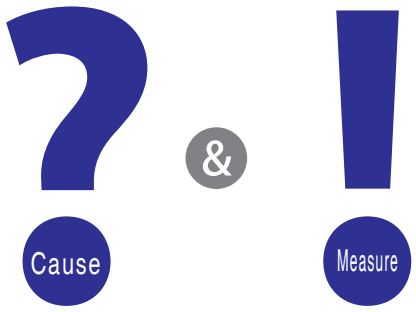
Troubleshooting case studies

[Micro switch]

Must-read Before using a switch



Let's Prolong Switch Life by Preventing Failures!

Introduction

We would like to thank you for using our switches.

We started to develop switches over half a century ago. In order to do everything possible to meet the needs of our customers , we have been committed to various types of switch development and quality improvement.
We are pleased to inform you that our switches have been used for equipment/devices in various applications, and we shipped about a billion switches in one year (actual figure in FY2016 by our research).
We appreciate selecting and continuing to use our products.
We summarized preventive measures against failures in this guide so that customers will use our switches more safely.
We appreciate if Troubleshooting case studies would be helpful in preventive/corrective actions when malfunction occurs.
We are going to meet our customers' needs by focusing on core technologies, and appreciate your continued business.

Notes

- "Troubleshooting case studies" introduces some typical examples of failures found by our customers.
  Please understand some cases may not apply to "Troubleshooting case studies".
- If you check the switch by yourself before requesting our analyzation, please check only the appearance and operation, and return it to us without disassembling it (Ex, open the cover).
  Please note that if you disassemble a switch (ex, open the cover), we may not be able to investigate the true cause.

Table of Contents

Miniature Basic Switch
Mechanism of Failure Occurrence

Cause/reason	Possible failure when using the switch
Foreign material such as dust adheres on switch	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Liquid adheres on switch.	<Contact failure> Contact doesn't turn ON, or keeps ON. Contact resistance value is high (unstable) Insulation failure between terminals
Flux adheres on switch	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Overcurrent flows to switch	<Contact failure> Contact doesn't turn ON, or keeps ON. Conduction doesn't switch when pushing the button. <Operating failure> Button doesn't release There is no sound of contact switching when pushing the button.
The excessive external force is applied to a lever of switch.	<Appearance failure> Lever deformation <Operating failure> Operating feeling of lever is stiff. Button doesn't go down when pushing the button.
A shock is applied to switch.	<Contact failure> Conduction doesn't switch when pushing the button. <Operating failure> Button doesn't release It cannot push the button. There is no sound of contact switching when pushing the button
Source of generating a silicon gas around switch.	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Source of sulfuric gas around switch	<Appearance failure> Discoloration in the terminals <Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable) <Soldering failure> Terminals cannot be soldered

V	D3V	VX	D2MV	D2RV
				

Direct causes leading to failures	Checkpoint for prevention (measures)
Foreign materials adhere on contact surface	Be sure not to adhere foreign materials when storing, mounting and using a switch. Please consider sealed type switch.
Contact surface is corroded. Insulation deterioration between terminals	Be sure not to adhere a liquid on switch. As a measure to extend life, please consider seal type switch.
Flux adheres on contact surface	Be sure not to adhere flux on switch when soldering. Please consider quick-connect terminal type.
Contact welding Contact transition Fusing of internal parts Generating carbide on contact surface	Be sure not to flow overcurrent to switch.
Lever is deformed due to an external force	Be sure not to apply external force from the direction other than operating direction to the lever.
Dropping of internal parts	Be sure not to apply the shock such as dropping switch.
An oxide silicon is generated on contact surface.	If silicon materials are used around switch or included in mold lubricant, make sure to exclude/change materials. When using a switch in the environment where a source of generating a silicone gas exists, make sure to implement the periodic check or replacement of switch.
Sulfurization of contact surface Sulfurization of terminal surface	Store switch under appropriate environment. Be sure to use switch in the place without source of sulfuric gas/sulfuric hydrogen gas.

[If foreign materials adhere…]

■What are the possible failures?

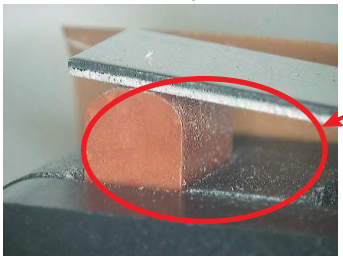
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

●Foreign material coming from outside of switch adheres on contact and contact failure results.

e.g.) VX

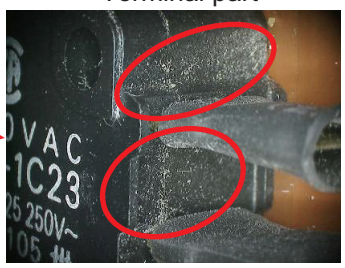
Button part



Adhesion of foreign material.

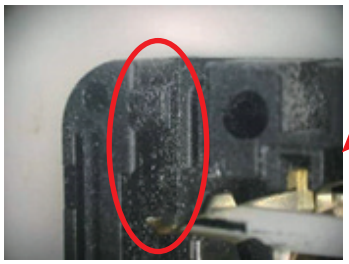
Appearance

Terminal part



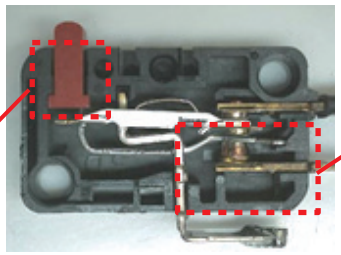
Adhesion of foreign material.

Sliding part of a button

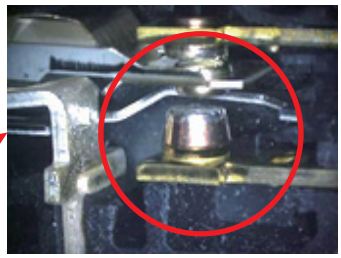


Foreign material enters through the sliding part of the button.

Inside of case



Contact part



Adhesion of foreign material on and around contact.

■Checkpoint for prevention!

Check!

Do you find any foreign material such as dust/board powder around switch?

Since this switch is non-sealed type, it's impossible to prevent foreign material and liquid from entering completely.
Make sure that no foreign materials adhere when storing/mounting/using a switch.

Check!

Please consider sealed switch! (D2VW series)

Since a sealed switch can prevent foreign material from entering switch, please consider it.

[If liquid adheres…]

■What are the possible failures?

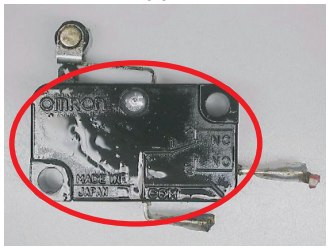
<Contact failure>
Contact doesn't turn ON, or stays ON.
Contact resistance value is high (unstable)
Insulation deterioration

■The failure case

●Adhesion of liquid causes insulation deterioration and contact doesn't turn OFF.

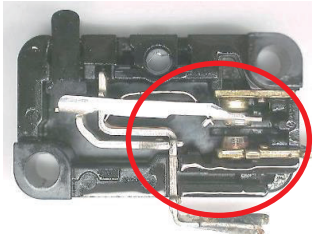
e.g.) V

Switch appearance



Liquid adheres.

Inside of case

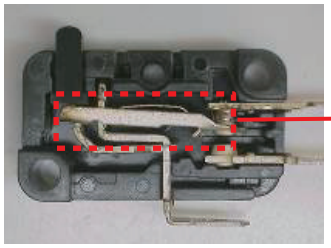


Liquid penetrates into the switch.

●The contact corrodes due to the adhesion of liquid, and contact failure results.

e.g.) V

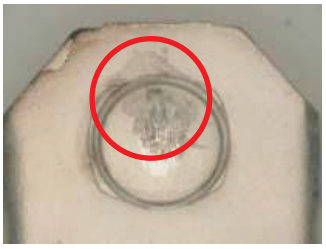
Inside of case



Focus on inside of case

Trace of liquid penetration

Contact surface



The corroded substances are generated.

■Checkpoint for prevention!

Check!

Do you use a switch in an environment where liquid adheres to switch?

Since this switch is non-sealed type, it's impossible to prevent foreign material and liquid from entering completely. Make sure that no liquid adhere.

Check!

As a measure to extend a lifetime, please consider sealed switch! (D2VW series)

Since it is hard for liquid to penetrate into sealed switch, please consider it.
In addition, since sealed switch is not water-resistant, make sure not to soak into oil/water directly or use it in an underwater setting.

[If flux adheres…]

■What are the possible failures?

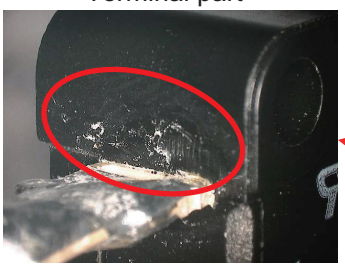
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

●The flux enters and adheres to the contact and contact failure results.

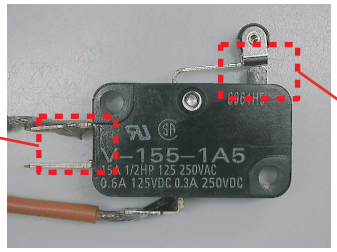
e.g.) V

Terminal part



A flux adheres around the terminal.

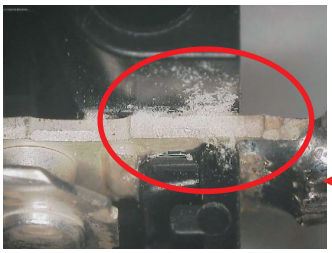
Switch appearance



Button part

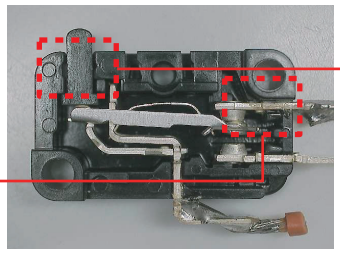
Scattered flux adheres to the button.

Terminal part



A flux enters and adheres on the contact.

Inside of case



Sliding part of button

A flux enters through the sliding part of the button.

■Checkpoint for prevention!

Check!

Do you find flux adhered on switch?

Use a soldering iron with a suitable amount of solder.
Make sure not to adhere a flux to switch.

Check!

Consider quick-connect terminal type!

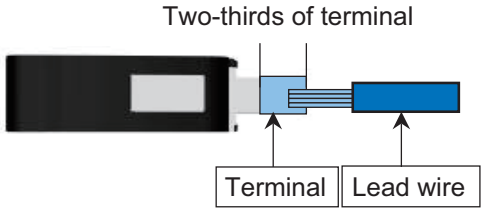
In V, D3V, VX, we prepare quick-connect terminal type wiring to receptacle.
Please consider it.

Check!

Is soldering condition under our recommended condition?

Solder switches following the conditions below.

(1) Be sure to make the range of soldering up to two-thirds or less of terminal.



(2) Soldering is operated by a solder iron of 60W.
Be sure to set 5 seconds max (temperature of a tip of iron is + 250 to + 350°C).

(3) Be sure not to apply any external force for 1 minute after soldering.

[If the current exceeding the rating flows, ...]

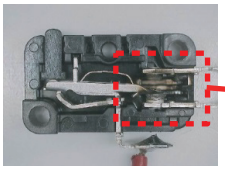
■What are the possible failures?

<Contact failure>
Contact doesn't turn ON
Conduction doesn't switch.
<Operation failure>
Contact doesn't switch.
Button doesn't return.

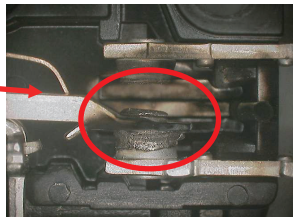
■The failure case

●Contact welding
e.g.) V

Inside case



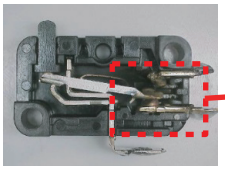
Contact part



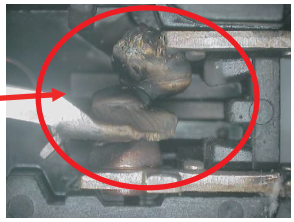
Contact dissolves,
and it doesn't switch.

