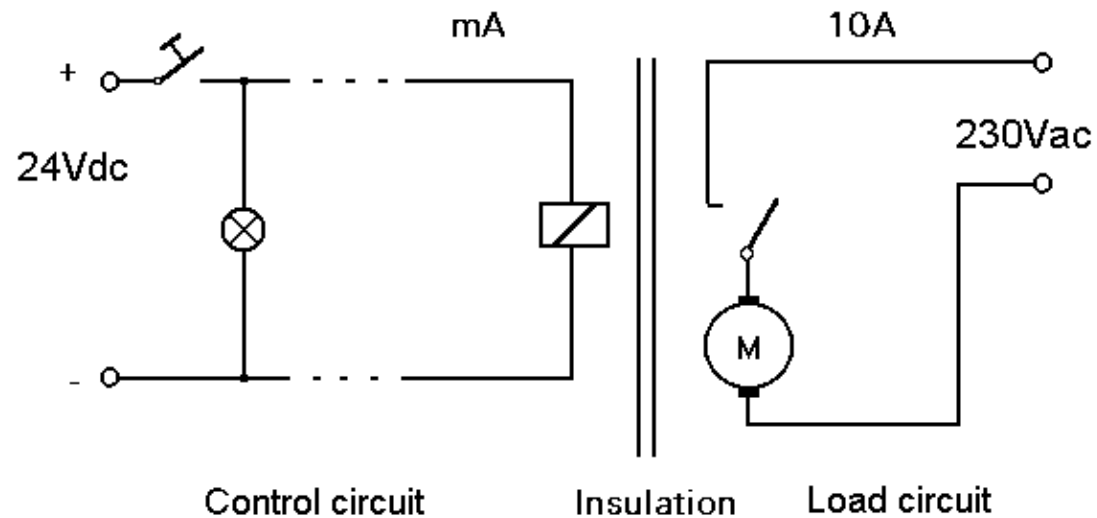


## Schematic Application Sketch

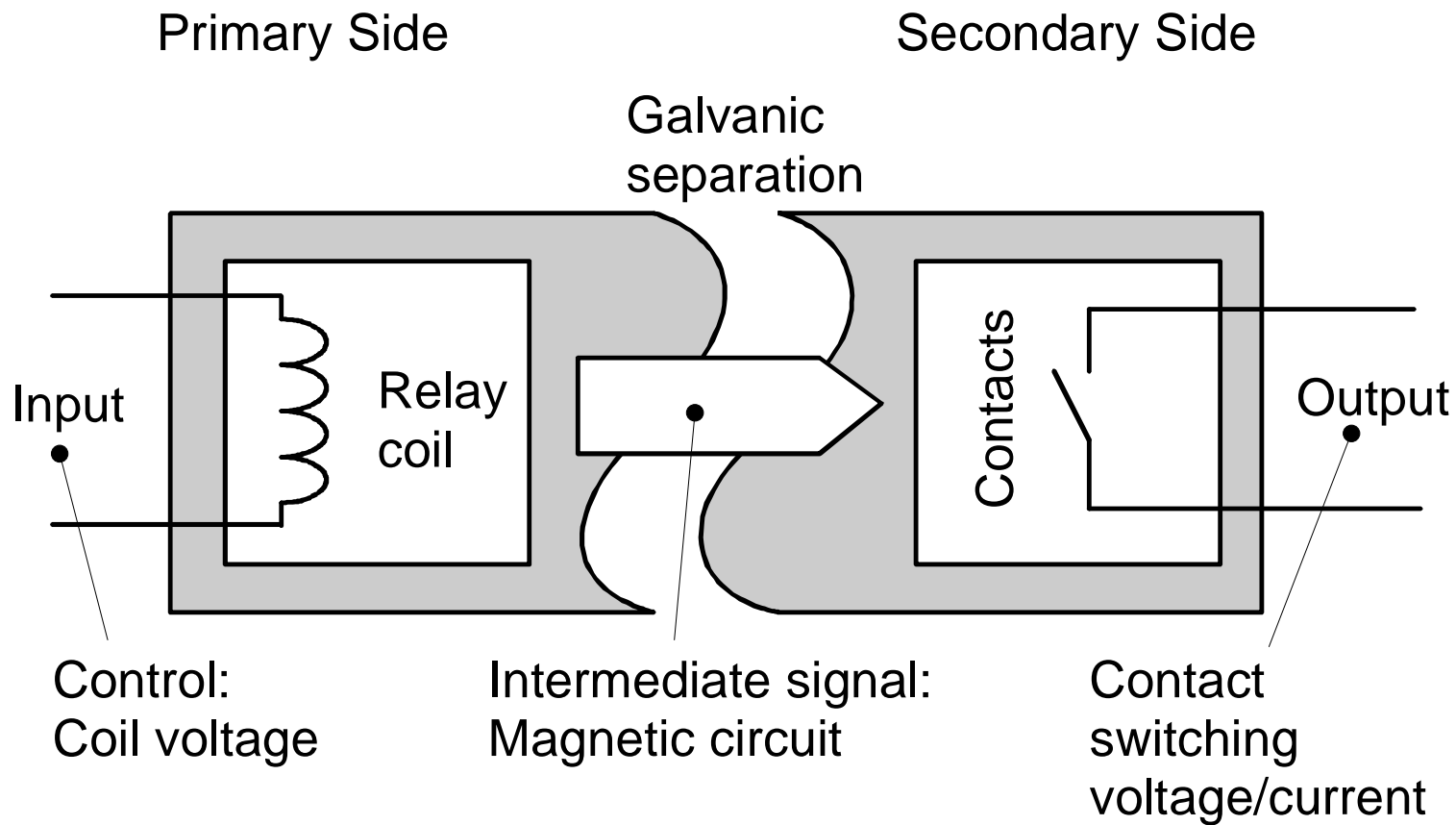
- Electrical controlled switch
- Controlling of heavy load with low control energy
- Galvanic separation between control and load circuit



