NEXEM

USER'S MANUAL

AUTOMOTIVE

MINIATURE POWER RELAY

FUNCTIONS AND NOTES ON CORRECT USE

⚠
- ●All specifications in this catalog and production status of products are subject to change without notice. Prior to the purchase, please contact EM Devices for updated product data.
- ●Please request for a specification sheet for detailed product data prior to the purchase.
- ●Before using the product in this catalog, please read "NOTES ON CORRECT USE" in the selection guide.

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CONTENTS

1. INTRODUCTION

Miniature power relays are widely used in the fields of automotive applications.

This document describes the configuration of the NEXEM's miniature power relay and points to be noted when using the relay. Reading both this document and the Data Sheet of each product is recommended when using the relay.

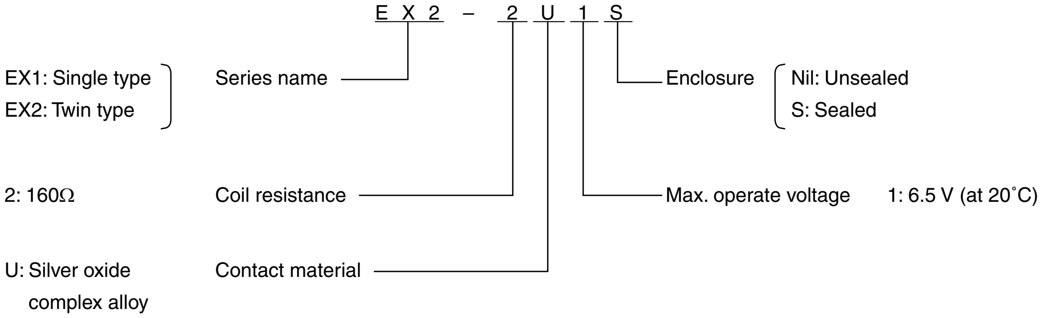
For further information, please consult EM Devices.

2. PRODUCT CODE LEGEND

The product name of NEXEM's power relay consist of codes indicating the configuration of each relay.

EM Devices has two types of power relay. One is the single type which has a unit of a coil and contacts in a housing. Other is the twin type which has two units of a coil and contacts in a housing. Both types are identified on the third numeric character of product name.

(Example) EX series



3. CLASSIFICATION OF NEXEM MINIATURE RELAY

3.1 GENERAL CLASSIFICATION

NEXEM's miniature power relays are classified as follows:

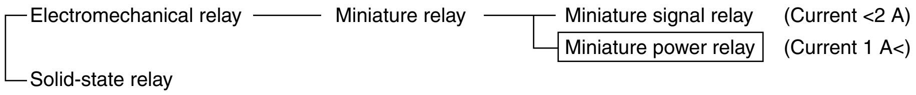


Figure 1 Classification of relays

3.2 CONTACT ARRANGEMENT

Main types of contact arrangement are Make contacts type, Break contacts type and Transfer contacts type.

Make contacts type:	Normally open contacts (Make contacts) are closed when the coil is driven. It is called Form A or 1a.
Break contacts type:	Normally closed contacts (Break contacts) are opened when the coil is driven. It is called Form B or 1b.
Transfer contacts type:	It has Make contacts and Break contacts. When the coil is driven, the movable contact moves from stationary break contact to stationary make contact. It is called Form C or 1c.

NEXEM's miniature power relays are almost transfer contacts types. But EM1 is a make contacts type.

3.3 SINGLE TYPE & TWIN TYPE (NUMBER OF BUILT-IN UNIT)

As for the number of built-in unit in a relay housing, there is a single type and a twin type.

Single type:	One unit that composes a coil and a pair of contacts is built into the relay housing. (Figure 2(a))
Twin type:	Two units are built into the relay housing. (Figure 2(b), (c))

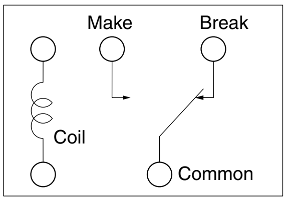
Twin type has smaller mounting area than one for two single types.

3.4 INTERNAL CONNECTION OF TWIN TYPE

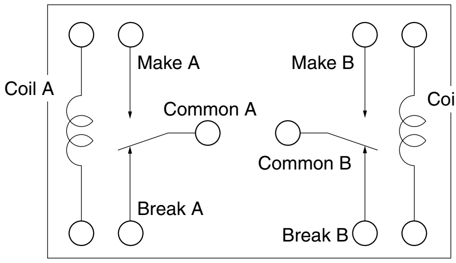
Twin type has two types of internal connection. One is Separate type and another is the H-bridge type.

Separate type:	Two units in the relay housing are independent. (Figure 2(b))
H-bridge type:	The stationary make or break contacts of each unit are mutually connected in the housing and there is one terminal of stationary make contact and one terminal of stationary break contact as a twin type relay. (Figure 2(c))

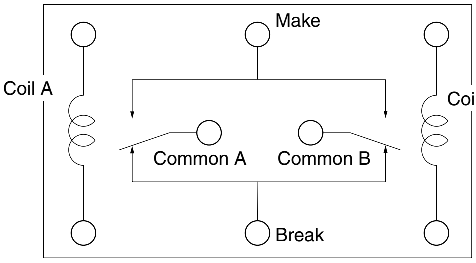
H-bridge type is suitable for the control of the rotational direction.



(a) Single relay



(b) Twin relay / Separate type



(c) Twin relay / H-bridge type

4. RELAY OPERATION

This section describes the operation of the coil as the input section of relay and contacts as the output section of relay. Generally, when a current flows through the coil, the contacts operate. And, the contacts release after the current ceases to flow through the coil. This type is called current holding type.

About the internal connections of typical types, which are single relay and the H-bridge type of twin relay, the operation is described below.

4.1 SINGLE TYPE

Figure 3 shows the single relay's operation. Figure 3(a) shows the state where no current flows through the coil. When voltage is applied to the coil (energized) shown in figure 3(b), the current flows through the coil and the contact operates.

