttons		Plunger Position () = Momentary		Connected Terminals		Throw & Switch Schematics
Pole	Model	Normal 	Down 	Normal 	Down 	Note: Terminal numbers are not actually on the switch.
SP	MB2011	ON	(ON)	2-3	2-1	SPDT 
	MB2065	ON	ON			
DP	MB2061	ON	(ON)	2-3 5-6	2-1 5-4	DPDT 
	MB2085	ON	ON			
4P	MB2181	ON	(ON)	2-3 5-6 8-9 11-12	2-1 5-4 8-7 11-10	4PDT 
	MB2185	ON	ON			

The Pole & Circuit table above, using MB2000 Pushbuttons as an example, shows operating characteristics in relation to switch model number. The first six characters in a part number, MB2011, denotes the amount of poles, plunger position, and connected terminals.

OPERATING CHARACTERISTICS

• Alternate Action

Toggle switches: When the actuator is operated, the circuit will switch over and the actuator and switch circuit will remain the same after it is released.

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, and may or may not be latchdown.

• Momentary Action

Momentary action is mechanically returning from a temporary circuit condition to the normal circuit condition as soon as the actuating force is removed.

Momentary mechanisms include a pushbutton switch that, when pressed and rotated to the right 30°, the cap locks in a down position. In addition, a locking lever toggle switch impedes operation even when lever is pushed down. This type is designed to prevent inadvertent operation. When the lever in the up position is actuated down, the circuit can be switched. When the lever is released in the switched position, the lever and circuit are locked.

• 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.

• Two Switches

Double switches only for pushbuttons. Two plungers beside each other, and when one is pressed, the circuit switches over. The pressed plunger stays down and the other one comes up. When the plunger that is up is pressed, the same functions are reversed.

MANUAL SWITCH OPERATION

NKK's products are designed to be operated manually. Switches may fail if operated using screwdriver, wrench or other tool.

Operate actuators by applying force in the proper operating direction. Do not operate toggle levers with excessive force from any direction, as it can cause malfunction. When adding caps or levers to ultra-miniature switches, guide the actuator on the panel surface.

If using an actuator other than from NKK, consider reinforcing the actuator and mounting areas with attention to the correct operating direction. Caution needs to be used to prevent damage or malfunction.

SWITCH MOUNTING & INSTALLATION

• Bushing Mounting

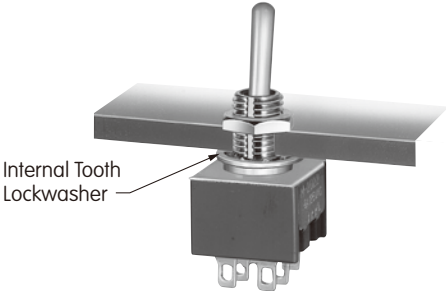
Avoid tightening nuts while holding the switch unit.

Bushing mount switches are generally mounted with a face nut and a backup nut. When mounting a subminiature switch on a thick panel and using an internal tooth lockwasher on bottom of panel, it can be mounted with one nut.

Mounting with Thick Panel

Subminiature Switches

M Series Toggle
M Series Pushbutton
P Series Toggle
(Excludes 12mm Bushing)

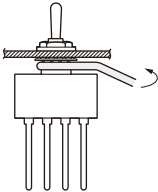


Internal Tooth Lockwasher

Mounting Torque

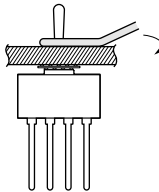
Thin Panel

Absolute Maximum
1.47Nm (13 lb•in)



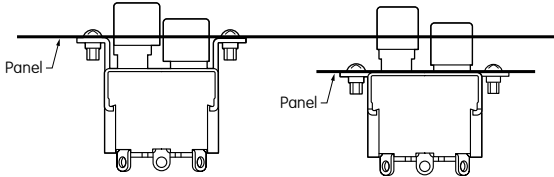
Thick Panel

Absolute Maximum
0.686Nm (6 lb•in)



Screw Mounting

Mounting hole specifications are provided with each series.



Panel

Switch User Manual

• Snap-in Mounting

When mounting switches on panels, insert by tilting slightly and adjusting the amount of force left and right to avoid shocking or jarring the switch.

To mount switch more firmly, align underside corner of the screw hole to be the sharp edge. When painting the panel surface, avoid clogging underside corner with paint.

Use caution if installing a switch with a plastic mounting spring. In dry, low temperature environments, the mounting spring may experience damage if forced into panel.

Avoid repeat installation of same switch, as it may weaken the mounting area. Particularly for plastic products, the spring may become worn and impaired.

After attaching to panel, do not apply excessive force to terminals.

• Printed Circuit Board Mounting

Printed circuit board mounting dimensions are provided for each product.

Soldering conditions should be according to specifications displayed for each series.

• Printed Circuit Board Mounting with Bushing or Screw Mount Switches

Confirm proper alignment between panel, switch and printed circuit board. Stress will occur if aligned incorrectly.

• MR Series, K Type

When installing the switch on a printed circuit board, assemble support bracket on the switch and then solder terminals, otherwise switch case may be damaged.

1. Insert switch into PC board, aligning locking ring and support bracket, then tighten hex nut.

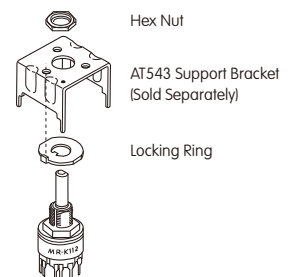
2. When removing knob, hold switch down while not applying too much pressure.

Notes:

1. A support bracket (AT543) is required when the MRK is mounted only to a PC board and does not have the bushing through a panel.