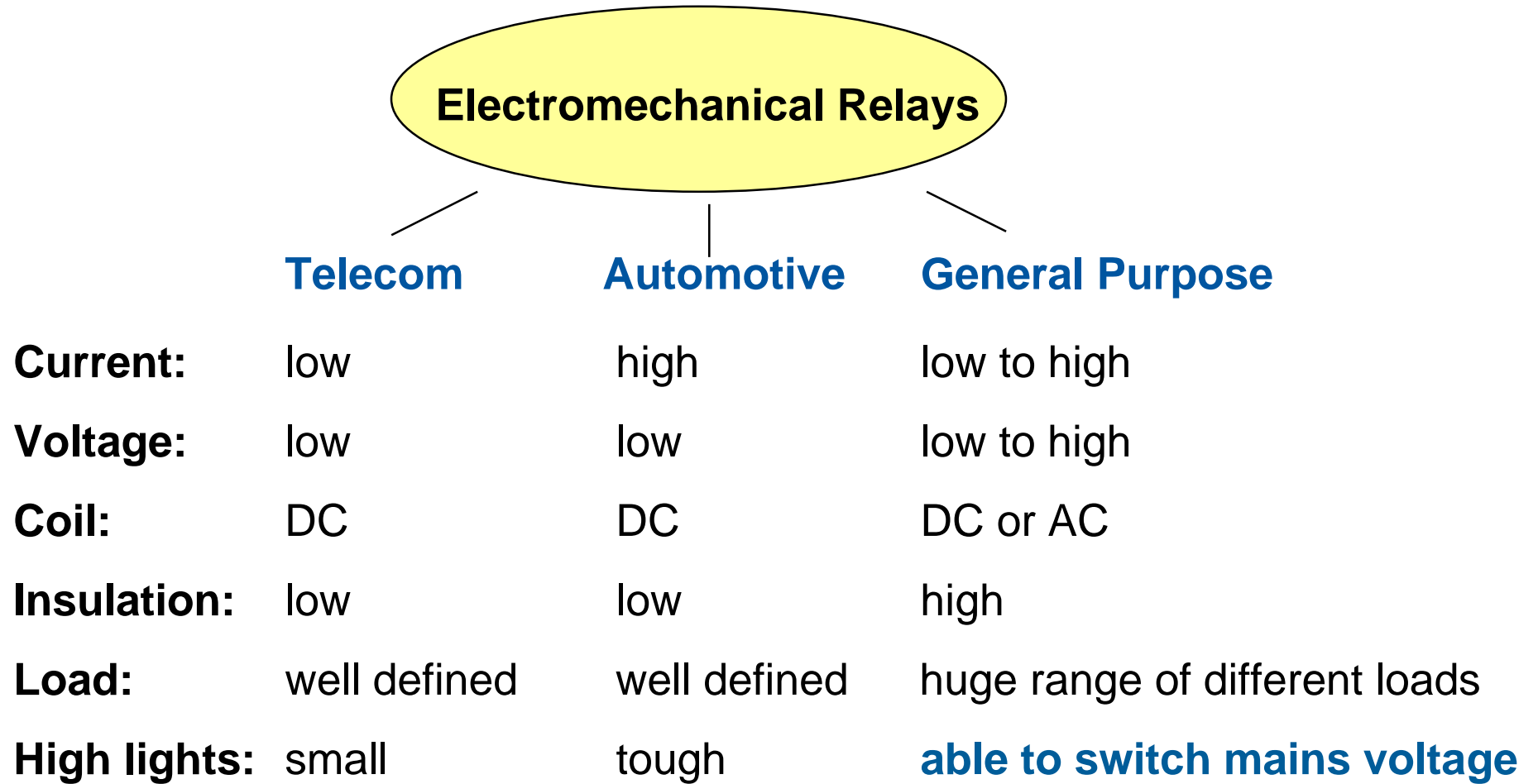
# Technical Requirements

	<b>Purpose</b>	<b>Aspects</b>	<b>Realised by</b>
The main function...	Control of electrical energy	Contact number and dimensions	<b>Contacts</b>
The need...	A "motor" to operate with the control signal	Voltage DC / AC	<b>Coil</b>
The consequence...	Separation of control and load	Protection class creepage/clearance	<b>Insulation</b>