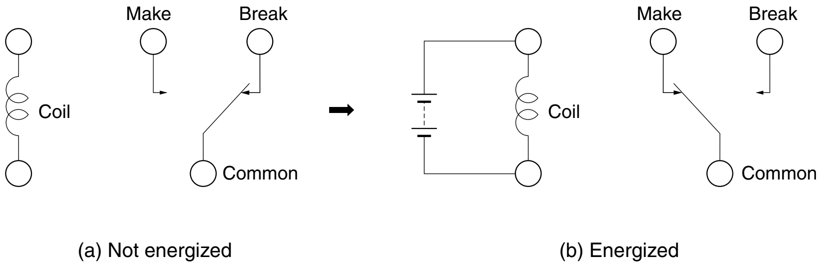


Figure 3 Single relay's operation

4.2 H-BRIDGE TYPE OF TWIN RELAY

Figure 4 shows the operation of H-bridge type. Figure 4(a) shows the state where no current flows through the coil. When the coil A is energized, the contact (Common A) operates, (Figure 4 (b)). When the coil A is de-energized, the contact (Common A) releases, (Figure 4(c)). Next when the coil B is energized, the contact (Common B) operates, (Figure 4(d)). When the coil B is de-energized, the contact (Common B) releases.

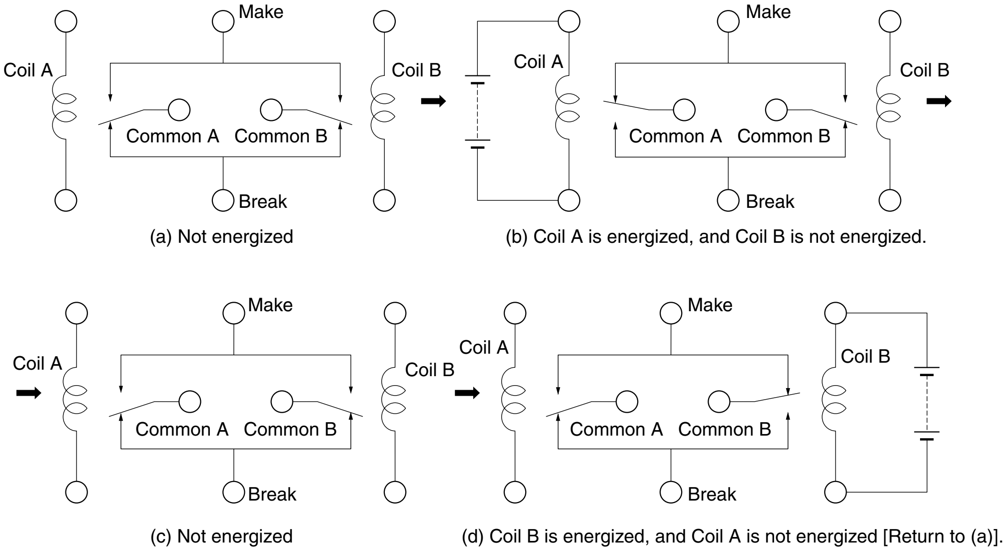


Figure 4 Operation of H-bridge type of twin relay

4.3 TIMING CHART OF RELAY OPERATION

Figure 5 shows the operation of the transfer contacts mentioned above by using timing charts. When the coil is energized, the common (movable) contact of the transfer contacts releases from the break contact and touches the make contact. When the coil is de-energized, the common (movable) contact releases from the make contact and touches the break contact. Therefore, there is a time when the common contact does not touch make nor break contacts (transfer time). This is the reason why transfer contact is also called “break-before-make” (BBM contact).

The transfer time of NEXEM’s miniature power relays is several msec.

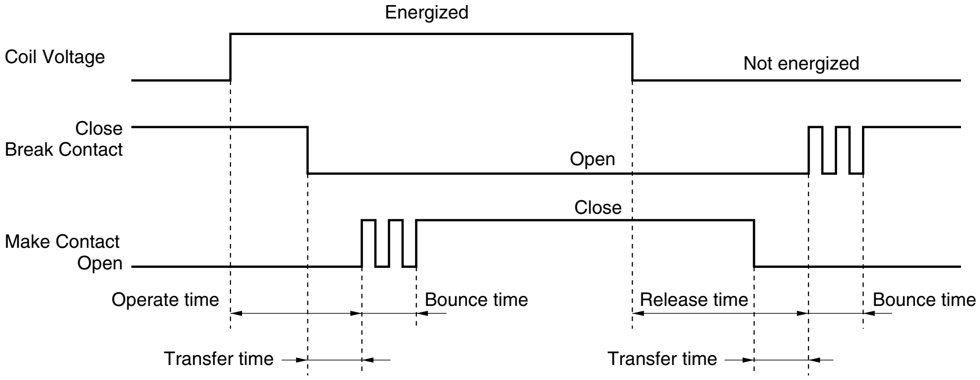


Figure 5 Timing chart of transfer contacts

<1> The operate time is the time when the common contact touches the make contact after the coil is energized.
This phenomenon includes the transfer time.

<2> An electromechanical relay such as a miniature power relay has a bounce time until the contacts are completely closed. This bounce time of the NEXEM’s miniature power relay is certain 100 μsec to msec.

<3> When the relay releases, there is a bounce time of break contact. The bounce time is the same level as one when the relay operates.

5. NOTES ON CORRECT USE

The possibility of defect cannot be eliminated entirely even though EM Devices Corporation has been making continuous effort to enhance the reliability of miniature power relays. To minimize the risks of damage or injury to persons of property arising from a defect in an NEXEM miniature power relay, customer must incorporate sufficient safety measures in its design; such as redundancy, fire-containment and anti-failure features.

5.1 GENERAL

(1) When a rippled DC power source is used, abnormalities such as beat in the coil may occur.

(2) Observe the specified operating temperature range. When using the below or above specified temperature range, relay life will extremely shortened. For use outside the specified temperature range, please consult with EM Devices.

(3) Never allow the contact load to exceed the maximum rating. Otherwise, the life of the relay will extremely shortened. The life described in catalog is under a certain load condition. Because the life is influenced by other factors in the actual circuit, the accurate life must be measured in the actual circuit.

(4) Handle the relay with care. Do not apply excessive shock such as drop. This phenomenon can cause change in its characteristics and destruction to its sealing that may result to not good performances.

(5) The flow soldering conditions are 5 to 10 seconds at 260 °C max.

(6) When cleaning the relay after soldering, use a sealed type relay. Clean the relay when it has turned cool to a room temperature after soldering. Use alcohol or a water-based solvent. Avoid using ultrasonic cleaning.

(7) When coating the printed circuit board, EM Devices does not recommend to dip the relay into a coating agent. Please coat the board by avoiding the relay using suitable protector so that the coating agent will not adhere to the relay.

5.2 NOTES ON CONTACT LOAD

(1) Minimum load

Use the relay at a voltage and current higher than the minimum load. Otherwise, the contact resistance will increase and the signal cannot be correctly transmitted. This is because stabilization of the contact can not be expected by under minimum load. (A certain level of load will eliminate minute substances generated on the contact surface.)