2. The switch is not process sealed if support bracket is used.

3. Do not tighten the hex nut after soldering the switch on PC board.



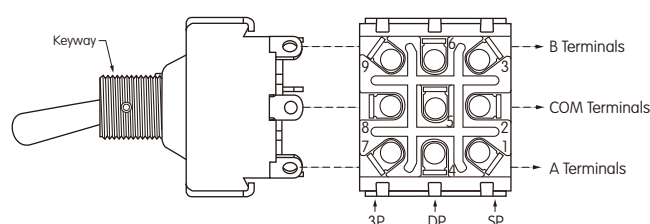
• Terminal Numbers

The terminal numbers on switch's bottom view are arranged in a fixed sequence corresponding with the keyway in a downward position.

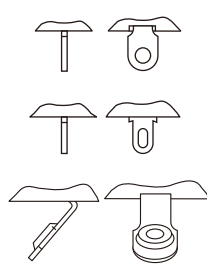
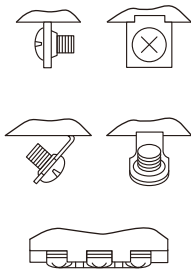
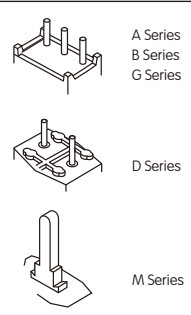
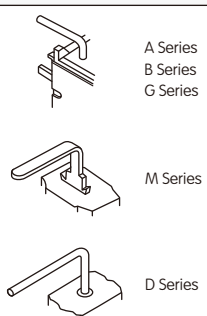
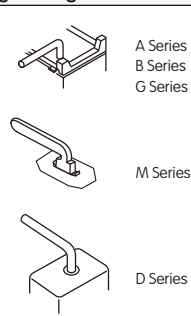
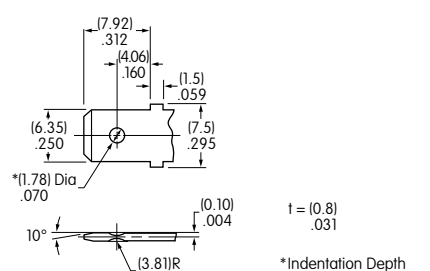
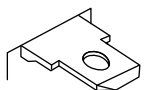
1. The numbers run from the bottom right upward and to the left.

2. Terminal numbers are generally placed on the switch's case; however, some products such as the subminiature switches do not have numbers due to space restrictions. Nonetheless, the numbers are still arranged in the same presumed sequence.

3. The number of poles increase from right to left, with the terminals in each vertical row as a single set.



TYPES OF TERMINALS

Solder Lug Terminals 	Screw Lug Terminals 	Straight PC Terminals  A Series B Series G Series D Series M Series
Vertical PC Terminals  A Series B Series G Series M Series D Series	Right Angle PC Terminals  A Series B Series G Series M Series D Series	Wirewrap Terminals  Thickness: 0.8mm (.031") Width: 1.27mm (.05") Length: 19.0mm (.748") M Series
Solder Lug / Quick Connect Terminals		
Solder Lug / Quick Connect .250" (6.35mm)  *Indentation Depth (0.1) / .004 Both Sides	Solder Lug / Quick Connect .187" (4.75mm)  P Series SCB Series JW Series	

Soldering Conditions & Precautions

- For solder terminals, insert wire in the terminal holes and fasten firmly. Especially with subminiature switches, since terminals are close together, be sure they are not touching. Terminal dimensions and intervals differ depending upon the switch, so use a soldering iron that would allow compliance with conditions listed in the product's specifications.
- Follow product's soldering specifications for time and temperature conditions when using soldering iron or solder bath.
- If soldering time exceeds recommendations, the switch case may deform or break due to the heat. Flux may also enter the case, exposing contacts to potential damage.
- Do not place excessive force on the terminals or lead wires. Do not operate the switch during soldering or for at least one minute after the soldering process.
- Solder wire to the PC terminals by wrapping the fine wire to the terminals and then soldering.
- If there is a large amount of flux, it may get into the contact area and affect the switch's performance by causing contact damage. To prevent this, use a good quality flux in an appropriate amount. Also, water soluble flux may have a similarly adverse effect, in part due to its strong permeability. For this reason, it is not recommended.
- Clean before and after the soldering process.
 - For series such as the A Series that allows immersion washing because of its airtight structure, the infiltration of flux is prevented following the soldering.
 - For other switches that do not have an airtight structure, avoid cleaning before or after soldering, as it may cause malfunctions. Switches for printed circuit boards should not come into contact with cleaning agents.
- For soldering and cleaning, it is recommended that practical conditions be confirmed in advance.
- For profile of manual solder, wave solder and reflow solder refer to page Z39-40.