●Fusing of internal parts
e.g.) V

Inside case



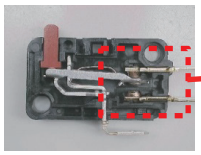
Contact part



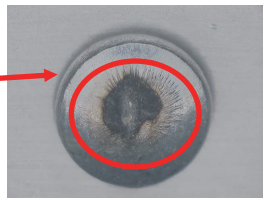
Internal parts are fused.

●Generation of Carbide
e.g.) V

Inside of case



Contact surface

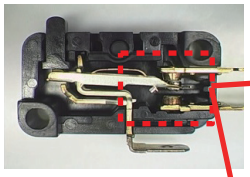


Carbide is generated,
and contact doesn't
turn ON

●Contact transition
e.g.) V

Moving contact

Inside of case



Contact dissolves, and
surface is in convex state.

Fixed contact

Contact dissolves, and
surface is in concave state.

Dissolved fixed contact
transfers to moving contact.

■Checkpoint for prevention!

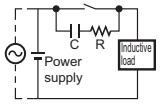
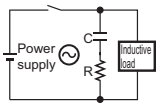
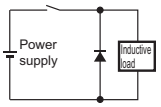
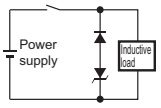
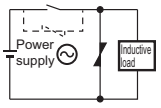
Check!

Did you use the circuit that caused over rated current to the switch?

Be sure not to flow over rated current to switch (including short-circuit current).
In addition, according to load type, there is much difference between inrush current and steady-state current and steady-state current and surge voltage, which may result in over rated current.
Please make sure to properly apply the contact protective circuit.

* Some typical examples of contact protective circuit are described in the following table.

Typical Examples of Contact Protective Circuits (Surge Killers)

Circuit example		Applicable current		Feature	Element selection
		AC	DC		
CR circuit		See note.	Yes	**Note:** When AC is switched, the load impedance must be lower than the C and R impedance.	C: 0.5 to 1 μF per switching current (1 A) R: 0.5 to 1 Ω per switching voltage (1 V) The values may change according to the characteristics of the load. The capacitor suppresses the spark discharge of current when the contacts are open. The resistor limits the inrush current when the contacts are closed again. Consider these roles of the capacitor and resistor and determine the ideal capacitance and resistance values from experimentation. Use a capacitor with a dielectric strength between 200 and 300 V. When AC is switched, make sure that the capacitor has no polarity. If, however, the ability to control arcs between contacts is a problem for high DC voltage, it may be more effective to connect a capacitor and resistor between the contacts across the load. Check the results by testing in the actual application.
		Yes	Yes	The operating time will increase if the load is a relay or solenoid. It is effective to connect the CR circuit in parallel to the load when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode method		No	Yes	Energy stored in the coil is changed into current by the diode connected in parallel to the load. Then the current flowing to the coil is consumed and Joule heat is generated by the resistance of the inductive load. The reset time delay in this method is longer than that of the CR method.	The diode must withstand a peak inverse voltage 10 times higher than the circuit voltage and a forward current as high as or higher than the load current.
Diode and Zener diode method		No	Yes	This method will be effective if the reset time delay caused by the diode method is too long.	Zener voltage for a Zener diode must be about 1.2 times higher than the power source since the load may not work under some circumstances.
Varistor method		Yes	Yes	This method makes use of constant-voltage characteristic of the varistor so that no high-voltage is imposed on the contacts. This method causes a reset time delay more or less. It is effective to connect varistor in parallel to the load when the supply voltage is 24 to 48 V and in parallel to the contacts when the supply voltage is 100 to 200 V.	Select the varistor so that the following condition is met for the cut voltage Vc. For AC currents, the value must be multiplied by $\sqrt{2}$. Vc > (Current Voltage × 1.5) If Vc is set too high, however, the voltage cut for high voltages will no longer be effective, diminishing the effect.

[If an excessive external force is applied...]

■What are the possible failures?

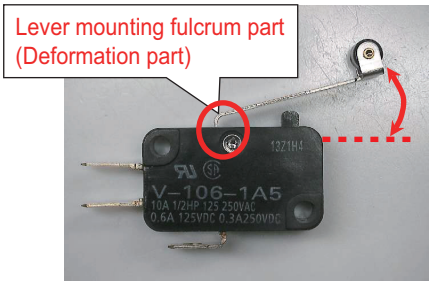
<Appearance failure>
Lever is deformed.
Angle of lever is large.
Lever is rocked.
<Operation failure>
Operating feeling of lever is stiff.
Even in operating a lever, button doesn't go down.

■The failure case

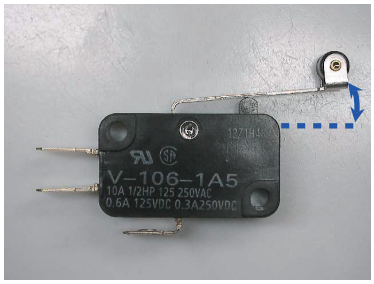
●Lever deformation

e.g.) V

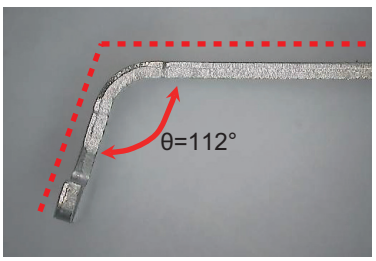
NG switch



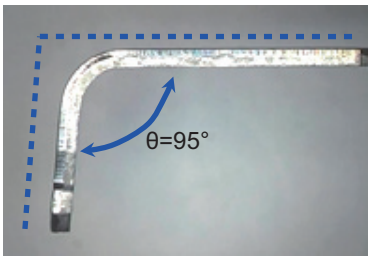
OK switch



Lever mounting fulcrum part
(NG switch)



Lever mounting fulcrum part
(OK switch)



■Checkpoint for prevention!

Check!

Is there force applied to the lever not from operating direction?

Do not apply to the lever unbalanced force and any force not from operating direction.
It may cause a operating failure, a breakage of lever and switch, and deterioration of durability.

[If a shock is applied to switch…]

■What are the possible failures?

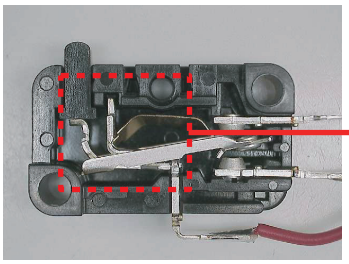
<Contact failure>
Conduction doesn't switch. (It doesn't turn ON, or keeps ON)
<Operation failure>
Button doesn't return.
Button cannot be pushed.
There is no touch feeling when operating the switch. (Except: D2RV)

■The failure case

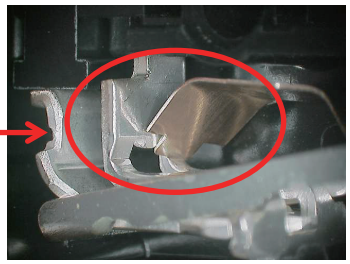
●Combination of internal parts gets shifted and conduction or operation failure result.

e.g.) V

NG switch Inside of case

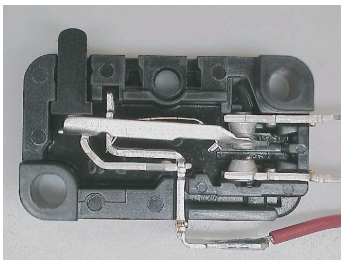


The position of moving spring drops, and the button cannot be pushed.



Internal part (spring) is deviated from the hinge point.

OK switch Inside of case



■Checkpoint for prevention!

Make sure not to apply the excessive shock to switch!

Make sure not to apply the excessive shock such as dropping a switch.
Please refer to catalog/specification for details.

[If a silicone gas exists…]

■What are the possible failures?

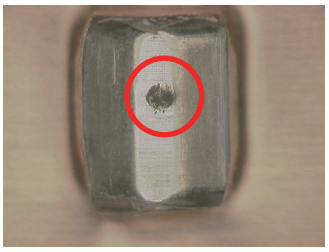
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

●An oxide silicon is generated on contact surface and contact failure results.

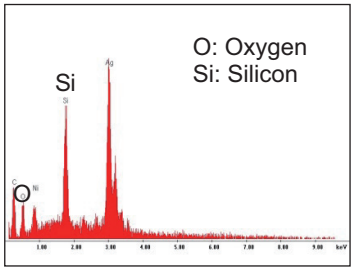
e.g.) VX

Contact surface



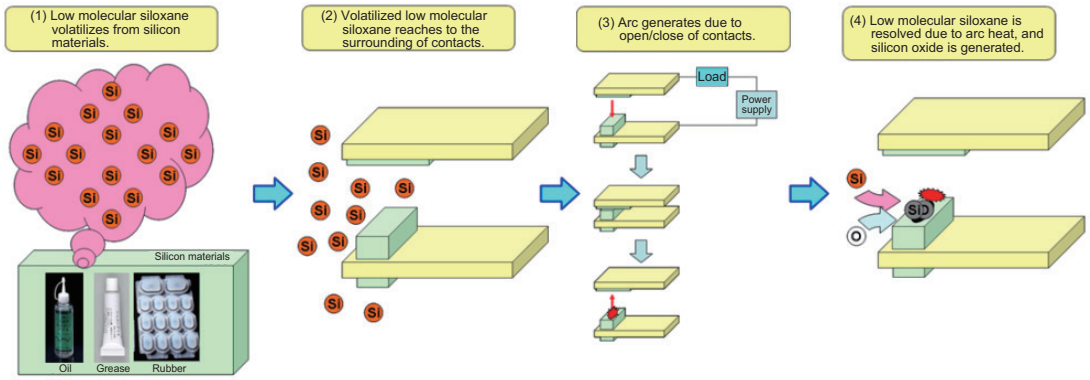
Black foreign material is generated.

Result of analyzing an element of ○ part



Detection of oxide silicon

An oxide silicon is generated on contact surface when a gas released from a silicon based materials existing around switch reacts to ark heat at load switching.



■Checkpoint for prevention!

Is there any material containing silicone elements (low-molecule siloxane) around the switch?

The followings are examples of a source of generating a silicone gas.

[Source]
Silicone based coating agents, Silicone based adhesive, Silicone rubber
Silicone oil/grease, Silicone based mold lubricant, Silicone filler
Silicone wire, etc.

If there is a source of generating a silicone gas, be sure to suppress ark by contact protective circuit, or eliminate the source around the switch or change to other materials.
Silicone based mold lubricant in die may be used in Molding, so make sure not to use it.
(In our molding is used Fluorine based mold lubricant.)

In addition, if using under environment where a source of generating a silicone gas exists, be sure to implement the periodic check or replacement.

[If sulfuric gas generates…]

■What are the possible failures?

<Appearance failure>
Discoloration in the terminals
<Contact failure>
Contact doesn't turn ON, Contact resistance value is high (unstable)
<Soldering failure>
Terminals cannot be soldered

■The failure case

●Terminal is discolored, and cannot be soldered.

e.g.) V

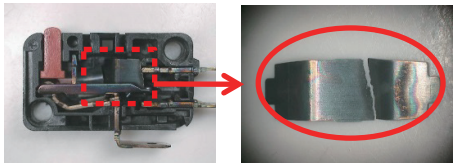
Terminal part

Discoloration

●Moving spring is broken due to sulfurization, and results in operating failure.

e.g.) V

Breakage of moving spring



Spring is broken

●Contact surface is sulfurized, and contact failure results.

Contact surface

Contact is sulfurized

■Checkpoint for prevention!

Are the storage environment and condition appropriate?

●**Storage environment**

To prevent degradation such as discoloration, in the terminals during storage, do not store the switch in locations that are subject to the following conditions.

(1)High temperature or humidity
(2)Corrosive gases
(3)Direct sunlight

●**Storage condition**

Store the switches in the packaging or box.
Please use switches as quickly as possible after packaging or box is opened
When storing leftover parts, make sure that appropriate measures are take against humidity and corrosive gases.