In addition to the above mentioned, even if the load is within the maximum ratings, note that the current does not drop below the minimum load while carrying.

(2) Switching loads

There are two types of load current control by a relay. One is “non-working”. It is the load current that is switched by the transistor, the relay only carries the load current. The other is “working”. It is a relay that switches and carries the load current. EM Devices recommends the working load current, because the effect of cleaning contacts by the arc phenomenon at the opening/closing the contacts will be expected.

(3) Contact protection circuit

To improve the use of the relay, provide a circuit that suppresses transient current and voltage applied to contacts during opening and closing. The applicable protection circuit differs depending on the load type of the contact.

(a) Inductive load

In inductive load, electromotive force is generated when the contacts are open. This electromotive force generates an electrical discharge such as arcing and glow discharge. This contact phenomenon can cause extreme contact erosion. To avoid contact erosion, a contact protection circuit is applied to absorb the electromotive force.

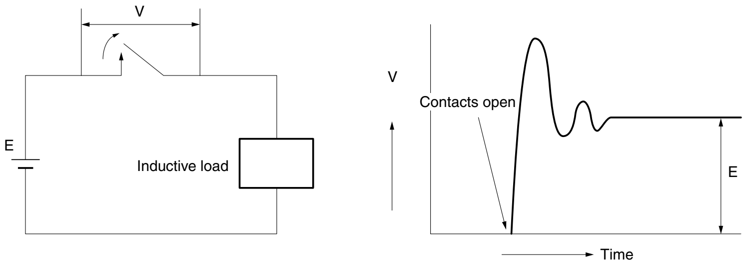


Figure 6 Inductive load circuit

Table-1 Inductive load contact protection circuit

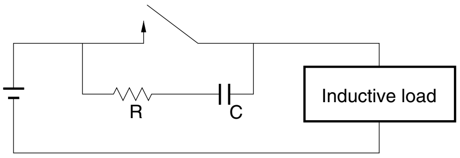
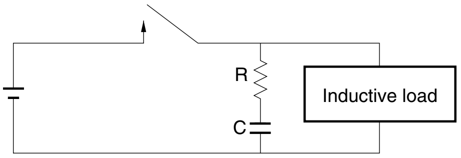
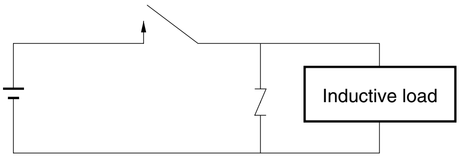
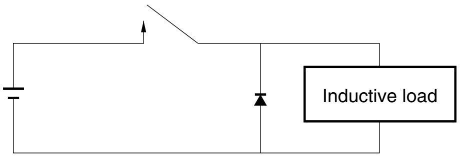
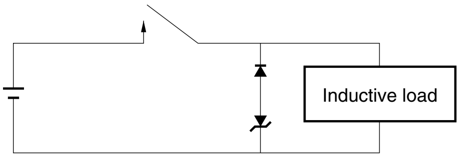
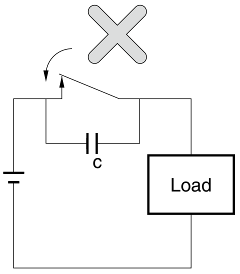
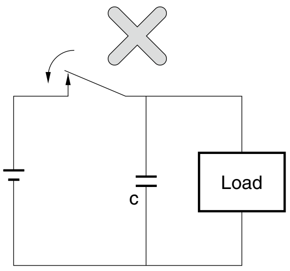
Protection element	Circuit example	Remarks
Capacitor + Resistor (CR circuit)	 	$R\ (\Omega) = \frac{\text{contact voltage (V)}}{0.5 \text{ to } 1}$ C (μF) = (0.5 to 1) × contact current (A) The withstand voltage of a non-polar capacitor should be 300 V or higher.
Varistor		High voltage is suppressed by using the voltage characteristics of the varistor.
Diode		Pay attention to the reverse withstand voltage of the diode. The release time of the relay or solenoid of the load becomes long.
Diode + Zener diode		The ON time of the diode is controlled by using the zener voltage characteristics and the release time of the relay or solenoid of the load can be shortened.

Table-1 shows examples of contact protection circuits. Please do not use the protection circuits of capacitor only shown in Table-2.

Table-2 Example of wrong circuit with a capacitor

	This circuit is effective for arc suppression when the contacts are opened, but when the contacts are closed a capacitor short-circuit current flows, making the contacts more susceptible to metal deposition.		This circuit is effective for arc suppression when the contacts are opened, but when the contacts are closed a capacitor charging current flows, making the contacts more susceptible to metal deposition.

(b) Capacitive load (I)

Capacitors are often used in parallel to the loads like motors to prevent noise and other purpose as shown in figure 7. In that case, inrush current is generated in the circuit. As a result, the contacts can stick together due to projection and pitting that are both formed at contact surface. So, it is necessary to hold down the inrush current by resistor which is connected in series to capacitor. It is desirable that capacitor value is as small as possible and the resistor value is as large as possible.

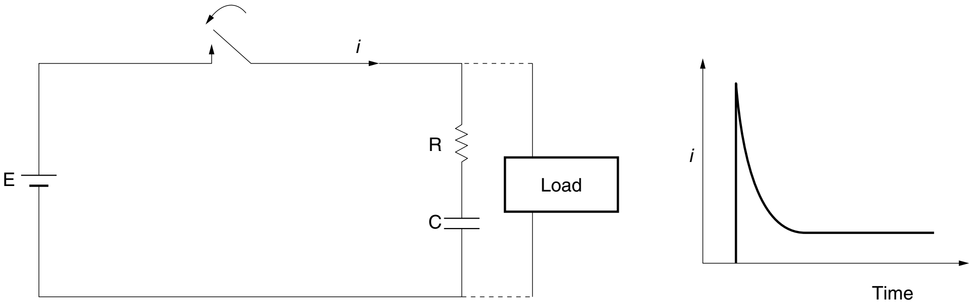


Figure 7 Inrush current of load from capacitor

(c) Capacitive load (II)

It is necessary to be careful when capacitors are connected in the circuit as shown in figure 8. When the common contact moves from the make contact to the break contact, the motor generates electromotive force.

Capacitor can be charged by over supply voltage.

Bigger inrush current from the capacitor flows to the break contact. Because the break contact has the bounce at ON, inrush current damages the break contact. Therefore it is necessary to decrease the inrush current by a resistor which is connected in series to capacitor as shown in figure 8.