SMARTSWITCH PROGRAMMABLE SWITCHES

IS Series OLED Pushbutton & Display

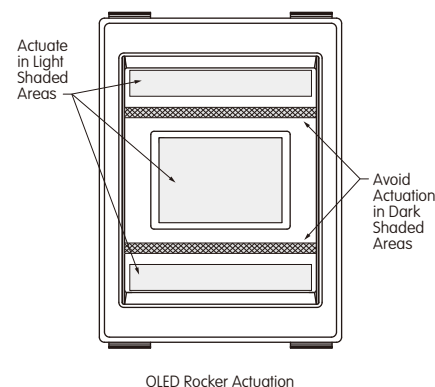
Precautions for Use & Storage

- The IS Series OLED devices are electrostatic sensitive. Do not touch terminals unless properly isolated from static electricity.
- Do not touch surface of display module's OLED panel with bare hands.
- For power, signal application and cutoff, follow ON/OFF sequence for the power and signal voltage. If conducted outside recommended conditions, it can cause malfunctions or display degradation.
- If the OLED panel is broken, avoid touching the contents. Wash off any contact to the skin or clothing.
- Recommended soldering time and temperature limits:
Preheat up to 110°C for less than 40 seconds, heat up to 270°C for less than 6 seconds.
When soldering, **do not expose OLED to heat above 80°C.**
Do not clean with immersion washing. The IS series OLED devices are not process sealed.
- Pixels acquire diminished brightness over time and use, and those most frequently habituated have greater reduction of brightness than those less used. To minimize this difference, operate OLED unit so that all pixels are used as consistently as possible.
- Limit operating force to switch keytop to 100.0N maximum, as excessive pressure may damage the OLED.
- For switch, clean cap surface with dry cloth. If further cleaning is needed, wipe with dampened cloth using neutral cleanser and dry with clean cloth. Do not use organic solvent. For display, avoid contact with any flux or detergent. If any liquids spill on display surface, immediately wipe with soft absorbent cloth.
- For OLED display, the bracket legs should be grounded.
- Store in original container and away from direct sunlight. Keep away from static electricity. Avoid extreme temperatures, high humidity, gaseous substances, and all forms of chemical contamination.

IS Series OLED Rocker

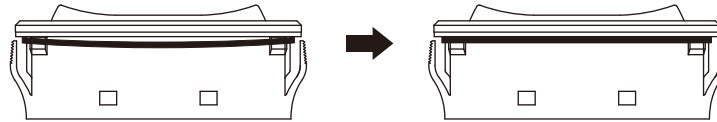
Precautions for Use & Storage

- OLED devices are electrostatic sensitive.
- Signal input under conditions not recommended may cause damage to the OLED unit or deterioration of the display. Follow directions regarding supply sequences of power and signal voltages.
- If the OLED panel is broken, avoid touching the contents. Wash off in case of contact to the skin or clothing.
- Limit operating force to 100.0N maximum, as excessive pressure may damage the display.
- Depending on where the actuator is pressed on its surface, the operating force and feel may differ.
- Rocker and center switch may simultaneously be actuated but is avoidable if pressed in proper operating area. (See illustration.) Corrections may also be made with software.
- Pixels acquire diminished brightness over time and use, and those most frequently habituated have greater reduction of brightness than those less used. To minimize this difference, operate OLED unit so that all pixels are used as consistently as possible.
- Clean key caps with dry cloth. If further cleaning is needed, wipe with dampened cloth using neutral cleanser and dry with clean cloth. Do not use organic solvent.
- Store in original container and away from direct sunlight. Keep away from static electricity. Avoid extreme temperatures, high humidity, gaseous substances, and all forms of chemical contamination.
- Switches cannot be operated underwater or immersed in oil.
- Do not use in locations where dust can accumulate in moving parts and cause loss of operability.
- When there is a potential for freezing, mount vertically to keep ice from forming and preventing switch movement.

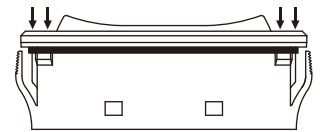


OLED Rocker Panel Mounting

- Before snapping a switch into the panel, align the gasket evenly under the bezel of the switch.
- When mounting into a panel, apply equal pressure to sides of bezel and insert parallel to the panel.

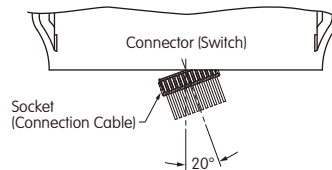


- After mounting, be sure there are no gaps between switch and panel. Lightly push into panel.
- After installing into panel, do not apply excessive force.
- After panel installation and wiring is completed, do not apply force horizontally or vertically from behind panel.
- Behind the panel, cut area should be squared. If front of panel is painted, do not allow any paint to collect in corners of cutout to prevent level mounting.
- Avoid reinstalling a switch once it has been mounted into panel. This may cause deterioration of panel sealability.
- The corners can be slightly rounded, or make the punch rounding the cutout on the surface of the panel. Confirm that no rubber or plastic debris or other contaminants are overlooked in area where panel is joined to the packing.

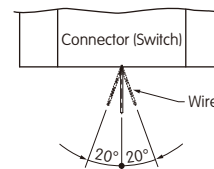
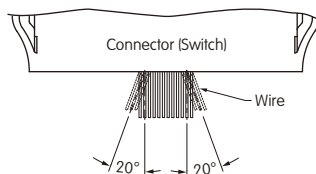


Connection Cables

- When mating a connection cable to a switch, align the position of the connection cable socket with the connector on the switch, then mate it coaxially to the switch connector. The position of the socket in relation to the connector should be within an angle of 20° . If mated at too deep an angle, there may be damage to the connector. After mating, confirm there is no gap between the connector and socket.



- When removing the connection cable from the switch, hold all the wires and pull it off coaxially. When removing, keep the angle in relation to the mating shaft within 20° . If the cable is forcibly removed at an angle exceeding 20° , the connector may be damaged.



- When wiring the connection cable, applied tension should be no greater than 1.0N per wire.