Has sulfuric gas or sulfuric hydrogen gas existed around switches?

When sulfuric gas or sulfuric hydrogen gas exists, it can cause corrosive damage to the contacts and malfunction results.
Please don't use in areas subject to toxic gases.

●As a source of sulfuric gas, the following example can be mentioned.

[Source]
Car exhaust gas, gypsum board, wood, papers such as cardboard, fiber scraps, seawater, dirt, Sludge, volcanic gas, hot springs, etc.
[Occurrence place]
Storage warehouse for gypsum, sewage / wastewater treatment plants, garbage disposal plants, abandoned site, petroleum refining, etc.

In addition, if there is less oxygen or no oxygen, and if it is humid, we judge that sulfuric gas is generated.
Injecting oxygen is the most effective to suppress the generation of sulfuric hydrogen gas.
In addition, eliminating the source of gas generation and making dry state is also effective.

Subminiature Basic Switch Mechanism of Failure Occurrence

Cause/reason	Possible failures when using the switch
Foreign matters such as dust adheres on switch	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Liquid adheres on switch.	<Contact failure> Contact doesn't turns ON, or keeps ON. Contact resistance value is high (unstable) Insulation failure between terminals
Flux adheres on switch	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Overcurrent flows to switch	<Contact failure> Contact doesn't turns ON, or keeps ON. Even if pushing a button, conduction is not switched. <Operating failure> Button doesn't release. Even if pushing a button, there is no sound of contact switching.
The excessive external force is applied to a lever of switch.	<Appearance failure> Lever deformation <Operating failure> Operating feeling of lever is stiff. Even if operating a lever, button doesn't go down.
A shock is applied to switch.	<Contact failure> Even if pushing a button, conduction is not switched. <Operating failure> Button doesn't release. It cannot push a pushbutton. Even if pushing a button, there is no sound of contact switching.
Source of generating a silicon gas around switch.	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Source of sulfuric gas around switch	<Appearance failure> Discoloration in the terminals <Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable) <Soldering failure> Terminals cannot be soldered

D3M

SS

SS-P

D2S

Direct causes leading to failures	Checkpoint for prevention (measures)
Foreign matters adhere on contact surface	Be sure not to adhere foreign materials when storing, mounting and using switch. Please consider sealed type switch.
Contact surface is corroded. Insulation deterioration between terminals	Be careful not to adhere a liquid on switch. As a measure to extend life, please consider seal type switch.
Flux adheres on contact surface	Be sure not to adhere flux on switch when soldering. Please consider quick-connect terminal type.
Contact welding Contact transition Fusing of internal parts Generating of carbide on contact surface	Be sure not to flow overcurrent to switch.
Lever is deformed due to an external force	Be sure not to apply external force from the direction other than operating direction to the lever.
Drop of internal parts	Be careful not to apply the shock such as dropping switch.
An oxide silicon generates on contact surface.	If using silicon materials around switch or in a mold lubricant of articles, be sure to exclude/change materials. Inevitably, if using under environment where a source of generating a silicone gas exists, be sure to carry out the periodic check or replacement of switch.
Sulfurization of contact surface Sulfurization of terminal surface	Store switch under appropriate environment. Be sure to use switch in the place without source of sulfuric gas/sulfuric hydrogen gas.

[If foreign materials adhere…]

■What are the possible failures?

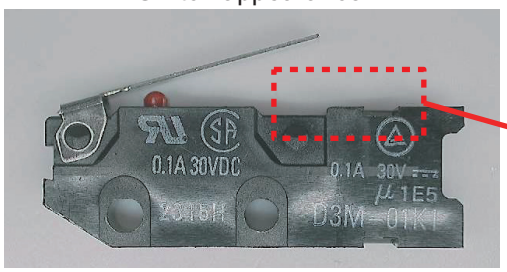
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

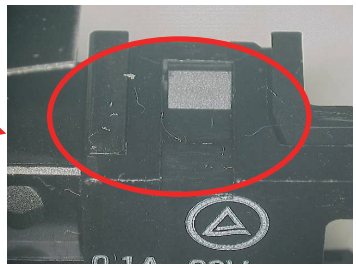
■The failure case

●Foreign material coming from outside of switch adheres on contact and contact failure results.

e.g.) D3M

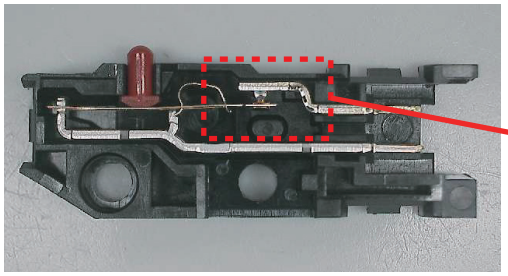
Switch appearance

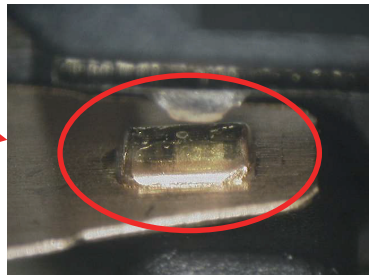




Foreign material adheres.

Inside of case





Foreign material adheres on contact part.

■Checkpoint for prevention!

Check!

Do you find any foreign material such as dust/board powder around switch?

Since this switch is non-sealed type, it's impossible to prevent foreign material and liquid from entering completely.
Make sure that no foreign material adheres when storing/mounting/using a switch.

Check!

Please consider sealed switch! (D2SW series)

Since sealed switch can prevent foreign material from entering switch, please consider it.

[If liquid adheres…]

■What are the possible failures?

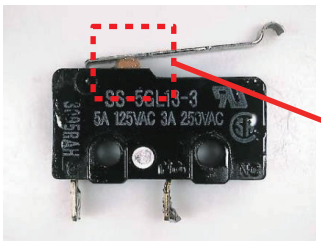
<Contact failure>
Contact doesn't turns ON, or keeps ON.
Contact resistance value is high (unstable)
Insulation Deterioration

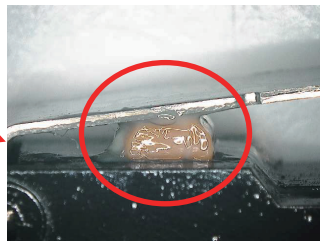
■The failure case

●Internal parts cannot operate normally due to adhesion of liquid.

e.g.) SS

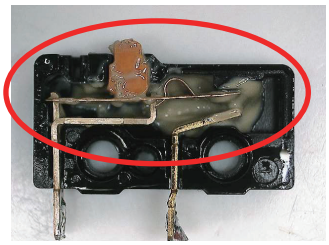
Switch appearance





Adhesion of liquid.

Inside of case

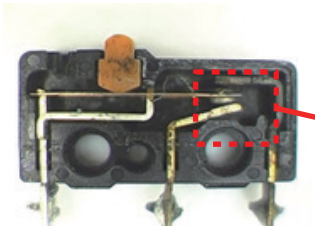


Liquid penetrates inside.

●Contact corrodes, doesn't turn on due to adhesion of liquid.

e.g.) SS

Inside of case



Contact part

Contact corrodes.

■Checkpoint for prevention!

Check!

Do you use a switch in an environment where liquid adheres to switch?

Since this switch is not sealed type, it's impossible to prevent foreign material and liquid from entering completely. Make sure that no liquid adheres.

Check!

As a measure to extend a lifetime, please consider sealed switch! (D2SW series)

Since it is hard for liquid to penetrate inside sealed switch, please consider it.
In addition, since sealed switch is not water-resistant, make sure not to soak into oil/water directly or use it in an underwater setting.

[If flux adheres…]

■What are the possible failures?

<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

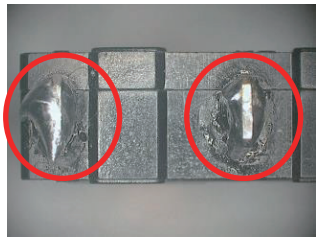
■The failure case

●The flux enters and adheres to the contact and contact failure results.

e.g.) SS

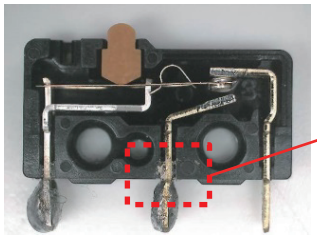
Switch appearance

Terminal part

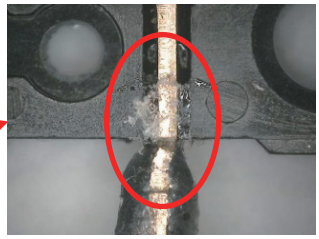


A flux adheres around the terminal.

Inside of case

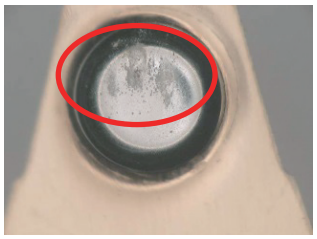


Terminal part



A flux enters inside.

Contact surface



A flux that entered switch adheres to the contact.

■Checkpoint for prevention!

Check!

Do you find flux adhered on switch?

Use a soldering iron with a suitable amount of solder.
Make sure not to adhere a flux to switch.

Check!

Consider quick-connect terminal type!

In SS and SS-P, we prepare quick-connect terminal type wiring to receptacle.
Please consider it.

Check!

Is soldering condition under our recommended condition?

Solder switches following the conditions below.

Model	Soldering method	Soldering temperature	Soldering time
SS	Manual soldering	350°C max. at the tip of the soldering iron	5 sec max.
SS-P (Solder terminal)	Manual soldering	Temperature of iron tip: 350 to 400°C	3 sec max.
SS-P (PCB terminal)	Automatic soldering baths	260°C±5°C	5 sec max.
	Manual soldering	Temperature of iron tip: 350 to 400°C	3 sec max.
D2S	Automatic soldering baths	260°C±5°C	5 sec max.
	Manual soldering	Temperature of iron tip: 350 to 400°C	3 sec max.

●Manual soldering

Do not apply any force for 1 minute after soldering.
Be sure to solder by separating from switch case and not to flow solder and flux to the case side.

●Automatic soldering baths (Flow soldering tank)

Be sure to control so that the liquid side of the solder or flux doesn't go over the board.
In SS, do not solder in the automatic solder tank, or flux may enter switch.

Check!

Is soldering method appropriate?

Refer to soldering procedure on page F-1.

[If a current exceeding the rating flows…]

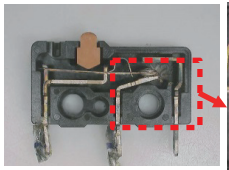
■What are the possible failures?

<Contact failure>
Contact doesn't turn ON
Conduction is not switched.
<Operation failure>
Contact doesn't switch.
Button doesn't release.

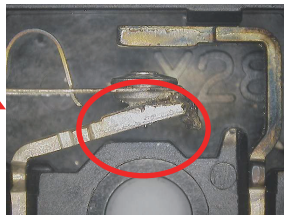
■The failure case

●Contact welding
e.g.) SS

Inside of case



Contact part



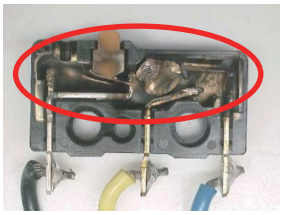
Contact dissolves,
and it doesn't switch.

●Dissolution of internal parts
e.g.) SS

Switch appearance

Button doesn't
return.

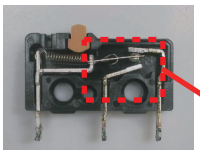
Inside of case



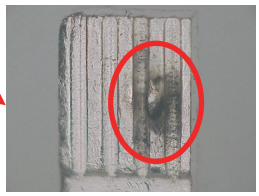
Internal parts dissolve.