Moreover, a diode connected with the relay coil in parallel can reduce bounces. The diode is more effective than a zener diode for it.

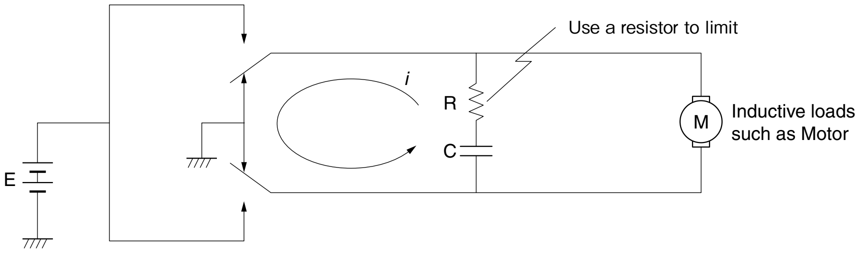


Figure 8 Countermeasure against capacitor in inductive load circuit

(d) Lamp load

Lamp loads like tungsten lamps, have a low initial resistance so that an inrush current of 5 to 10 times as high as the steady-state current may flow through the relay contacts. In this case, it is necessary to keep the current within the maximum rated value. A current-limiting resistor is connected to the contacts in series.

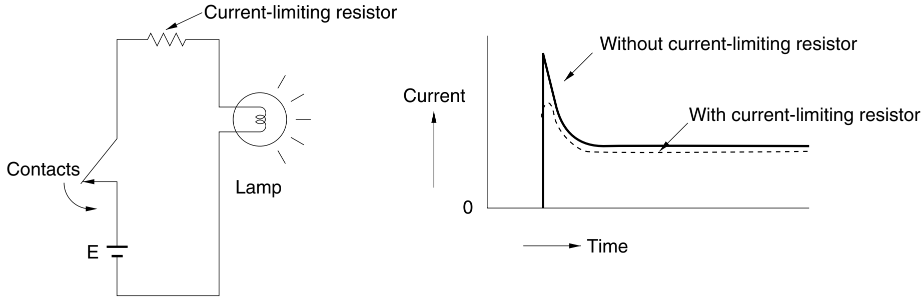


Figure 9 Inrush current under lamp loads

5.3 NOTE ON DRIVING RELAYS

(1) Ambient temperature

When NEXEM relay is used at an ambient temperature exceeding or below the range that is shown in the catalog, the performance of the relay may be degraded and the life may be extremely shortened.

<1> Please use the relay at coil rated voltage within the specified temperature range. NOTE: Permissible coil voltage may be restricted and must be confirmed before the relay is used. (Refer to (2) in “Maximum applied coil voltage”).

<2> The operating characteristics of the relay change with ambient temperature. Confirm the temperature condition in the application and confirm the characteristics changes at the technical documents. Figure 10 shows the example of the temperature characteristics.

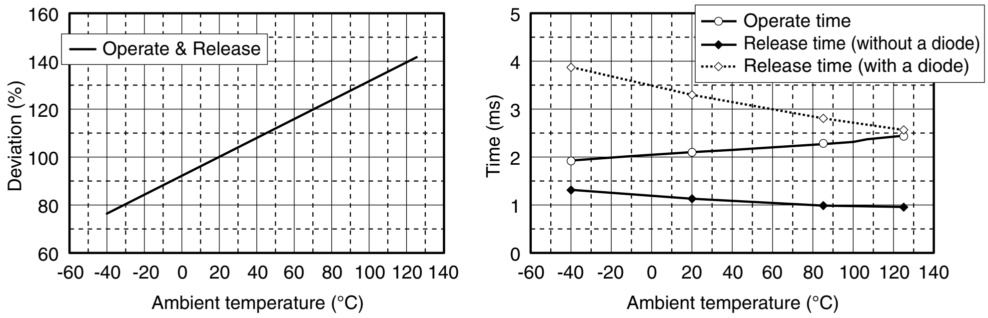


Figure 10 Temperature characteristics of relay (Example: EX2 relay)

(2) Maximum applied coil voltage

The maximum applied voltage of the relay coil depends on the ambient temperature and the carrying load current. The upper limit is decided on the heat resistance of the relay. It mainly depends on the permissible temperature of the coil wire and the plastic material. When the voltage applies the coil continuously, the coil generates the heat corresponding to applied voltage. Then the coil temperature rises up. The higher the ambient temperature is, the less the margin of the heat resistance temperature of the coil wire material is. Therefore, it is necessary to restrict the coil voltage at high ambient temperature. Figure 11 shows the example of permissible applied voltage. The coil temperature is also affected by the load current. Consult EM Devices about the permissible maximum applied voltage in use condition like ambient temperature, carrying load current and carrying duration.

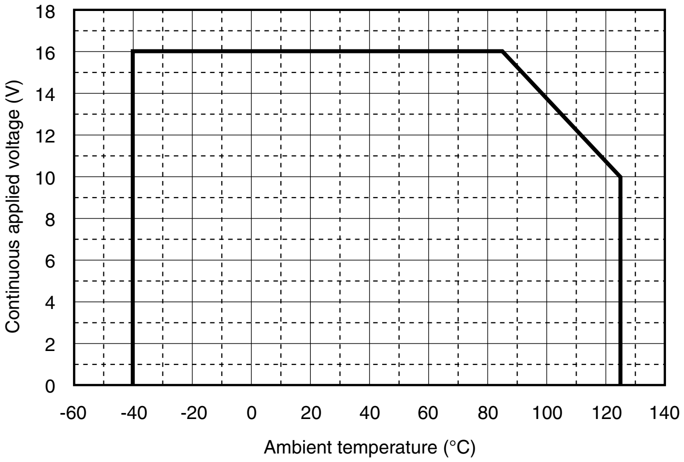


Figure 11 Coil voltage versus temperature derating characteristics (Example)

(3) Hot start

There is a case that a relay is energized again immediately after it is energized continuously and after de-energized. This phenomenon is called hot start. The relay might not operate at this case. This is because the increase in the coil resistance due to heat in the relay causes the current to fall even though the applied voltage remains constant. This problem occurs especially when the operating temperature is high and a voltage which is lower than the rated voltage is applied. confirm first the must operate voltage at the time of a hot start.

(4) Drive circuit

Since the coil of a relay has inductive impedance, an electromotive force is generated when the circuit is opened. This voltage may damage the relay driver IC. In order to suppress this electromotive force, a diode is connected in parallel to the coil as shown in Figure 12. The release time increases when a diode is connected with the coil in parallel.