Switch User Manual

Toggles

Rockers

Pushbuttons

Illuminated PB
Programmable

Keylocks

Rotaries

Slides

Tactiles

Tilt

Touch

Indicators

Accessories

Supplement
Z

IS Series 64 x 32 Pushbutton, Display, Compact Pushbutton

Precautions for Use & Storage

- The IS Series devices are electrostatic sensitive.
- Limit operating force to keytop to 100.0N maximum, as excessive pressure may damage the LCD device.
- The IS series devices are not process sealed.
- If the LCD is accidentally broken, avoid contact with the liquid and wash off any liquid spills to the skin or clothing.
- Clean cap surface with dry cloth. If further cleaning is needed, wipe with dampened cloth using neutral cleanser and dry with clean cloth. Do not use organic solvent.
- The display module is in a format in which the LCD display element is exposed, so avoid touching its surface. Prevent flux or any liquids from getting on the element. When embedding it into the device, first add a transparent resin layer (or similar) as protection.
- Recommended soldering time and temperature limits:
 - Preheat up to 110°C for less than 40 seconds; heat up to 270°C for less than 6 seconds.
 - When soldering, **do not expose LCD to heat above 60°C**. Do not clean with immersion washing.
- Excessive images may result after the same image is emitted continuously for an extended period of time.
- The highest backlight brightness level should not be used for temperatures above +35°C.
- For display, the bracket legs should be grounded.
- Store in original container and away from direct sunlight. Keep away from static electricity. Avoid extreme temperatures, high humidity, gaseous substances, and all forms of chemical contamination.
- In low temperature environments (0°C or less), the LCD response time decreases. In high temperatures (near 50°C), non-displayed pixels can become somewhat darker.

IS Series 36 x 24 Pushbutton, Display, Compact Pushbutton

Precautions for Use & Storage

- The IS Series devices are electrostatic sensitive.
- Limit operating force to keytop to 100.0N maximum, as excessive pressure may damage the LCD device.
- The IS series devices are not process sealed.
- If the LCD is accidentally broken, avoid contact with the liquid and wash off any liquid spills to the skin or clothing.
- Clean cap surface with dry cloth. If further cleaning is needed, wipe with dampened cloth using neutral cleanser and dry with clean cloth. Do not use organic solvent.
- The display module is in a format in which the LCD display element is exposed, so avoid touching its surface. Prevent flux or any liquids from getting on the element. When embedding it into the device, first add a transparent resin layer (or similar) as protection.
- For display, the bracket legs should be grounded.
- Recommended soldering time and temperature limits:
 - Do not exceed 70°C at the LCD level.
 - Preheat up to 110°C for less than 40 seconds; heat up to 270°C for less than 6 seconds.
 - When soldering, **do not expose LCD to heat above 70°C**. Do not clean with immersion washing.
- Recommendation for backlight color uniformity: Use constant current driver. For current limiting resistor method, the power source should be at least twice the backlight LED forward voltage.
- The VLC voltage should not be applied before logic voltage. If VLC voltage is present before logic voltage, it may cause the driver logic to freeze and damage the LCD, and the driver logic may become damaged.
- Backlight Forward Current should not exceed the derated Absolute Maximum Forward Current based on the temperature.
- Excessive images may result after the same image is emitted continuously for an extended period of time.
- Store in original container and away from direct sunlight. Keep away from static electricity. Avoid extreme temperatures, high humidity, gaseous substances, and all forms of chemical contamination.
- In low temperature environments (0°C or less), the LCD response time decreases. In high temperatures (near 60°C), non-displayed pixels can become somewhat darker.

TILT SWITCHES

DSA Series

Precautions for Use

- There are product specifications for each product, and specification figures differ depending on the device mounting format and position. When using the product, check it after embedding in the device.
- DSA Switches are sealed devices, but the terminals are not protected. Do not allow exposure to liquids.
- In order to avoid unnecessary detection of contact area chattering or chattering time, set an adequate OFF pulse time on the sensing circuit (OFF time of 500ms or more). This will follow confirmation with the switch embedded in the device.
- Confirm that the switch will not easily detach from the mount after installation.
- When using devices in critical applications, confirm all safety circuits.

DSB Series

Handling

- The absolute maximum rating is 25°C with the photo interrupter embedded in the switch. If excessive voltage is applied between the terminals that exceeds the maximum rating, normal function is compromised. It is recommended that the switch is discarded and not reused.
- Applying an excessive load on the terminals will damage the internal components.

Processing

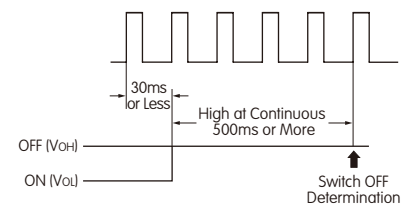
- After soldering, allow terminals to sit undisturbed for one minute. Confirm that the switch is mounted horizontally or vertically in relation to the circuit board.
- When removing flux after soldering, use an alcohol based cleaning agent. Do not use organic solvents.
- Cleaning conditions: Immerse in a cleaning bath with a depth of 5cm for less than one minute.

Operating Environment

- This switch is a noncontact switch with an embedded photo interrupter. When using continuously for an extended period of time in high or low temperature or high humidity environments, there may be significant changes in the output voltage associated with the reduced intensity of the LED.
- In such cases, provide a buffer against changes in output characteristics and increase reliability. This can be accomplished by changing the threshold and inserting a comparator on the output side.
- When securing the switch with a sealing agent for printed circuit boards, confirm that none of the sealing agent got inside. Depending upon usage conditions and operating environment, short circuits may occur between terminals due to solder migration. When mounting on circuit board, allow for sufficient insulation distance.
- The switch should be mounted within $\pm 3^\circ$ with the photo interrupter ON.