●Generation of Carbide
e.g.) SS

Inside of case



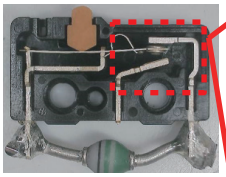
Contact surface



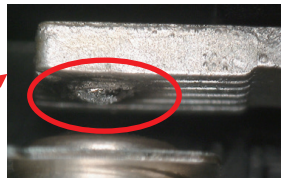
Carbide is generated,
and contact doesn't
turn ON

●Contact transition
e.g.) SS

Inside of case

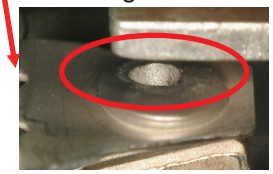


Fixed contact



Contact dissolves, and
convex state results.

Moving contact



Contact dissolves, and
concave state results.

Dissolved part of moving
contact transfers to a
fixed contact.

■Checkpoint for prevention!

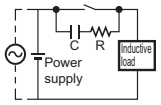
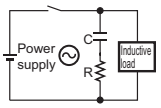
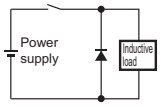
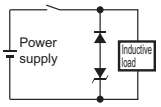
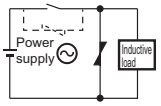
Check!

Did you use the circuit that caused over rated current to the switch?

Be sure not to flow over rated current to switch (including short-circuit current).
In addition, according to load type, there is much difference between inrush current and steady-state current and steady-state current and surge voltage, which may result in over rated current.
Please make sure to properly apply the contact protective circuit.

* For your information, refer to the below examples of general contact protection circuit.

Typical Examples of Contact Protective Circuits (Surge Killers)

Circuit example		Applicable current		Feature	Element selection
		AC	DC		
CR circuit		See note.	Yes	**Note:** When AC is switched, the load impedance must be lower than the C and R impedance.	C: 0.5 to 1 μF per switching current (1 A) R: 0.5 to 1 Ω per switching voltage (1 V) The values may change according to the characteristics of the load. The capacitor suppresses the spark discharge of current when the contacts are open. The resistor limits the inrush current when the contacts are closed again. Consider these roles of the capacitor and resistor and determine the ideal capacitance and resistance values from experimentation. Use a capacitor with a dielectric strength between 200 and 300 V. When AC is switched, make sure that the capacitor has no polarity. If, however, the ability to control arcs between contacts is a problem for high DC voltage, it may be more effective to connect a capacitor and resistor between the contacts across the load. Check the results by testing in the actual application.
		Yes	Yes	The operating time will increase if the load is a relay or solenoid. It is effective to connect the CR circuit in parallel to the load when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode method		No	Yes	Energy stored in the coil is changed into current by the diode connected in parallel to the load. Then the current flowing to the coil is consumed and Joule heat is generated by the resistance of the inductive load. The reset time delay in this method is longer than that of the CR method.	The diode must withstand a peak inverse voltage 10 times higher than the circuit voltage and a forward current as high as or higher than the load current.
Diode and Zener diode method		No	Yes	This method will be effective if the reset time delay caused by the diode method is too long.	Zener voltage for a Zener diode must be about 1.2 times higher than the power source since the load may not work under some circumstances.
Varistor method		Yes	Yes	This method makes use of constant-voltage characteristic of the varistor so that no high-voltage is imposed on the contacts. This method causes a reset time delay more or less. It is effective to connect varistor in parallel to the load when the supply voltage is 24 to 48 V and in parallel to the contacts when the supply voltage is 100 to 200 V.	Select the varistor so that the following condition is met for the cut voltage Vc. For AC currents, the value must be multiplied by $\sqrt{2}$. Vc > (Current Voltage × 1.5) If Vc is set too high, however, the voltage cut for high voltages will no longer be effective, diminishing the effect.

[If an excessive external force is applied...]

■What are the possible failures?

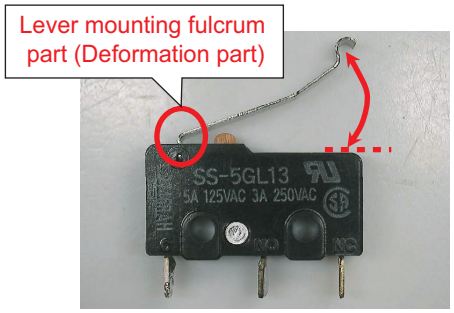
<Appearance failure>
Lever is deformed.
Angle of lever is large.
Lever is rocked.
<Operation failure>
Operating feeling of lever is stiff.
Even in operating a lever, button doesn't go down.

■The failure case

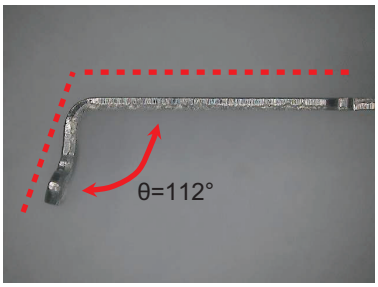
●Lever deformation

e.g.) SS

NG switch

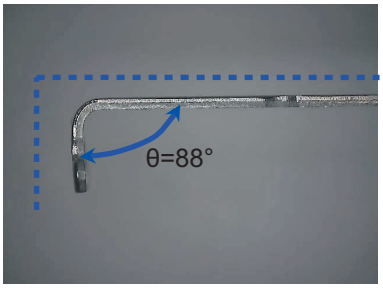


Lever mounting fulcrum part (NG switch)



OK switch

Lever mounting fulcrum part (OK switch)



■Checkpoint for prevention!

Check!

Is there force applied to the lever not from operating direction?

Do not apply to the lever unbalanced force and any force not from an operating direction.
It may cause a operating failure, a breakage of lever and switch and deterioration of durability.

[If a shock is applied to switch…]

■What are the possible failures?

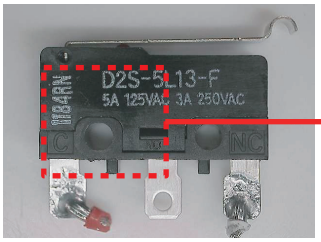
<Contact failure>
Conduction doesn't switch. (It doesn't turn ON, or keeps ON.)
<Operation failure>
Pushbutton doesn't return.
It cannot push a pushbutton.
There is no touch when operating the switch.

■The failure case

●Combination of internal parts is shifted, and it cannot perform the conduction or operate normally.

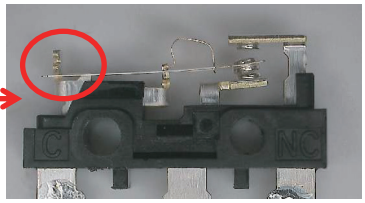
e.g.) D2S

Switch appearance

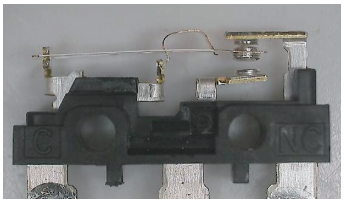


Pushbutton doesn't return.

NG switch



OK switch

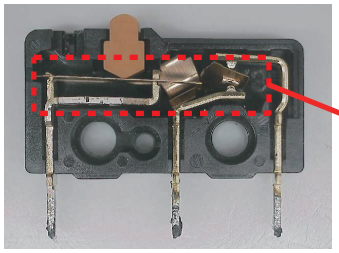


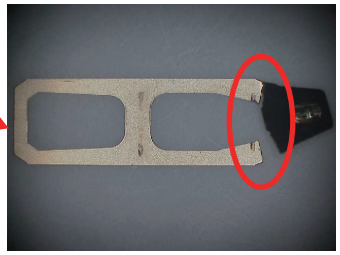
Moving spring is deviated from the hinge point.

●Internal parts are broken and conduction or operate failure result.

e.g.) SS

Inside of case





Moving plate is broken.

■Checkpoint for prevention!

Make sure not to apply the excessive shock to switch!

Make sure not to apply the excessive shock such as dropping a switch.
Please refer to catalog/specification for details.

[If a silicone gas exists…]

■What are the possible failures?

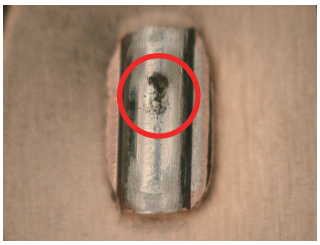
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

●An oxide silicon is generated on contact surface and contact failure results.

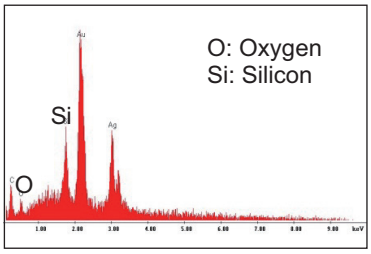
e.g.) SS

Contact surface



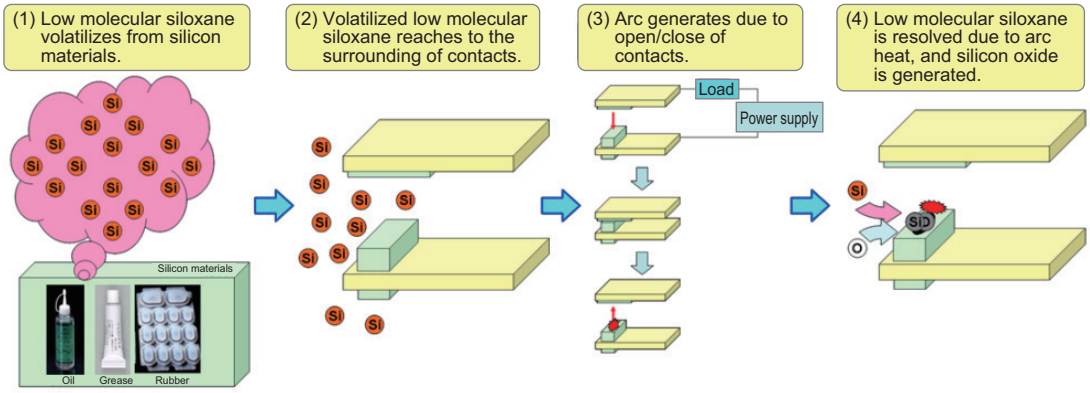
Black foreign material is generated.

Result of analyzing an element of ○ part



Detection of oxide silicon

A oxide silicon is generated on contact surface when a gas released from a silicon based materials existing around switch reacts to ark heat at load switching.



■Checkpoint for prevention!

Is there any material containing silicone elements (low-molecule siloxane) around the switch?

The followings are examples of a source of generating a silicone gas.

[Source]
Silicone based coating agents, Silicone based adhesive, Silicone rubber
Silicone oil/grease, Silicone based mold lubricant, Silicone filler
Silicone wire, etc.

If there is a source of generating a silicone gas, be sure to suppress ark by contact protective circuit, or eliminate the source around the switch or change to other materials.
Silicone based mold lubricant in die may be used in Molding, so make sure not to use it.
(In our molding is used Fluorine based mold lubricant.)

In addition, if using under environment where a source of generating a silicone gas exists, be sure to implement the periodic check or replacement.

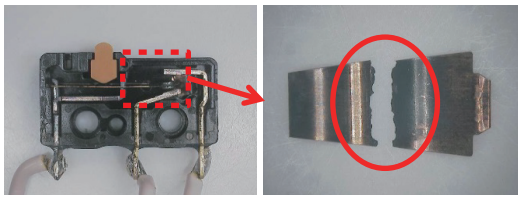
[If sulfuric gas generates…]

■What are the possible failures?

<Appearance failure>
Discoloration in the terminals
<Contact failure>
Contact doesn't turn ON, Contact resistance value is high (unstable)
<Soldering failure>
Terminals cannot be soldered

■The failure case

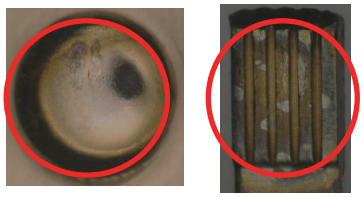
●Moving spring is broken due to sulfurization and operating failure results.
e.g.) SS



Moving spring is broken.