For EM1 and EL1 relay, the circuit shown in Figures 12(c) or (d) are recommended. The circuit shown in Figure 12(b) is not recommended because the relay can not provide enough performance.

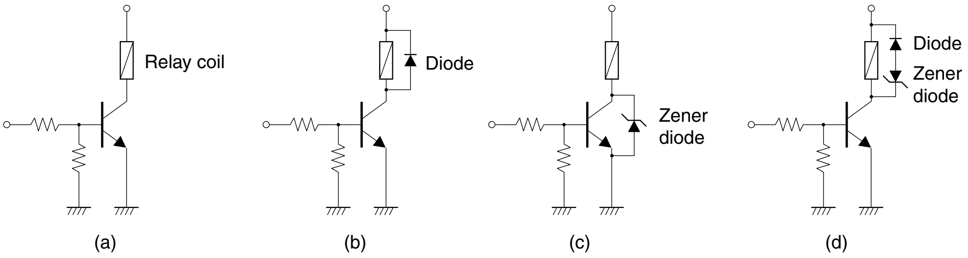


Figure 12 Driving circuit

(5) Drive waveform

The voltage must instantaneously rise and fall as a pulse. It is not desirable that the waveform of the voltage applied to a relay coil gradually increases and decreases. If the voltage gradually increases and decreases, the relay contacts do not perform its snap action, and an enough performance cannot be achieved.

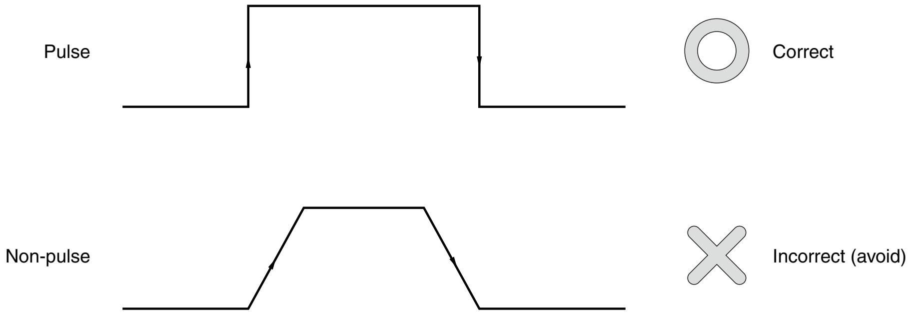


Figure 13 Coil drive waveform

(6) Opening/closing frequency

If the contacts open and close frequently with a high current load, repeated electric discharges may cause contact metal welding or damage to the contact spring. Consult EM Devices when using the relay with high current load with frequent opening and closing of contacts.

(7) Power source capacity

Note the power source capacity when the same power source is used for the relay drive and the load such as a lamp load. The moment the contacts are closed, the source voltage may drop if the power source capacity is small. In this case, the relay may be released or an oscillation phenomenon where the relay repeatedly releases and operates may occur.

Ensure the power source enough capacity to prevent this phenomenon.

(8) Polarity reversal circuit

Note the operating sequence of 2 relays in case of polarity reversal circuit, is using two single relays or one twin relay which is called H-bridge circuit (Figure 14(a)). If two relays (A and B) are switched at a time, contacts are instantaneously applied power supply voltage and inductive voltage by motor. Contacts are damaged by discharge of excessive voltage. Contact life might decrease by contact welding or contact material transition. It is necessary to take more than 100 ms intervals for on/off timing between driving A and B relay (Figure 14(b)).

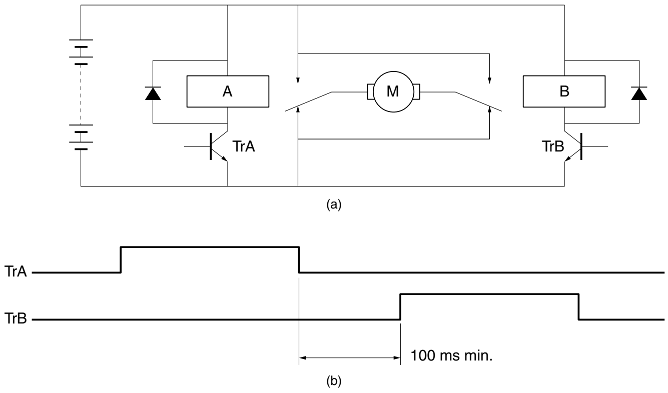


Figure 14 Polarity reversal circuit and coil drive timing

(9) Jump start

NEXEM's power relay is the product for 12V battery system and does not correspond to 24V "Jump start" testing.

5.4 NOTES ON OPERATING ENVIRONMENTS

(1) Ambient temperature

Ensure that the ambient temperature of the relay mounted on the device is within the "operating temperature range" in the catalog. Use of the relay at a temperature that is not in the specified range may adversely affect insulation or contact performance.

(2) Humidity

Under a high humidity (RH85% or higher) environment for a long time, moisture may penetrate inside the relay. This moisture may combine with NOx or SOx generated by glow discharges to produce nitric acid or sulfuric acid. In this case, the acid produced may corrode the metal that forms the relay, and it may cause operation troubles in the relay. If the use of the relay in a high humidity environment is unavoidable, consult EM Devices in advance.

(3) Atmospheric pressure

NEXEM's power relay supposes to use under normal pressures (810 to 1200 hPa). However, if it is used under other pressure conditions, it's performance may be destroyed and the relay may be deformed. This can cause functional troubles with the relays. Be sure to use the relay under normal pressure conditions.

(4) Vibration and shock

The vibration and shock resistance of a relay are shown in the catalog. The use of the relay under conditions that are not specified may cause malfunction or damage. Excessive vibration and shock during contact load current carrying may cause considerable damage or wear of the contacts.

Note that the relay may malfunction due to vibration or shock by the solenoid coil, that are placed near the relay.

(5) Influence of magnetic fields

Under the influence of magnetic flux leaking from a transformer, speaker, or magnet placed near the relay; the operate and release voltage; operate and release time, and other dynamic characteristics may change. In applications where these characteristics changes can cause problems, it is necessary to take measures such as magnetic shielding.

5.5 INFLUENCE OF RELAY OPERATION ON SURROUNDINGS

(1) Electromagnetic noise

Switching the relay coil generates a high electromotive force due to induction. This high voltage might break the relay driver circuits such as microcontrollers. Add an appropriate absorption element such as diode to prevent electronic circuits from malfunctioning. The example of protection circuits are shown in 5.3 (4).