Preventing Accidental Operation

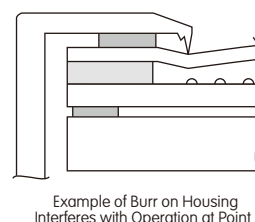
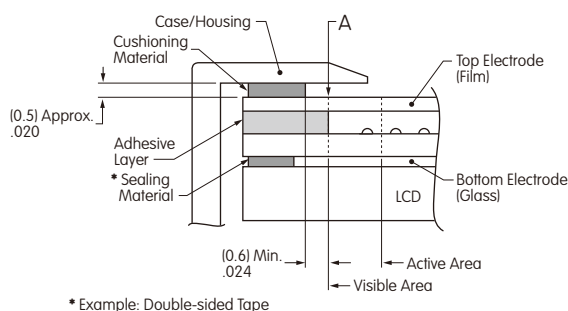
- The DSB switch utilizes an internal ball, and when the ball moves as a result of vibration or shock, chattering occurs. To prevent inadvertent operation from chattering, determine whether the switch is ON or OFF when normal read processing is conducted at a pulse of 30ms or less and reads Low or High at a continuous output level of 500ms or greater.
- The general recommendation of the vibration level at which chattering does not occur (the ball does not move) should be 2.94m/s² or less at 10–400Hz. However, at approximately 260 – 320Hz (when the ball resonates), it should be 0.98m/s² or less.
- To prevent accidental operation, avoid using in direct sunlight or with a light source near the switch.
- Avoid magnetism, static electricity, surge voltage, induction and other noise, as these can cause inadvertent operation and malfunction of the photo interrupter.



TOUCH SCREENS

Installation Precautions

- Confirm that case and housing are not causing any stress to the touch screen.
- Tail should not be creased, which may cause an open circuit or increase resistance.
- Do not pull on tail or apply stress to tail area.
- Avoid vibration or shock.
- The touch screen mounting should not be loose.
- Ensure there are no burrs around edges of case or housing that may cause false actuation. The edges of the case or housing should not enter the keying area.
- The case or housing and upper electrode should have a space of about 0.5mm to accommodate expansion or shrinkage due to humidity variances. If a shock barrier is used, do not press on the upper electrode area. Any shock barrier should be installed more than 0.6mm above the screen. See "A" in following illustration.



- If case or housing is pressed by hand and external pressure is added to the touch screen frame, keep it from malfunctioning by the case, tip of housing, or distortion.
- To secure the touch screen, secure the lower portion with an item such as the LCD display panel. Do not secure the upper electrode with double-sided tape or similar items to avoid stress that can damage the upper or lower electrode.
- In order to balance upper and lower pressure, an air vent may be installed. Do not block the air vent during installation. Ensure that no liquid or oil will enter into the device.
- Avoid air pressure from entering inside of touch screen through the air vent, as it will cause the top electrode to rise. There may be adverse effects, such as causing an input state or Newton ring if the pressure inside is lowered through an air vent.
- When installing a touch screen, handle carefully to prevent damage to the glass.
- If moisture or condensation gets on tail area, a short circuit may be caused by migration.

Operating Precautions

- Only operate with fingers or a polyacetal touch screen stylus. Do not operate with hard objects such as ball point pen, sharp pencil, etc., as hard objects may damage the touch screen.
- Do not press hard with pen or similar objects between viewing area and key area.

Handling Precautions

- When opening product, take precaution with up/down and front/back directions. Glass edges are not chamfered, corners or edges can be sharp. Wear gloves when handling the product.
- Do not pick up the product by the tail or pull the tail area.
- Use gloves or finger cots to prevent fingerprints on surface.
- When handling the product, hold it outside of the viewing area.
- Avoid stacking multiple products or placing other items on the product.
- Remove protective film after installation is completed.

- NKK warranties the 5-wire touch panel when it is used with the NKK control board and driver. Do not use third party control boards.
- 5-wire devices can misalign cathode position or touch position even after calibration. Take into account when developing applications.
- Create a larger input area. If you have the input button at the edge of a screen, it might not operate properly.
- Complete 9 point calibration with NKK driver. If more precision is desired, 25 point calibration is recommended.

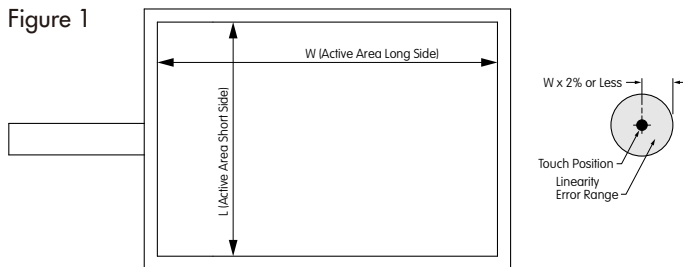


Figure 1 defines the touch position and cursor position discrepancy (linearity error).

The discrepancy between the touch position and cursor position after 9-point calibration is within 2% on the long side of the active area.

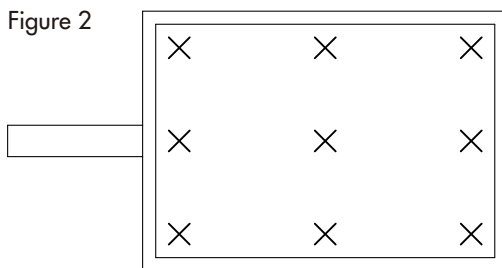


Figure 2 is an example of touch positions when running a 9-point calibration.

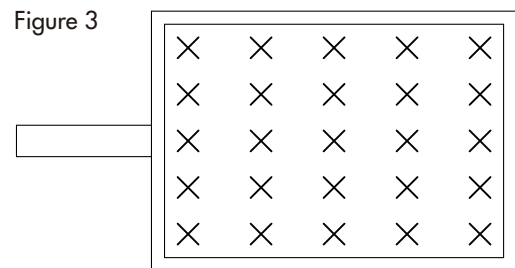


Figure 3 depicts touch positions when running a 25-point calibration.