●Contact surface is sulfurized and contact failure results.
e.g.) SS

Contact surface



Contact is sulfurizing

●Terminal is discolored and a solder doesn't adhere.
e.g.) SS

Terminal part

Discoloration

■Checkpoint for prevention!

Are the storage environment and condition appropriate?

●Storage environment

To prevent degradation such as discoloration, in the terminals during storage, do not store the switch in locations that are subject to the following conditions.

(1)High temperature or humidity
(2)Corrosive gases
(3)Direct sunlight

●Storage condition

Store the switches in the packaging or box.
Please use switches as quickly as possible after packaging or box is opened
When storing leftover parts, make sure that appropriate measures are take against humidity and corrosive gases.

Check!

Has sulfuric gas or sulfuric hydrogen gas existed around switches?

When sulfuric gas or sulfuric hydrogen gas exists, it can cause corrosive damage to the contacts and malfunction results.
Please don't use in areas subject to toxic gases.

●As a source of sulfuric gas, the following example can be mentioned.

[Source]
Car exhaust gas, gypsum board, wood, papers such as cardboard, fiber scraps, seawater, dirt, Sludge, volcanic gas, hot springs, etc.
[Occurrence place]
Storage warehouse for gypsum, sewage / wastewater treatment plants, garbage disposal plants, abandoned site, petroleum refining, etc.

In addition, if there is less oxygen or no oxygen, and if it is humid, we judge that sulfuric gas generates.
Injecting oxygen is the most effective to suppress the generation of sulfuric hydrogen gas.
In addition, eliminating the source of gas generation and making dry state is also effective.

Ultra Subminiature Basic Switch Mechanism of Failure Occurrence

Cause/reason	Possible failures when using the switch
Foreign materials such as dust adheres on switch	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Liquid adheres on switch.	<Contact failure> Contact doesn't turns ON, or keeps ON. Contact resistance value is high (unstable) Insulation failure between terminals
Flux adheres on switch	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
Source of generating a silicon gas around switch.	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)
The excessive external force is applied to a lever of switch.	<Appearance failure> Lever deformation <Operating failure> Operating feeling of lever is stiff. Even if operating a lever, pushbutton doesn't go down.

D2LS	D2FS	D2FD	D2F	D2MQ
				

Direct causes leading to failures	Checkpoint for prevention (measures)
Foreign materials adhere on contact surface	Be sure not to adhere foreign materials when storing, mounting and using switch. Consider seal type switch also.
Contact surface is corroded. Insulation deterioration between terminals	Be careful not to adhere a liquid on switch. As a measure to extend life, consider seal type switch also.
Flux adheres on contact surface	Be sure not to adhere flux on switch when soldering. Consider quick-connect terminal type also.
An oxide silicon generates on contact surface.	If using silicon materials around switch or in a mold lubricant of articles, be sure to exclude/change materials. Inevitably, if using under environment where a source of generating a silicone gas exists, be sure to carry out the periodic check or replacement of switch.
Lever is deformed due to an external force	Be sure not to apply external force from the direction other than operating direction to the lever.

[If foreign materials adhere…]

■What are the possible failures?

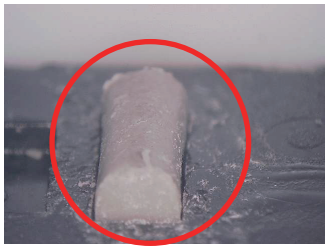
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

●Foreign material coming from outside of switch adheres on contact and contact failure results.

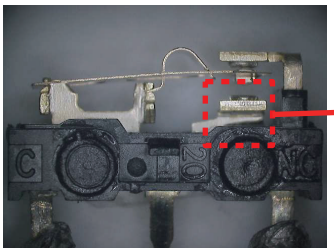
e.g.) D2FN

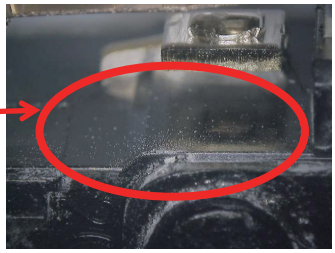
Around button



Foreign materials are scattering.

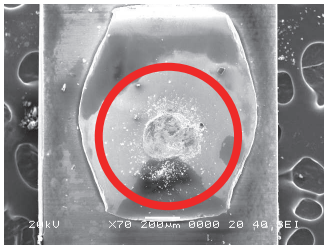
Inside switch





Foreign materials enter inside.

Contact (observation by electron microscope)



Foreign materials adhere.

■Checkpoint for prevention!

Check!

Do you find any foreign material such as dust/board powder around switch?

Since this switch is non-sealed type, it's impossible to prevent foreign material and liquid from entering completely.
Make sure that no foreign material adhere when storing/mounting/using a switch.

Check!

Please consider sealed switch! (D2JW series)

Since a sealed switch can prevent foreign material from entering switch, please consider it.

[If liquid adheres…]

■What are the possible failures?

<Contact failure>
Contact doesn't turns ON, or stays ON.
Contact resistance value is high (unstable)
Insulation Deterioration

■The failure case

●Parts are corroded due to penetration of liquid, and contact failure results.

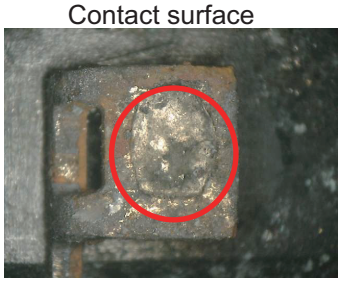
e.g.) D2F

Switch terminal part

Trace that liquid adhered.

Inside switch

Contact surface



It corrodes.

■Checkpoint for prevention!

Check!

Do you use a switch in an environment where liquid adheres to switch?

Since this switch is non-sealed type, it's impossible to prevent foreign material and liquid from entering completely. Make sure that no liquid adhere.

Check!

As a measure to extend a lifetime, please consider sealed switch! (D2JW series)

Since it is hard for liquid to penetrate inside sealed switch, please consider it.
In addition, since sealed switch is not water-resistant, make sure not to soak into oil/water directly or use it in an underwater setting.

[If a flux penetrates …]

■What are the possible failures?

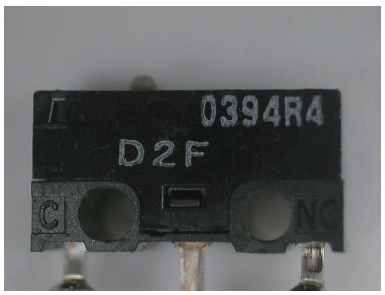
<Appearance failure>
A flux adheres.
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

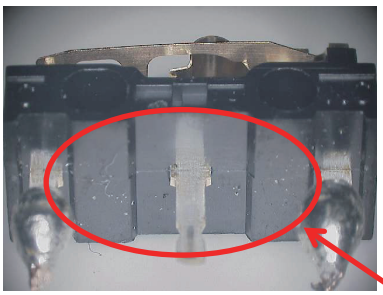
●Evaporated flux or scattered flux enters switch at soldering, it adheres to the contact surface and contact failure results.

e.g.) D2FN

Switch appearance

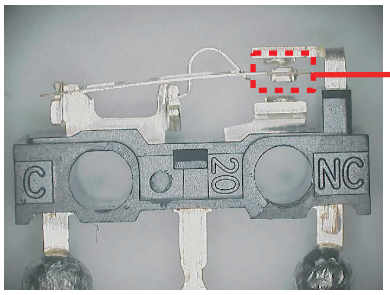


Switch Bottom

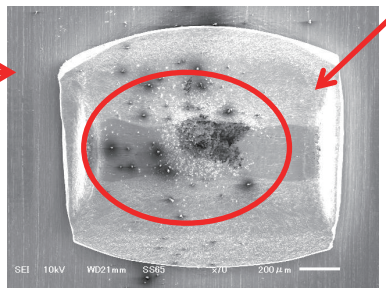


Adhesion of a flux.

Inside switch



Electron microscope image of contact



■Checkpoint for prevention!

Check!

Do you use a switch in an environment where liquid adheres to switch?

Since this switch is not sealed type, it's impossible to prevent foreign material and liquid from entering completely. Make sure that no liquid adhere.

Check!

Do you use a smoke filter at soldering?

Ultra Subminiature Basic Switch is made in insert mold, so flux doesn't enter through the terminal part. However, evaporated flux may enter inside switch at soldering.
Make sure to use a smoke filter when soldering so that evaporated flux doesn't enter switch.
In addition, be sure to carry out a periodic cleaning in order to keep the power.

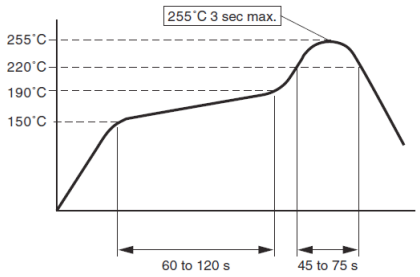
Check!

Is soldering condition under our recommended condition?

Solder switches following the conditions below.
In addition, be sure not to adhere the scattered flux on switch.

Model	Soldering method	Soldering temperature	Soldering time
D2FN (solder terminal) D2MQ	Manual soldering	300°C at max. at the tip of the soldering iron	3s max.
D2FD (solder terminal)	Manual soldering	350°C max. at the tip of the soldering iron	3s max.
D2FN (PCB terminal) D2FD (PCB terminal) D2FS	Automatic soldering tank	260°C±5°C	5s max.
	Manual soldering	350°C max. at the tip of the soldering iron	3s max.
J	Manual soldering	280°C max. at the tip of the soldering iron	3s max.
D2LS	Manual soldering	350°C max. at the tip of the soldering iron	3s max.
	Reflow soldering	Within the heating curve shown in the following diagram	

●D2LS Terminal temperature profile



The peak temperature may vary depending on the reflow bath used.
Confirm the conditions beforehand.
D2LS cannot be washed.
Doing so will cause the washing agent, together with flux or dust particles on the PCB, to enter switch, resulting in operating failure.

●Manual soldering

Be sure not to apply external force for one minute after soldering.
Be sure to provide solder by separating from switch case and not to flow solder and flux to case side.

●Automatic soldering tank (Flow soldering tank)

Be sure to control so that the liquid side of the solder or flux doesn't go over the board.

Check!

Is soldering method appropriate?

Refer to soldering procedure on page F-1.

[If a silicone gas exists…]

■What are the possible failures?

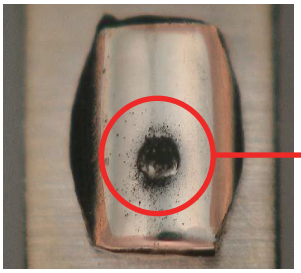
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

●An oxide silicon is generated on contact surface, and contact failure results.

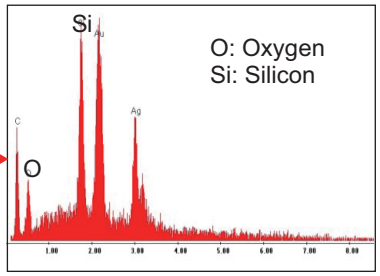
e.g.) D2F

Contact surface



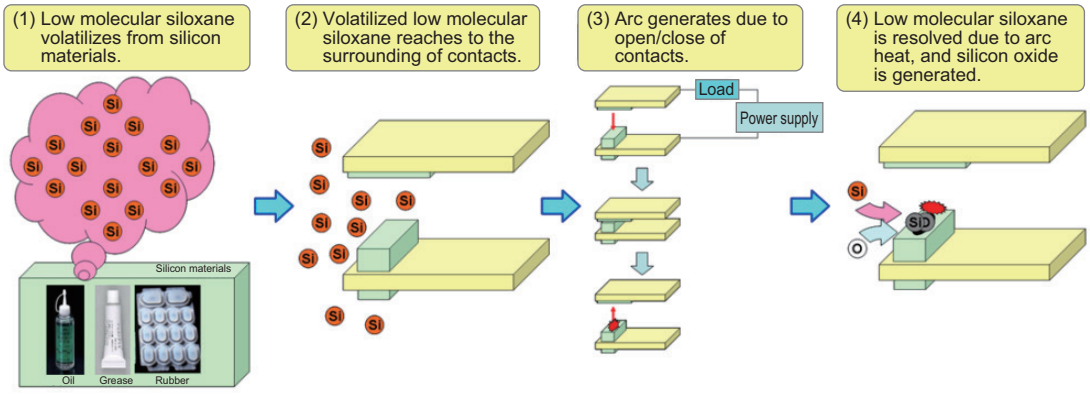
Black foreign material is generated.