(2) Arc discharge

Connecting/disconnecting a high current at the relay contacts generates an arc discharge. This discharge may cause electronic circuits such as microcontrollers to malfunction and therefore it is necessary to take appropriate measures such as electrostatic shields or separation of power supply.

(3) Generation of leakage magnetic flux

Leakage magnetic flux exists slightly in the vicinity of the relay when in the magnetized state. Magnetic sensors, etc. that are close to the relay may malfunction.

5.6 NOTES ON HANDLING RELAYS

(1) Use of magazine case stoppers

Generally, relays are packaged in a magazine cases for shipment. When some relays are taken out from the case and space is freed inside the case, be sure to secure the relays in the case with a stopper. If the relays are not enough secured, vibration during transportation may cause contact problems.

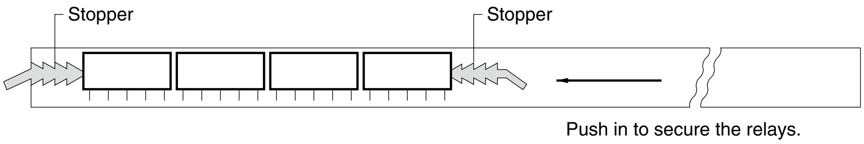


Figure 15 Storage in magazine case

(2) Drop

If a relay falls from the work table, etc. a shock of 9800 m/s^2(1000G) or more is applied to the relay and its functions may be destroyed. Do not use relays which have been dropped.

If a relay might have received some shock, confirm the relay if it is not in abnormal condition before using.

(3) Long term storage

<1> Contacts

When the relay which has been stored for long term is used, check the electric continuity of it. If the storage condition (temperature, humidity and atmosphere, etc.) is not good, contact surface might decay and can result to contact failure.

<2> Terminals

Check the solderability of terminals. The surface of terminal will become oxidized and the solderability might deteriorate.

Moreover; oil, water or solvent, etc. must not splash the terminals.

5.7 NOTES ON MOUNTING

(1) Print circuit board

For the printed circuit board on which the relay is mounted, use a board of 1 mm or more thicker. If the printed circuit board is not thick enough, it may be subject to warpage which can add tension to the relay, causing variations in the relay characteristics. Be careful with the relay location, base material and through hole shape to decrease the influence of warpage.

Consult EM Devices before using the pad layout other than the layout described in catalog.

(2) Relay mounting position

The vibration and shock resistance of a relay are greatly affected by its mounting position. It is particularly important to select the mounting position to prevent the break contacts from being momentary open instantaneously due to vibration and shock. The vibration and shock resistance are at a minimum when the direction of vibration and shock applied to the relay matches the operation direction of the armature (movable iron piece) and contacts. Therefore, if it is possible to anticipate the direction of vibration or shocks, mount the relay so that the direction in which vibration or shocks are applied is perpendicular to the direction of the relay armature operation. Figure 16 shows the direction of relay armature operation.

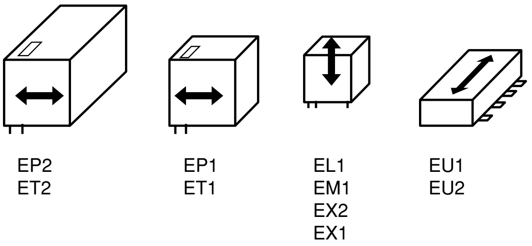


Figure 16 Direction of armature operation

(3) Chucking

When a relay is mounted using an automatic machine, note that the application of an excessive external force to the cover at the time of chucking or insertion of the relay may damage or change the characteristics of the cover. The chucking force is approximately 4.9 N (500 g) or less.

(4) Clinching terminals

Avoid bending the terminal to temporarily secure the relay to the printed circuit board. Bending the terminals may damage sealability or adversely influence the internal mechanism.

(5) Soldering

In all NEXEM's power relays, terminals are all pre-soldered with Pb free solder.
(Pb free solder: Sn-3Ag-0.5Cu)

<1> Automatic soldering (Flow solder)

[Recommended conditions] *Preheating: 100°C max. 1 minute max.
*Solder temperature: 260°C max.
*Solder time: 5 to 10 seconds

<2> Automatic soldering (Reflow solder)

Surface mounting type relay EU1/EU2 and pin in paste reflow type relay are for reflow soldering. Confirm first the recommended temperature profile to EM Devices.

<3> Manual soldering (by soldering iron)

[Recommended conditions] *Solder temperature: 350°C max.
*Solder time: 2 to 3 seconds

Free immediately after soldering is recommended.

Avoid immersing the board in cleaning solvent after soldering; otherwise thermal shock may be applied to it.

(6) Cutting terminal

Do not cut the terminals of the relay with a revolving blade or an ultrasonic cutter, because vibration that is applied to the relay during the cutting may cause the characteristics to change, breaking of the coil wire or sticking of the contacts.

(7) Cleaning

Avoid immersing the board in cleaning solvent after soldering, otherwise breaking sealability might be caused by thermal shock. After the relay and board returned to room temperature, clean them.

<1> **Cleaning solvent**

Use of alcohol or water-based cleaning solvents is recommended. Never use thinner or benzene because these solvents may damage the relay housing.

<2> **Avoid ultrasonic cleaning**

Ultrasonic cleaning may cause changing characteristics, breaking of the coil wire or sticking of the contacts due to the energy of vibration.

(8) Coating

If coating the printed circuit board due to ensure electric insulation and anticorrosion of the board, EM Devices recommends to coat the board to avoid the relay by suitable protector so that the coating agent should not adhere to the relay. If the relay is coated with the board by necessity, lower the relay and board up to room temperature after soldering and cleaning process; and then coat them. Moreover, heat them until perfectly curing in case of heat curing type agent. If the agent is not stiffened and relay sealability is broken in some causes, the agent may penetrate inside the relay that will lead to malfunctioning of relay during operation avoid using silicone coating agent, this can cause contact failure.

5.8 NOTES ON USING SMT RELAYS

(1) Printed circuit board

Determine the dimensions of the mounting pads on printed circuit board consider the factor of solderability and insulation in order to fit in the mounting accuracy of automatic mounting machine. Refer to the dimensions of the mounting pads in the catalog.

(2) Solder reflow

The SMT relay is highly resistant to heat. However, solder the relay under the correct temperature conditions so that the full performance of the relay can function properly. Referring to recommended temperature profile with EM Devices' experiment equipment, be sure to confirm the soldering conditions and the influence of the relay in advance before setting work standards.