Design Precautions

- With analog type, resistive value change can dislocate the input area. Confirm that hardware and software are able to calibrate the input area and generate calibration when input area is dislocated.
- When installing on top of an LCD, noise from the display device can create misoperation. To avoid noise, implement actions such as grounding the display device frame.
- When operating with finger or pen, contact resistance changes when aggressive pressure is applied, and data should be disregarded. Once contact resistance has stabilized, the data should then read accurately.
- When used to draw a line, analog type will have a break at dot spacer. Compensate for this with software.
- If using an overlay sheet on a top electrode with double-sided tape or other adhesive, confirm there is no malfunction caused by distortion of top electrode or overlay sheet.
- Do not create software for simultaneous touch points as analog type will read the center point between two touch points.

Other Precautions

- Clean with a soft cloth and ethanol. Do not use any cleaning agents other than ethanol.
- Store product in original package and store at the temperature and humidity range specified.
- Do not store in an environment with acids or other corrosive gases or dew.
- Pack or store with the glass side up.
- The storage and operation temperatures and humidity range is guaranteed by evaluation based on product specifications, and does not guarantee the same temperature and humidity values indefinitely.
- Not suited for use in critical control systems such as nuclear power, aerospace, medical or transportation equipment, without proper fail-safe design consideration.

Switch User Manual

Handling of Controller Board

- Warranty for one year after delivery. We do not warranty the controller board unless used with NKK touch panel.
- Use arc prevention to protect device from static electricity. Workers and areas need to be grounded when handling products.
- Power source should be activated after host and touch panel are connected.
- When inserting connector CN1 and touch panel tail, be sure the slider of connector CN1 is pulled. Do not pull more than 10 times.
- Do not alter the product.
- Content of product may be changed at manufacturer's discretion without prior notification for improvement purposes.
- Do not use any commands other than the ones specified in specifications.
- NKK Switches cannot accept any responsibility for any damages that occur through the use of this product.
- Place the product away from noise source (such as inverter from LCD operation) since tail can be affected by noise.
- If device driver (USB) does not work after installation, reboot the host computer while connected to the controller board.
- This product does not support suspended mode (USB).
- Protocol of USB transmission is one frame per one transaction. Contact factory if using protocol other than outlined here.
- Use the product with an NKK device driver.

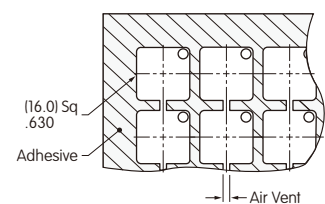
MEMBRANES

Installation Precautions

- Assembly of legend card insert is handled by the customer. Therefore, it is recommend to evaluate the finished product with the card assembled.
- Nonilluminated products have a loophole on each key. It is possible to add optional illumination by installing appropriate LEDs. Legend card does not have loopholes.
- To test proper electrical operation of switches, use of an electric buzzer is recommended.
- Use an additional chattering prevention circuit for the switch circuit.
- Do not operate switches with pointed objects (i.e. screwdrivers) to prevent perforation of film overlay.
- Use an FPC connector that corresponds to the printed circuit. Contact factory for suitable connectors.
- During assembly and installation of legends place devices on a level, sturdy surface. We do not recommend assembly and installation of device using a free hand or on a soft surface.
- Do not fold, bend, or apply pressure to the product.
- Store in horizontal position, with no weight placed on any part of the product.
- These devices contain adhesive that may emit noise. This does not affect product functionality.
- Do not depress any switch areas during assembly/installation.
- These membrane switches are built with air vents. Prior to installation, make corresponding holes to allow air vents to function. These holes should first be aligned with the membrane switch device, then made on the body of the final installation structure. Do not allow water or oil to penetrate through the air vents. Entry of any liquids through the air vents may cause contact failure.
- When assembling switch to the casing, avoid excessive stress by bending or creasing the tail.

Without Surface Sheet

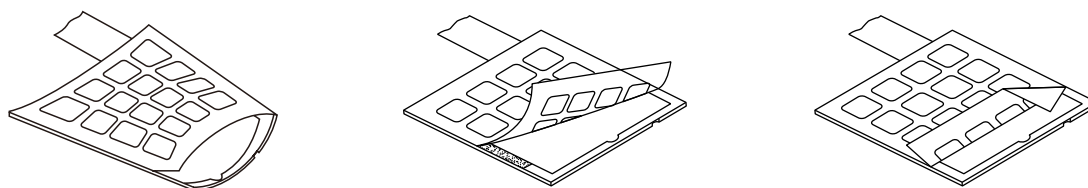
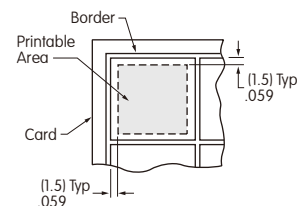
- Remove adhesives on the actuator to about 1.6mm as shown in illustration. Create air vents, lining up all of the holes.



Surface Sheet Shown from Underside

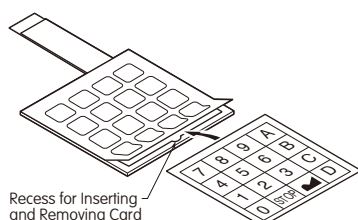
Card Insert

- For the included card, design the text, numbers, diagrams, etc., within the frame.
- When using with illumination, make holes in the card's light emitting area. For LED positioning, refer to the external dimensions figure.
- The card frame is one size larger than the surface sheet frame, so use the part approximately 1.5mm from the outer edge.
- When inserting the card, use caution to prevent switch area from bending.
- Do not remove the surface sheet from the backing paper, or allow it to bend.
- When replacing the card, avoid using sharp objects.

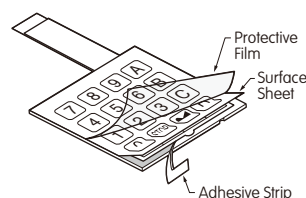


To prevent damage to the card, do not bend, do not remove surface sheet from backing paper, and avoid folding the surface sheet.