Result of analyzing an element of ○ part



Detection of oxide silicon

An oxide silicon is generated on contact surface when a gas released from a silicon based materials existing around switch reacts to ark heat at load switching.



■Checkpoint for prevention!

Is there any material containing silicone elements (low-molecule siloxane) around the switch?

The followings are examples of a source of generating a silicone gas.

[Source]
Silicone based coating agents, Silicone based adhesive, Silicone rubber
Silicone oil/grease, Silicone based mold lubricant, Silicone filler
Silicone wire, etc.

If there is a source of generating a silicone gas, be sure to suppress ark by contact protective circuit, or eliminate the source around the switch or change to other materials.
Silicone based mold lubricant in die may be used in Molding, so make sure not to use it.
(In our molding is used Fluorine based mold lubricant.)

In addition, if using under environment where a source of generating a silicone gas exists, be sure to implement the periodic check or replacement.

[If an excessive external force is applied...]

■What are the possible failures?

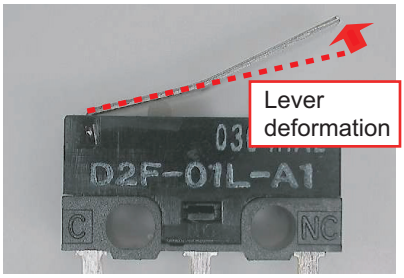
<Appearance failure>
Lever is deformed.
The lever dropped out.
<Operation failure>
Operating position of contact is different from the normal.

■The failure case

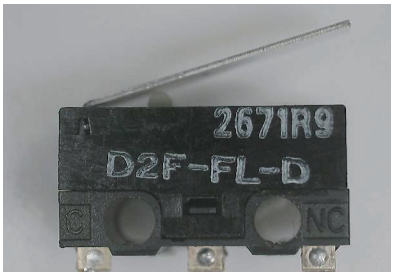
●Lever deformation

e.g.) D2F

NG switch



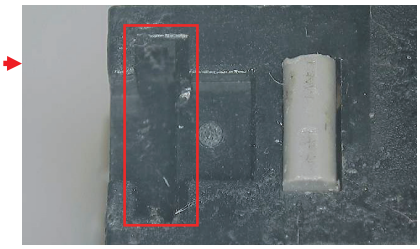
OK switch



●The lever dropped out.

e.g.) D2F

Lever mounting fulcrum part (OK switch)



■Checkpoint for prevention!

Is there force applied to the lever not from an operating direction?

Do not apply to the lever unbalanced force and any force not from an operating direction.
It may cause a operating failure, a breakage of lever and switch and deterioration of durability.

memo

Sealed Switch
Mechanism of Failure Occurrence

Cause/reason	Possible failures when using the switch
Overcurrent flows to switch	<Contact failure> Contact doesn't turns ON, or keeps ON. Even in pushing a button, conduction is not switched. <Operating failure> Button doesn't release. Even in pushing a button, there is no sound of contact switching.
The excessive soldering heat is applied to switch.	<Contact failure> Contact doesn't turns ON, or keeps ON. Even in pushing a button, conduction is not switched. <Operating failure> Lever and Pushbutton don't release. Even in pushing a pushbutton, there is no sound of contact switching.
Pushing a switch to TTP (total travel position) or more.	<Appearance failure / Operating failure> Lever deformation Lever and button don't release. <Contact failure> Conduction is not switched.
A shock is applied to switch.	<Contact failure> Contact doesn't turn ON Even in pushing a button, conduction is not switched. <Operating failure> Lever and Pushbutton don't release. Even in pushing a button, there is no sound of contact switching.
The excessive external force is applied to a lever of switch.	<Appearance failure> Lever deformation <Operating failure> Lever cannot be operated. Even in operating a lever, button doesn't go down.
Source of generating a silicon gas around switch.	<Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable)

D2VW

D2SW

D2SW-P

D2HW

D2JW

D2QW

Direct causes leading to failures	Checkpoint for prevention (measures)
Contact welding Contact transition	Be sure not to flow over rated current to switch.
Position of terminal is deviated due to dissolution of resin.	Be sure to solder within the soldering condition recommended by Omron. Be sure not to apply the force to the terminal right after soldering.
Lever is deformed due to an external force Pushbutton is broken.	Be sure not to push a lever/pushbutton to TTP (total travel position (1)) or more.
Dropping of internal parts	Be sure not to apply the shock such as dropping switch.
Lever is deformed due to an external force	Be sure not to apply external force from the direction other than operating direction to the lever.
An oxide silicon is generated on contact surface.	If silicon materials are used around switch or included in mold lubricant, make sure to exclude/change materials. When using a switch in the environment where a source of generating a silicone gas exists, make sure to implement the periodic check or replacement of switch.

[If a current exceeding the rating flows…]

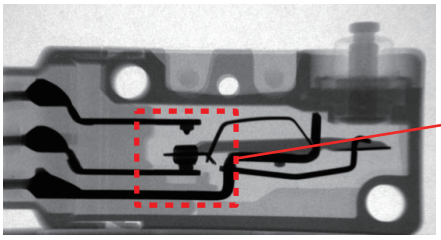
■What are the possible failures?

<Contact failure>
Contact doesn't turn ON
Conduction doesn't switch.
<Operating failure>
Contact doesn't switch.
Button doesn't release.

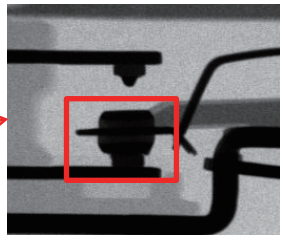
■The failure case

●Contact welding
e.g.) D2VW

X-ray image, FP(Free position)

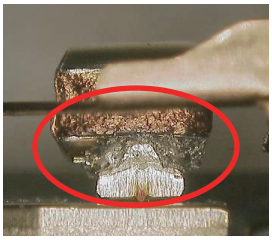


Focus of contact part



Moving contact doesn't return from NO side.

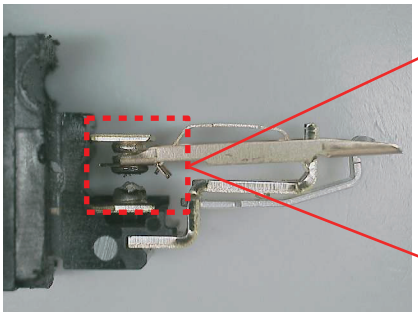
Contact part



Moving contact and fixed contact are dissolved.

●Contact transition
e.g.) D2VW

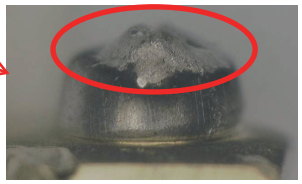
Inside of case



Moving contact

Contact dissolves, and concave state results.

Fixed contact



Dissolved moving contact transferrs to a fixed contact.

Contact dissolves, and convex state results.

■Checkpoint for prevention!

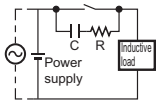
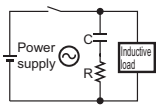
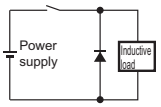
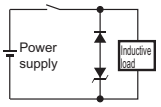
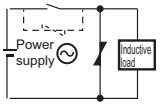
Check!

Did you use the circuit that caused over rated current to the switch?

Be sure not to flow over rated current to switch (including short-circuit current).
In addition, according to load type, there is much difference between inrush current and steady-state current, steady-state current and surge voltage, which may result in over rated current
Please make sure to apply the contact protective circuit properly.

* For your information, refer to the below examples of general contact protection circuit.

Examples of general contact protection circuit

Circuit example		Applicable current		Feature	Element selection
		AC	DC		
CR circuit		See note.	Yes	**Note:** When AC is switched, the load impedance must be lower than the C and R impedance.	C: 0.5 to 1 μF per switching current (1 A) R: 0.5 to 1 Ω per switching voltage (1 V) The values may change according to the characteristics of the load. The capacitor suppresses the spark discharge of current when the contacts are open. The resistor limits the inrush current when the contacts are closed again. Consider these roles of the capacitor and resistor and determine the ideal capacitance and resistance values from experimentation.
		Yes	Yes	The operating time will increase if the load is a relay or solenoid. It is effective to connect the CR circuit in parallel to the load when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	Use a capacitor with a dielectric strength between 200 and 300 V. When AC is switched, make sure that the capacitor has no polarity. If, however, the ability to control arcs between contacts is a problem for high DC voltage, it may be more effective to connect a capacitor and resistor between the contacts across the load. Check the results by testing in the actual application.
Diode method		No	Yes	Energy stored in the coil is changed into current by the diode connected in parallel to the load. Then the current flowing to the coil is consumed and Joule heat is generated by the resistance of the inductive load. The reset time delay in this method is longer than that of the CR method.	The diode must withstand a peak inverse voltage 10 times higher than the circuit voltage and a forward current as high as or higher than the load current.
Diode and Zener diode method		No	Yes	This method will be effective if the reset time delay caused by the diode method is too long.	Zener voltage for a Zener diode must be about 1.2 times higher than the power source since the load may not work under some circumstances.
Varistor method		Yes	Yes	This method makes use of constant-voltage characteristic of the varistor so that no high-voltage is imposed on the contacts. This method causes a reset time delay more or less. It is effective to connect varistor in parallel to the load when the supply voltage is 24 to 48 V and in parallel to the contacts when the supply voltage is 100 to 200 V.	Select the varistor so that the following condition is met for the cut voltage Vc. For AC currents, the value must be multiplied by $\sqrt{2}$. Vc > (Current Voltage × 1.5) If Vc is set too high, however, the voltage cut for high voltages will no longer be effective, diminishing the effect.

[If excessive soldering heat is applied…]

■What are the possible failures?

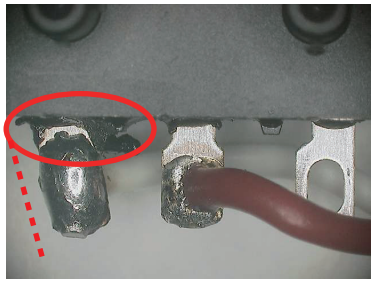
<Contact failure>
Contact turns ON, or keeps ON.
Conduction doesn't switch.
<Operating failure>
Lever and pushbutton don't release.
Even in pushing a button, there is no sound of contact switching.
(excluding D2QW.)

■The failure case

●When an external force is applied while applying an excessive solder heat to terminal, the position of internal parts get shifted, and it cannot operate normally.

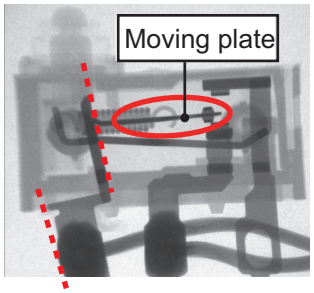
e.g.) D2HW

Focus on terminal part

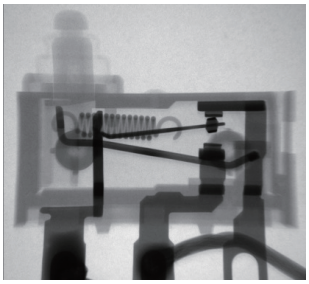


Resin in the lower part of terminal is dissolving, and the terminal get tilted.

NG switch X-ray



OK switch X-ray



Terminal inclines, moving plate doesn't return.