(3) Storage

The sealability of a surface mounting relay may be lost if the relay absorbs moisture and when heated during soldering.

Note this in cleaning and coating process.

6. ELECTRICAL CHARACTERISTICS MEASUREMENT

This section describes some methods how to measure the electrical characteristics of a relay. Below are the test method. When conducting acceptance test, please consult EM Devices.

6.1 CONTACT RESISTANCE

(1) The resistance between contacts when they are closed (ON) is measured by the voltage drop method. Set the supply voltage (voltage between contact terminals when the contacts are open) to 6 VDC and adjust variable resistor so that the measurement current may become 7 A. Calculate the contact resistance from the voltage drop and carrying current.

(2) To measure the resistance of the make contact, apply the rated voltage to the coil.

(3) The contact resistance measurement includes the conductor resistance of the relay terminals.

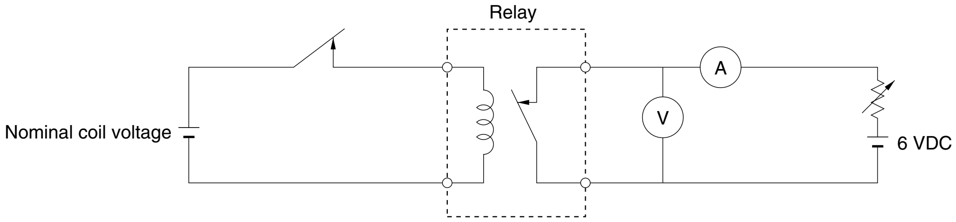


Figure 17 Measuring contact resistance

6.2 OPERATION VOLTAGES (OPERATE AND RELEASE VOLTAGES)

(1) Apply a pulsating voltage to the coil and observe the contact state. To generate the coil voltage, using a programmable power supply is convenient. To observe the contact state, apply the signal potential to contacts.

(2) To measure the operate voltage, a first apply rated voltage to the coil as a soak voltage and then gradually increase the pulse voltage applied to the coil. To measure the release voltage, the stepwise voltage combined with soak and check voltage is applied to the coil. Gradually decrease the check voltage from the rated voltage to a certain value.

(3) If a pulsating voltage cannot be easily obtained, use a slope voltage. However, the measured value will not be accurate.

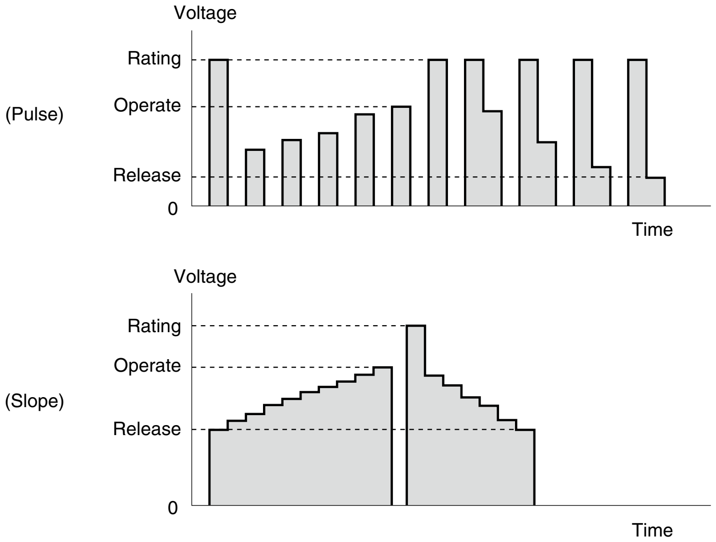


Figure 18 Measuring waveform of operation voltage (Coil voltage)

6.3 TIME CHARACTERISTICS (OPERATE TIME AND RELEASE TIME)

(1) To measure the operate time, apply a pulse voltage to the coil and measure the time until contacts change their state (make contact: OFF to ON; Break contact: ON to OFF).

(2) To measure the release time, remove the coil voltage and measure the time until the contacts change their state.

(3) A single pulse with a pulse width of 20 ms is the best coil voltage. However, a repetitive pulse at about 10 Hz (Duty 50%) can be also used.
To observe the contact state, connect a load of 5 VDC, 20 mA and use an oscilloscope.

(4) The time characteristics can be measured with the following circuit.

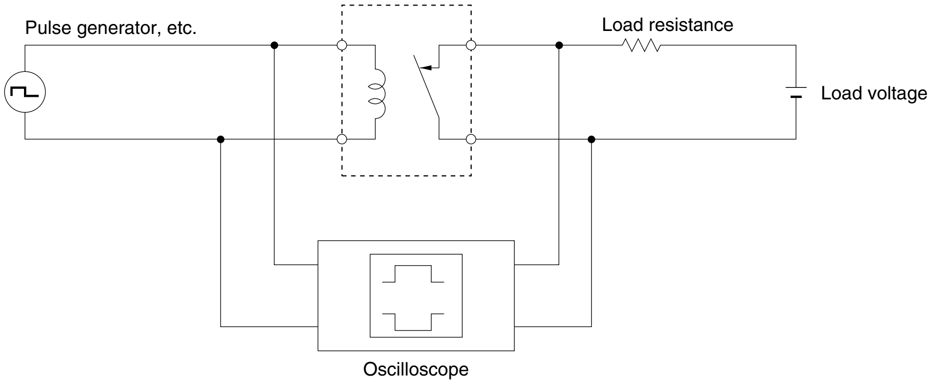


Figure 19 Measuring time characteristics

6.4 INSULATION RESISTANCE

(1) Measure the electric resistance between insulated conductors with a megohmmeter.
The measured value changes with atmosphere (the insulation resistance decreases as the humidity rises). Measure under standard conditions (temperature: 15 to 35°C, relative humidity: 15 to 85%).

(2) Measure the insulation resistance at the following relay terminals:

(a) Between opposing contacts (while make contact not energized and the break contact energized)
(b) Between coil and contact

6.5 BREAK DOWN VOLTAGE

(1) Apply AC voltage between insulated conductors and confirm that breakdown does not occur.

(2) Use a breakdown voltage tester and apply the specified voltage to the sample for 1 minute.
Set the detection break current (that detects breakdown and protect the sample from damages) to 1 mA.
According to JIS (Japanese Industrial Standards), a test in which 110% of the specified voltage is applied to the sample for 1 second can be used instead if there is no problem in measurement.

(3) Measure the breakdown voltage at the same terminals in which the insulation resistance is measured.

7. TERMINOLOGY

This section describes the major technical terms described in the catalog, data sheet and related manuals.