- When design is complete, remove the spacer area backing paper and attach the surface sheet. Protective film is attached for surface sheet protection, and must be removed before using.
- Attach the surface sheet and smooth any wrinkles.
- The surface sheet cannot be removed once it is attached.



The customer creates design on the card and carefully inserts into product .



To complete, remove the spacer backing paper and attach the surface sheet .

CUSTOM & SPECIALTY PRODUCTS

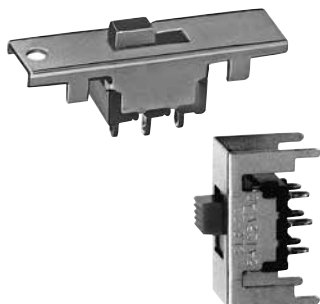
NKK manufactures a myriad of switches with custom specifications. For products of the highest quality, performance and endurance, NKK is equipped to accommodate the most unique requests. We look forward to opportunities to provide solutions for our customers, whether searching for resolution in a distinctive actuator, an unusual mounting method, or a coarse environment. Our products are validated with years of expertise, knowledge and unparalleled customer service.

The following are examples of customized options and switches. Some are available for sale, others are not, due to design rights.

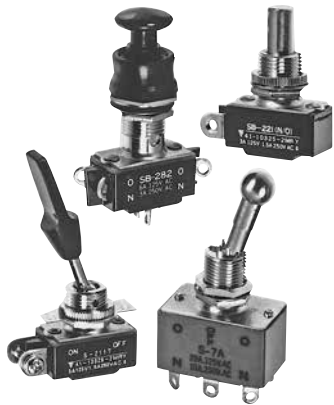
Accessories

AT532 Dress Nut	AT533 Dress Nut
 AT532 Threaded through Dress Nut designed for functionality as well as enhancement. Available in both metric and inch options.	 AT533 Threaded through Dress Nut designed for functionality as well as enhancement. Available in both metric and inch options.
AT512 Conical Nut	AT455 Round Shroud
 AT512 Conical Nut in lustrous metallic finish enhances any design.	 AT455 Shrouds complement switch assemblies and prevent accidental operation. Available in Black, White or Gray

Legends & Mounting

Legends	Mounting
 Custom printing suited to client's specifications. Screen print, pad print or laser etching options.	 Slide switches can directly mount to printed circuit board.

Custom Solutions

Customized Terminals	Assembly
 If the challenge for the application is special terminals, NKK can individualize according to the requirement.	 NKK's Value Added Services feature assembly of lead wires and connectors, saving customers time and money.
Panel Seal & Designer Levers	Assembly
 A sample of NKK's Panel Seal switches, including the custom designed levers, are represented here.	 Specialized mounting is depicted here as examples of accommodating our customer's specifications.

NKK SWITCHES: QUALITY FIRST

With a motto of "Quality First," NKK Switches prides itself on excellence and consistent quality. We have the largest product lineup and the highest production capacity. We incorporate rigid tests from parts processing to production to sales, and aspire to manufacture products that exceed our customers' expectations. Over the decades, our methodology has garnered relationships built upon integrity.

ISO 9001 Assurance

We obtained ISO 9001 manufacturer certification in November 1992, the international standard for quality management and quality assurance. This was the result of a public, third party institution recognizing our continued commitment to maximal standards since our inception, and our unwavering focus for creating quality assurance systems.

Superior Quality

In order to advance our quality and reliability as verified by multiple certification programs, we utilize every conceivable quality management method, including the QC and QA system, under a proactive total quality management (TQM) system. Additional recognition includes UL standards, cUL, CSA standards, TUV certification, VDE standards, and DSP standards. We work collectively as a company to maintain and further promote the utmost degree of reliability. We recommend that you confirm Standard & Approval on page Z37.

Exceptional Product Development Technologies

As a specialized manufacturer of switches, NKK's product development technologies are supported by continual refinement, a long history of extensive skills and experience, and exceptional research facilities. We maximize these qualities to develop unique, user-oriented new products and create product series that facilitate customers in selecting the optimal device. Our product development capacities as a specialist manufacturer are evidenced by our numerous registered patents and utility models.

Premium Materials

Beginning with contact materials, and from spring insulation to plating and more, our materials include high performance specialty substances developed by our technology team through many years of research. Before their selection, the material of which our switches are composed endure a rigorous testing process. They are scrutinized for their strengths, stability, durability, deterioration resistance, and more, ending with a durable, attractive exterior design after mounting to the panel surface.

Application Examples

- Medical Electronic Equipment
CT scans, brain wave sensor, electrocardiographs, medical electromagnetic recording devices, medical data processing devices, x-ray devices
- Communication Equipment and Wireless Devices
Communication satellites, satellite broadcasting transceivers, electronic switching equipment, broadcasting equipment, fax machine, data telegraphs, electrical aircraft components, depth gauges, radar equipment, transceivers, ATS equipment
- Electronic Application Systems
Cash dispensers, electron telescopes, electron microscopes, radiation meters, spectrometers, ultrasonic washing machines, high frequency electronic equipment, pulse generators, scanners
- Electronic Measuring Instruments
Pollution measurement and analysis equipment, electronic surveying equipment, IC checkers, electronic counters, synchroscopes, AC/DC converters, surveying instruments, electromagnetic recording devices, chemical analyzers, voltmeters
- Automation Equipment
Robots, operation panels, vending machines, printing and platemaking machines, print-related machines, NC machine tools, electric tools, electrical discharge machines, multi-axis milling machines, automatic lathes, automatic packaging machines, various control panels, automatic stamping machines, automatic bill counters
- Office Equipment
Computers and peripheral devices, automatic storage systems, shredders, copiers, CAD/CAM systems, optical filing systems
- Disaster Prevention/Preparedness Equipment
Pollution control equipment, emergency broadcast equipment, gas leak alarms, fire alarms, anti-theft devices, power generators
- Media Equipment
Audio equipment (stereos, switchers, mixers), visual equipment (BS, VTR cameras, VTR, televisions, theater acoustic systems, decoders, VTR editing systems
- Household Appliances
POS systems, HA devices, electronic musical instruments, microwave ovens, kitchen appliances, beauty equipment, automatic massagers, home health management devices
- Other
Audio visual teaching systems, gaming devices, train cars, automobiles, light fixtures, hearing aids, motor boats, agricultural equipment, automatic ticket gates, elevators, automatic doors, construction machinery