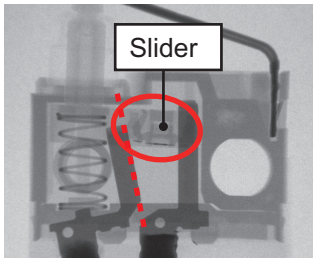
●When an external force is applied while applying an excessive solder heat to terminal, a slider is deformed, and it cannot operate normally.

e.g.) D2QW

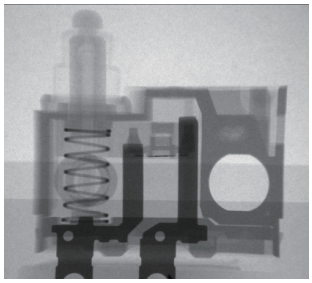
Focus on terminal part

Resin in the lower part of terminal is dissolving, and the terminal is tilted.

NG switch X-ray



OK switch X-ray



Terminal inclines, and a slider get deformed.

■Checkpoint for prevention!

Check!

Is soldering condition under our recommended condition?

Solder switches following the conditions below.
Working under the excessive temperature, overheating for long time, or soldering twice may cause the characteristic degradation.
In the case of hand soldering, be sure not to push the iron strongly or apply the excessive external force such as pulling the lead wire while soldering.
In addition, be sure not to apply the external force for 1 min after soldering.

Model	Soldering method	Soldering temperature	Soldering time
D2AW D2QW D2HW	Manual soldering	300°C max. at the tip of the soldering iron	3s max.
	Automatic soldering tank	260°C max.	5s max.
D2VW D2SW (solder terminal)	Manual soldering	Between 350 to 400°C at the tip of the soldering iron	5s max.
D2SW (PCB terminal)	Automatic soldering tank	260°C±5°C	5s max.
	Manual soldering	Between 350 to 400°C at the tip of the soldering iron	5s max.
D2SW-P (solder terminal) D2JW	Manual soldering	Between 350 to 400°C at the tip of the soldering iron	3s max.
D2SW-P (PCB terminal)	Automatic soldering tank	260°C±5°C	5s max.
	Manual soldering	Between 350 to 400°C at the tip of the soldering iron	3s max.

Check!

Is soldering method appropriate?

Refer to soldering procedure on page F-1.

[If pushing to TTP or more …]

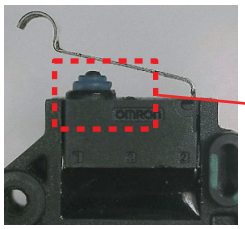
■What are the possible failures?

<Appearance failure / Operating failure>
Lever is deformed, and lever and button don't release.
<Contact failure>
Conduction doesn't switch. (It doesn't turn ON, or stays ON.)

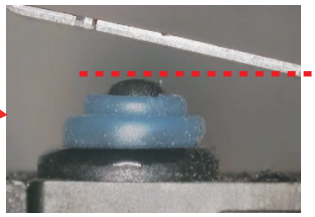
■The failure case

●Button is broken, and a return failure results.
e.g.) D2HW

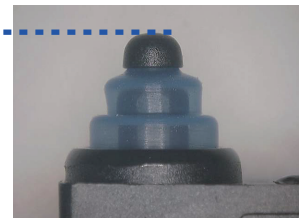
Appearance



NG switch button

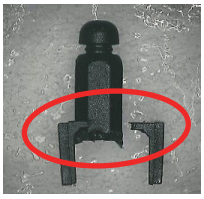


OK switch button



Button doesn't return.

NG switch A single button



OK switch A single button

It is broken.

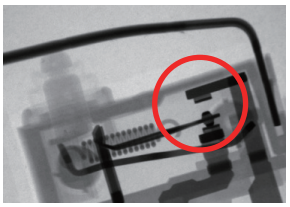
●Lever is deformed, and a return failure returns.
e.g.) D2HW

NG Switch appearance

OK Switch appearance

Lever is deformed, and keeps pushing a button.

NG switch X-ray image



Contact doesn't return.

■Checkpoint for prevention!

Is the setting of operating stroke of switch appropriate?

Be sure not to set the stroke such as pushing TTP (total travel position) or more.
Be sure to push the operation stroke with 70 to 100% of standard value of the over travel (OT).

[If a shock is applied to switch…]

■What are the possible failures?

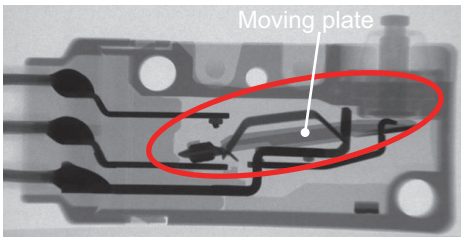
<Contact failure>
Contact doesn't turn ON
Conduction doesn't switch.
<Operating failure>
Contact doesn't switch.
Button/Lever don't return.

■The failure case

●Moving plate is broken, and it doesn't operate normally.

e.g.) D2VW

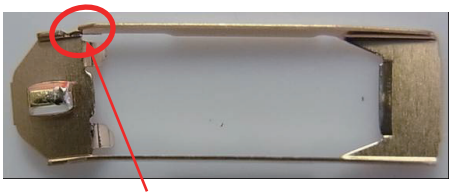
NG switch X-ray



OK switch X-ray

Internal parts incline due to the breakage of moving plate.

Moving plate



It is broken.

■Checkpoint for prevention!

Be careful not to apply the excessive shock to switch!

Be sure not to apply the excessive shock such as dropping switch.
Check the details of shock durability by catalog/specification.

[If an excessive external force is applied...]

■What are the possible failures?

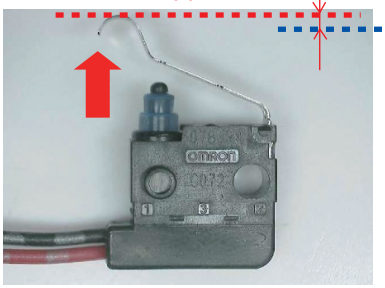
<Appearance failure>
Lever is deformed
<Operating failure>
Lever cannot be operated.
Even in operating a lever, button doesn't go down.

■The failure case

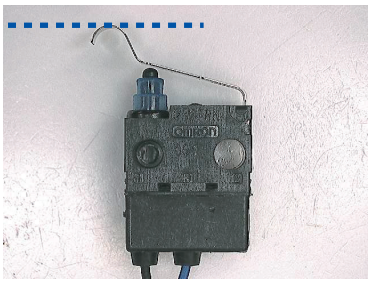
●Deformation by applying the excessive external force from the lower direction of lever (the red arrow).

e.g.) D2QW

NG switch Appearance



OK switch Appearance

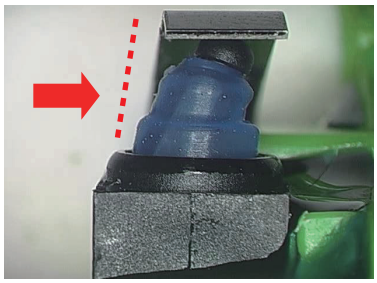


Lever is deformed in the red direction.

●Deformation by applying the excessive external force from the side of lever (the red arrow).

e.g.) D2HW

NG switch Appearance



OK switch Appearance

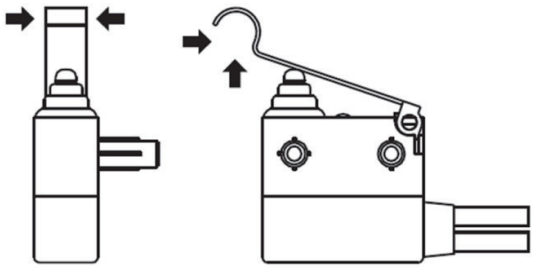
Lever is deformed in the red direction.

■Checkpoint for prevention!

Check!

Is there force applied to the lever not from operating direction?

Make sure not to apply the unbalanced force and the force from the direction other than operation direction as shown in the below figure.
It causes the breakage of lever and switch, and the decline of durability.



In addition, when handling a switch, make sure to follow the below contents.

- When taking out a switch from packing box, be sure not to snag a lever to the box.
- Be sure not to get the levers tangled when keeping multiple switches together.
- Be sure not to snag a lead wire to the lever when keeping multiple switches with long lead wire together.

[If a silicone gas exists…]

■What are the possible failures?

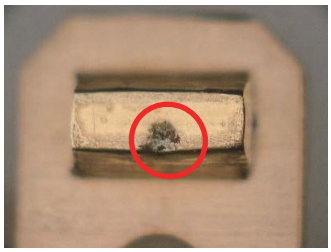
<Contact failure>
Contact doesn't turn ON
Contact resistance value is high (unstable)

■The failure case

●An oxide silicon is generated on contact surface, and contact failure results.

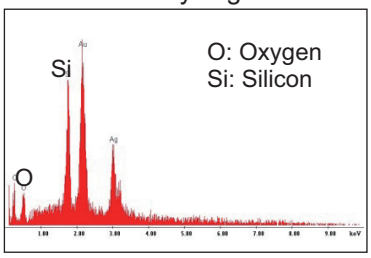
e.g.) D2HW

Contact surface



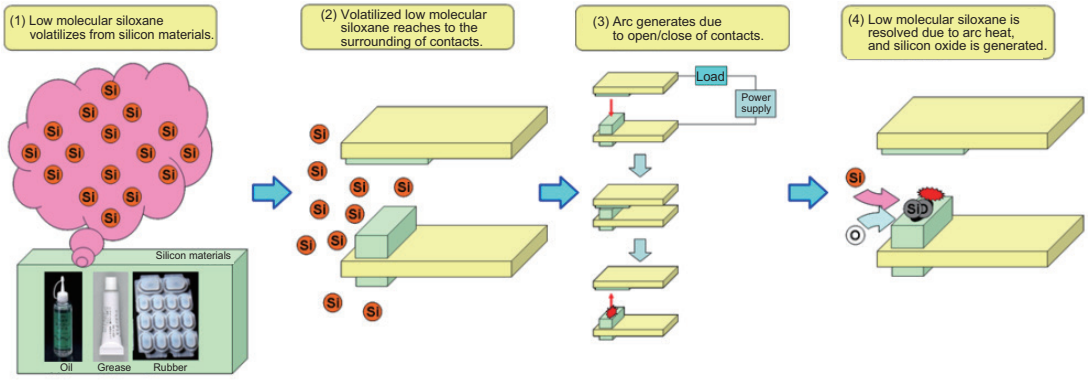
Black foreign material is generated.

Result of analyzing an element of ○ part



Detection of oxide silicon

An oxide silicon is generated on contact surface when a gas released from a silicon based materials existing around switch reacts to ark heat at load switching.



■Checkpoint for prevention!

Is there any material containing silicone elements (low-molecule siloxane) around the switch?

The followings are examples of a source of generating a silicone gas.

[Source]
Silicone based coating agents, Silicone based adhesive, Silicone rubber
Silicone oil/grease, Silicone based mold lubricant, Silicone filler
Silicone wire, etc.

If there is a source of generating a silicone gas, be sure to suppress ark by contact protective circuit, or eliminate the source around the switch or change to other materials.
Silicone based mold lubricant in die may be used in Molding, so make sure not to use it.
(In our molding is used Fluorine based mold lubricant.)

In addition, if using under environment where a source of generating a silicone gas exists, be sure to implement the periodic check or replacement.

This sealed switch has a protective structure against water/dust, but it cannot prevent a silicon gas entering completely.

Detection Switch
The mechanism of failure occurrence

Cause/reason	Possible failures when using the switch
The excessive external force is applied to switch	<Appearance failure> Cover hook part is broken, and switch is scattered. <Operating failure> It doesn't operate normally.
Source of sulfuric gas around switch	<Appearance failure> Discoloration in the terminals <Contact failure> Contact doesn't turn ON Contact resistance value is high (unstable) <Soldering failure> Terminals cannot be soldered
Energizing switch under high temperature and high humid environment.	<Contact failure> Contact doesn't turn OFF.

D2A

D3C

D2X

Direct causes leading to failures	Checkpoint for prevention (measures)
Switch is broken due to an external force.	Be sure not to push a switch to TTP (total travel position) or more. Be sure not to apply the excessive force to the side of switch.
Sulfurization of contact surface Sulfurization of terminal surface	Store switch under appropriate environment. Be sure to use switch in the place without source of sulfuric gas/sulfuric hydrogen gas.
Short circuit between contacts due to generation of migration.	Be sure to avoid the conduction under high temperature/ high humid environment. Consider fixed contact gold-plated type.