7.1 TERMS RELATED TO COIL

(1) Nominal coil voltage

A standard voltage applied for the coil for use the relay. Nominal coil voltage of NEXEM's power relays is 12 VDC.

(2) Coil resistance

DC resistance of the coil. It is usually measured at 20°C. A tolerance of ±10% usually applies.

(3) Maximum coil voltage

The maximum voltage that can be applied to coil. Usually, the ambient temperature is specified as a condition.

(4) Coil temperature rise

Rise of the coil temperature at a given input (power or voltage).

(5) Power dissipation rating of coil

A product of the nominal coil voltage and coil current. Normal power dissipation will operate the relay.

(6) Operate voltage

Minimum voltage required to change the state of all contact (Make contacts: OFF to ON, Break contacts: ON to OFF). Maximum operate voltage is the maximum specified value to operate the relay.

(7) Non-operate voltage

Maximum voltage required not to change the state of all contact (Make contact is still opened, Break contact is still closed), when the coil voltage is increased.

(8) Holding voltage

Minimum voltage required not to change the state of all contact (Make contact is still closed, Break contact is still opened) when the coil voltage is decreased.

(9) Release voltage

Maximum voltage required to change the state of all contact (Make contacts: ON to OFF, Break contacts: OFF to ON). Must release voltage is the minimum specified value to release the contact.

7.2 TERMS RELATED TO CONTACT

(1) Contact resistance

Resistance through closed contacts. This is the sum of the contact resistance and conductor resistance. The maximum initial value (on delivery) is usually set forth on the catalog.

Generally in case of Ag alloy contact material, the smaller measurement current makes the measurement value unstable. 7 A is used for measurement on EM Devices' standard method.

(2) Maximum switching voltage

Maximum voltage switchable with relay contact. The peak value is indicated in the catalog under DC load.

NEXEM's miniature power relays are generally 16 VDC.

(3) Maximum switching current

Maximum current switchable with relay contact. It is described by the peak value.

(4) Maximum switching power

Maximum load power switchable with relay contact.

(5) Maximum carrying current

Maximum current that can flow between contacts when the contacts are closed. The value depends on duration time and ambient temperature.

(6) Minimum switching power

Minimum load power through relay contact necessary for normal operation. It is expressed as the minimum values of voltage and current.

(7) Inrush current

Large current that flow instantaneously after contact is closed in case of a tungsten lamp, motor, solenoid and capacitor. It will become several times to ten-odd times of steady current.

7.3 TERMS RELATED TO OTHER CHARACTERISTICS

(1) Operate time

Time required to change the state of all contact (Make contacts: OFF to ON, Break contacts: ON to OFF) after voltage (control input) has been applied to coil.

(2) Release time

Time required to change the state of all contact (Make contacts: ON to OFF, Break contacts: OFF to ON) after the coil has been de-energized.

(3) Bounce (Contact bounce)

Transitional, intermittent opening and closing phenomenon of contacts that is caused by shock or vibration at operation or release. The shock or vibration is generated by impact of the armature and core or back stop or the movable contact and the stationary contact.

(4) Insulation resistance

Resistance between two parts electrically independent of each other, such as between the contact and coil. Usually, this specifies the insulation resistances between the coil and contact terminals between open contact terminals, and between adjacent contact terminals (if the relay has two or more contacts pairs).

In addition, the insulation resistance between the terminals of the contacts that are open in the operate state is also specified. Minimum value is also specified.

(5) Breakdown voltage

Threshold value at which breakdown does not occur when AC voltage is applied between terminals. This is similar to insulation resistance. Usually, the breakdown voltage is tested for 1 minute and the current value that defines breakdown is 1 mA. The minimum value is specified.

(6) Shock resistivity

Threshold value to shock from the outside. Half sine wave pulsating mechanical shock is applied to the relay during evaluation.

Destructive failure: Threshold limit value which does not ruin characteristic or function of relay.

Misoperation: Threshold limit value which does not cause instantaneous contact or interruption of relay contacts.

(7) Vibration resistivity

Threshold value to vibration from the outside. Sine wave mechanical vibration is applied to the relay during evaluation.

Destructive failure: Threshold limit value is the value that dose not offect or damege the relay's characteristics and function.

Misoperation: Threshold limit value which does not cause instantaneous contact or interruption of relay contacts

(8) Mechanical life

Running performance without contact load under the conditions that the nominal coil voltage is applied. The relay is operated at the rated operating frequency.

(9) Electrical life

Running performance with certain contact load under the conditions that the nominal coil voltage is applied. The relay is operated at the rated operating frequency.

(10) Operating temperature range

Temperature range in which the steady performances of the relay can be expected. However, the situation when the relay freezes is excluded. The coil resistance, operate voltage, release voltage, maximum applying coil voltage and carrying load current etc. depends on ambient temperature.

8. APPLICATIONS

Main automotive applications are shown in Table-3.

Table-3 Automotive applications

Application	Current (A)	EM1	EL1	EP1K	EP1 EP2	ET1 ET2	EX1 EX2	EU1 EU2
Horn	3 – 20				Y	Y	Y	Y
Mirror	3				Y	Y	Y	Y
Door locks	~25				Y	Y	Y	Y
Window	~25				Y	Y	Y	Y
Sunroof	~25				Y	Y	Y	Y
Wiper (Front, Rear)	~25		Y	Y	Y	Y(Rear)	Y(Rear)	
Washer pump	5 – 25	Y	Y	Y	Y	Y	Y	Y
Fuel pump	5 – 30	Y	Y	Y	(Y)*			
Starter solenoid	5 – 30	Y	Y	Y	(Y)*			
HVAC fan	10 – 30	Y	Y	Y	(Y)*			
DC/DC Converter	10 – 30		Y	Y				
Engine fan	30 – 120	Y	Y	Y				
Heater	5 – 20	Y	Y	Y	(Y)*			
Diurnal beam	5 – 40	Y						
High/low beam	5 – 80	Y						
Power outlet	5 – 120	Y						
APC	5 – 120	Y						

* R type is available.

Though durability life is about 100,000 cycles in general, real performance changes depending on conditions. Confirm the ability by real use conditions before the adoption.

The information in this document is based on documents issued in April, 2019. The information is subject to change without notice. For actual design-in refer to the latest publications of data sheets, etc., for the most up-dated specifications of the device.

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EM Devices products are classified into three quality grades: Standard, Special, and Specific.
The Specific quality grade applies only to devices that are developed based on a customer designated Quality Assurance program for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade for each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots
Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control system, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)
Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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