IEC STANDARD OF PROTECTION

The protective structure under the International Electrotechnical Commission standard, IEC 60529, is used to provide an Ingress Protection rating for mechanical casings and electrical enclosures. It classifies and rates the degree of protection provided against intrusion of hands or fingers, dust, accidental contact, and liquids, and is indicated by the letters IP followed by two digits and an optional letter. The European equivalent European standard is EN 60529.

IP

International
Protection Marking

Protection Against
Ingress of Solid Objects

Protection Against
Ingress of Liquids

IP Ratings Table		
IP	First Digit: Ingress of Solid Objects	Second Digit: Ingress of Liquids
0	No protection	No protection
1	Protected against solid objects over 50mm (hands, large tools)	Protected against vertically falling drops of water or condensation
2	Protected against solid objects over 12.5mm (hands, large tools)	Protected against falling drops of water, if enclosure is tilted at an angle up to 15° from normal position
3	Protected against solid objects over 2.5mm (wire, small tools)	Protected against sprays of water at any angle up to 60° from the vertical
4	Protected against solid objects over 1.0mm (wires, screws)	Protected against splashing water from any direction
5	Limited protection against dust ingress (no harmful deposit)	Protected against low pressure water jets (6.3mm) from any direction. Limited ingress permitted.
6	Totally protected against dust ingress	Protected against high pressure water jets (12.5mm) from any direction. Limited ingress permitted.
7	N/A	Protected against short periods of immersion in water (no greater than 1 meter of submersion)
8	N/A	Protected against long, durable periods of immersion in water
9k	N/A	Protected against close-range high pressure, high temperature spray downs

Example:

IP

6

IP	IP First Digit - NKK Test Method	
6	Totally protected against dust ingress	

Examples:

IP

4

IP	IP Second Digit - NKK Test Method	
0	No test	
4	Sprayed with water for 10 minutes from all directions at a rate of 0.07L/minute per sprinkler nozzle with test equipment	
5	Streamed with water for a total of over 3 minutes at a rate of one minute per 1m² of exposed surface from any direction using test equipment represented here	
7	Immersion in water for 30 minutes at a depth of 1 meter. If the device height is 850mm or more, the distance from the top of the device to the water surface is set at 150mm	

Caution: IP codes are based on the above testing methods. The protective structure of a device should be confirmed in advance in the actual usage environment under typical usage conditions.

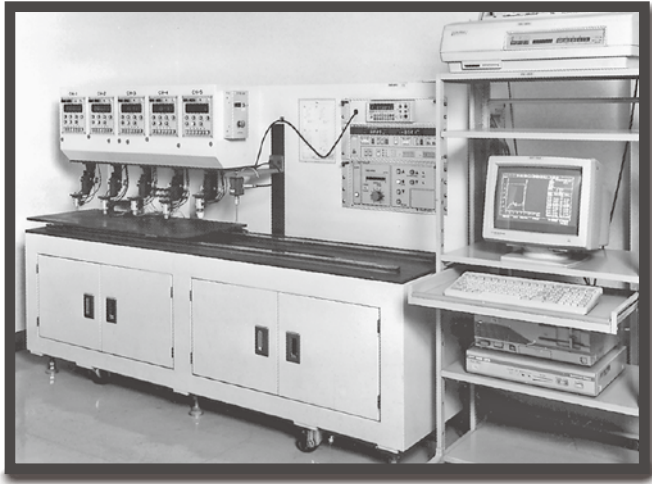
Switch User Manual

Testing Facilities & Equipment

The following displays some of NKK's state-of-the-art testing equipment in our testing and research laboratory. The equipment was developed through the collective efforts of our technology team and manufactured with the cooperation of a leading manufacturer.



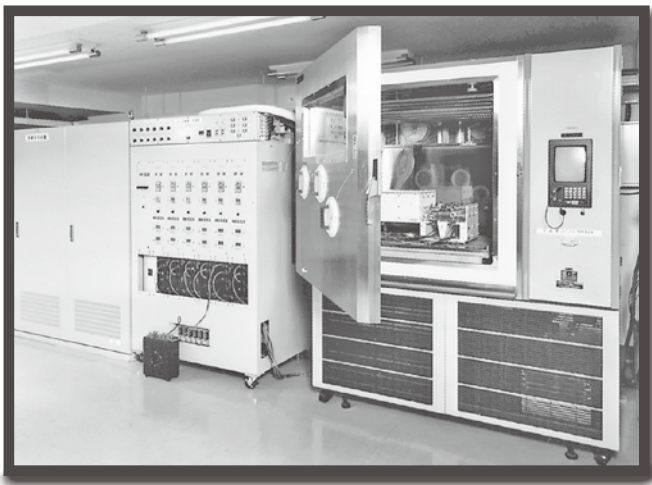
Endurance Test Equipment



Membrane Keypad Switch Testing Machine



Environmental Testing Machines



Endurance Test Equipment for IEC61058-1