[If an excessive external force is applied...]

■What are the possible failures?

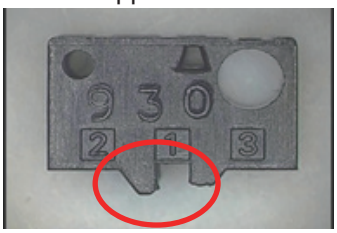
<Appearance failure>
Cover hook part is broken, and switch is scattered.
<Operating failure>
It doesn't operate normally.

■The failure case

●When pushing with TTP or more, or applying the excessive force from the side of switch, cover hook part is broken.

e.g.) D2A

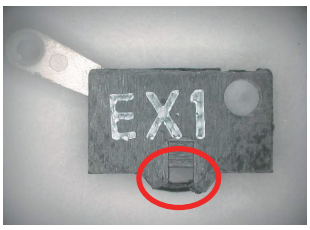
Appearance



Broken cover hook part

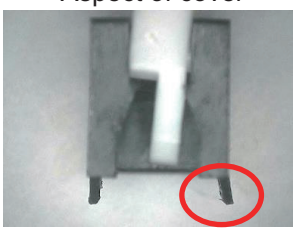
e.g.) D3C

Front side of cover



Broken cover hook part

Aspect of cover

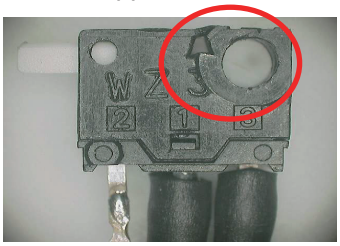


Deformation of cover hook part

●When tightening a screw by the excessive torque, cover is deformed, and switch doesn't operate normally.

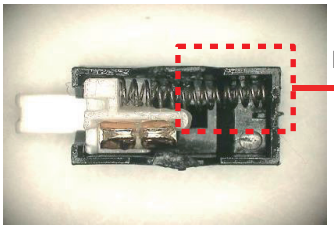
e.g.) D2A

Appearance

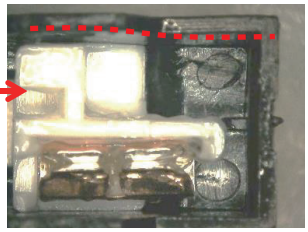


Mounting hole crashed.

Inside of cover



Enlargement of inside of cover



Cover is deformed, and internal parts don't operate normally.

■Checkpoint for prevention!

Check!

Is the operating method appropriate?

(1)When operating switch, be sure to set not to push the lever TTP (total travel position) or more.
(2)Be sure not to apply the excessive force from the side of switch.
(3)As for torque type for securing the screws (D2A, D3C), be sure not to apply the force of Tightening torque or more when mounting.
Tightening torque: within 4.9 to 9.8×10^{-2}N·m

[If energizing under high temperature and humid environment...]

■What are the possible failures?

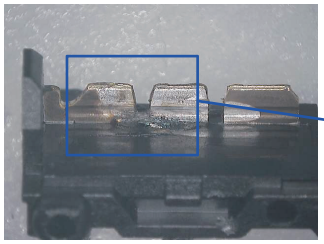
<Contact failure>
Contact doesn't turn off.

■The failure case

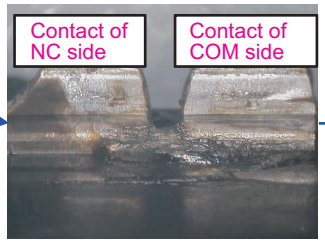
●Migration occurs in the silver of contact, and it results in short-circuit.

e.g.) D3C

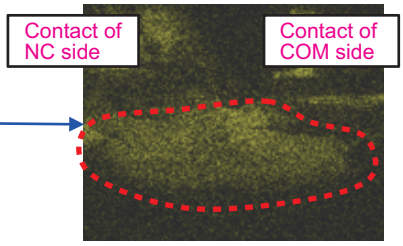
Fixed contact



Enlargement of contact part



Distribution of silver (Yellow part)



Electrochemical migration of silver is found between COM-NC contacts.
Therefore, the contacts are short-circuited, and contacts doesn't turn OFF.

■Checkpoint for prevention!

Is the using environment appropriate?

(1)Electrochemical migration of silver is a phenomenon in which it is easy to be generated between the insulated contacts under high temperature and high humid environment.
Be sure not to use in high temperature and high humid.

(2)When using under the environment more tough than the general environment,
be sure to implement the periodic check/replacement of switch.

(3)It can suppress the generation of a electrochemical migration of silver when switching to fixed contact gold-plated type.
Please consider it.

[If sulfuric gas generates…]

■What are the possible failures?

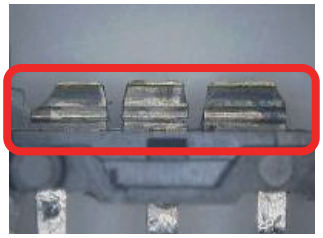
<Appearance failure>
Discoloration in the terminals
<Contact failure>
Contact doesn't turn ON, Contact resistance value is high (unstable)
<Soldering failure>
Terminals cannot be soldered

■The failure case

●Contact part is discolored due to sulfurization, and contact failure results.

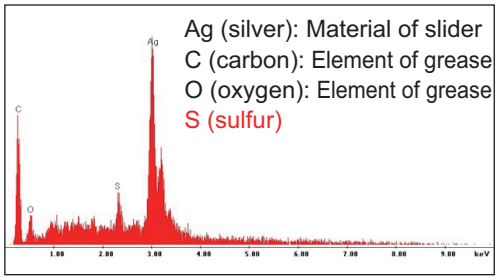
e.g.) D3C

Fixed contact



Discoloration of a fixed contact can be seen.

Analysis result of element on discolored part



Sulfur (S) is detected.

■Checkpoint for prevention!

Are the storage environment and condition appropriate?

●Storage environment

To prevent degradation such as discoloration, in the terminals during storage, do not store the switch in locations that are subject to the following conditions.

(1)High temperature or humidity
(2)Corrosive gases
(3)Direct sunlight

●Storage condition

Store the switches in the packaging box.
Please use a switch as quickly as possible after packing is opened.
When storing leftover parts, make sure that appropriate measures are take against humidity and corrosive gases.

Check!

Has sulfuric gas or sulfuric hydrogen gas existed around switches?

When sulfuric gas or sulfuric hydrogen gas exists, it can cause corrosive damage to the contacts and malfunction results.
Please don't use in areas subject to toxic gases.

●As a source of sulfuric gas, the following example can be mentioned.

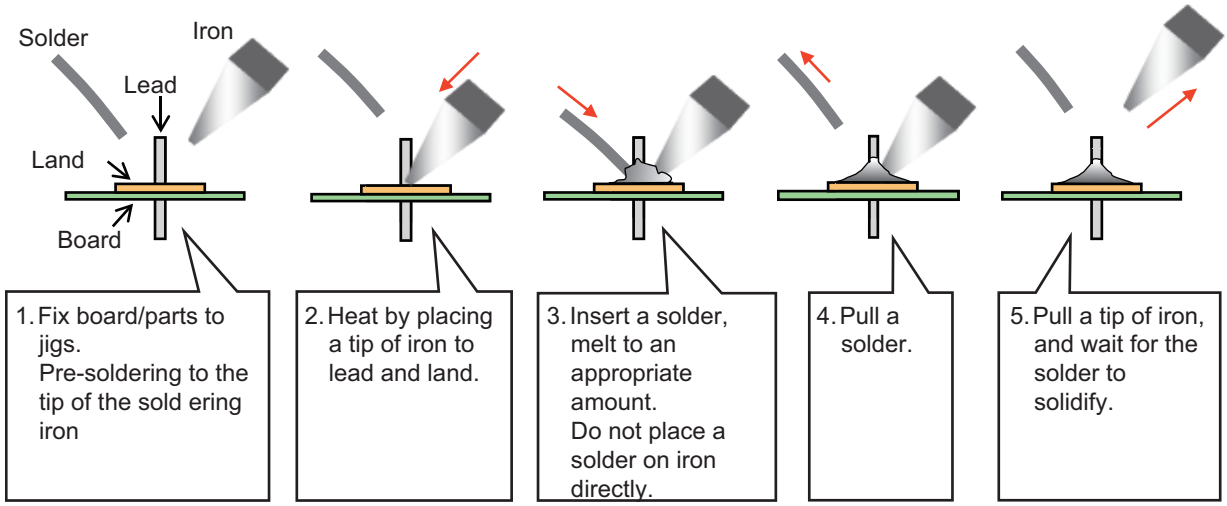
[Source]
Car exhaust gas, gypsum board, wood, papers such as cardboard, fiber scraps, seawater, dirt, Sludge, volcanic gas, hot springs, etc.
[Occurrence place]
Storage warehouse for gypsum, sewage / wastewater treatment plants, garbage disposal plants, abandoned site, petroleum refining

In addition, if there is less oxygen or no oxygen, and if it is humid, we judge that sulfuric gas generates.
Injecting oxygen is the most effective to suppress the generation of sulfuric hydrogen gas.
In addition, eliminating the source of gas generation and making dry state is also effective.

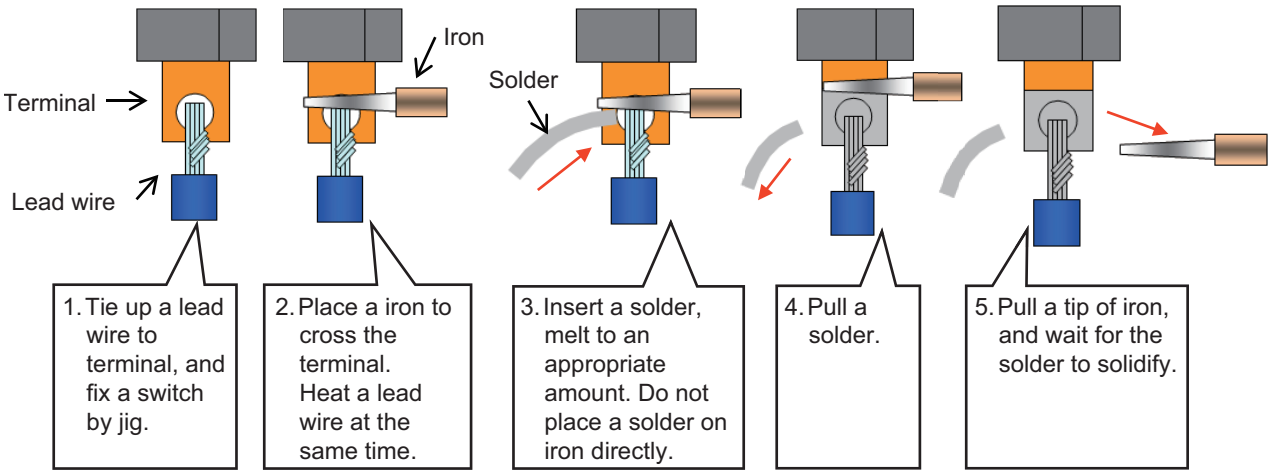
[Reference material:Soldering procedure]

Be sure to solder referring to the below contents.

■If soldering to board

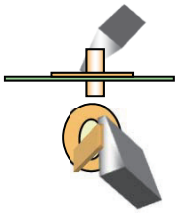


■If soldering the lead wire to terminal



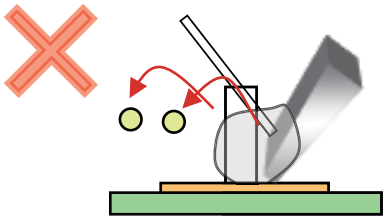
Check!

Raise a temperature for mutual base materials.



Check!

If placing an iron on solder directly, as flux scatters, melt a solder by heated base materials.



Check!

Be sure to use a smoke extractor when soldering. Be sure to clean a smoke extractor filter periodically to keep a suction power.

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