The interface...	Electrical connection	PCB, Plug in	<b>Pin configuration</b>
The conditions...	Adaptation to surrounding	Space, packing, ambient temperature	<b>Dimensions</b>

# Block Diagram



# Application Areas



# Typical Application Area

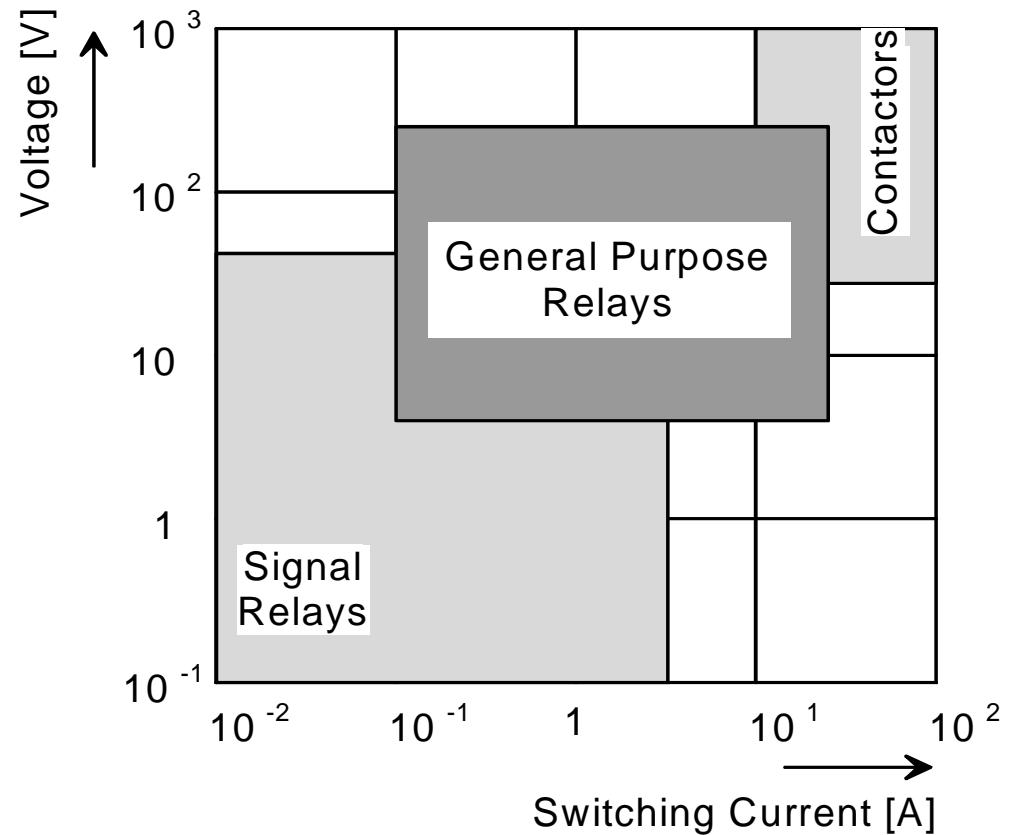
## General Purpose Relays:

Load range:

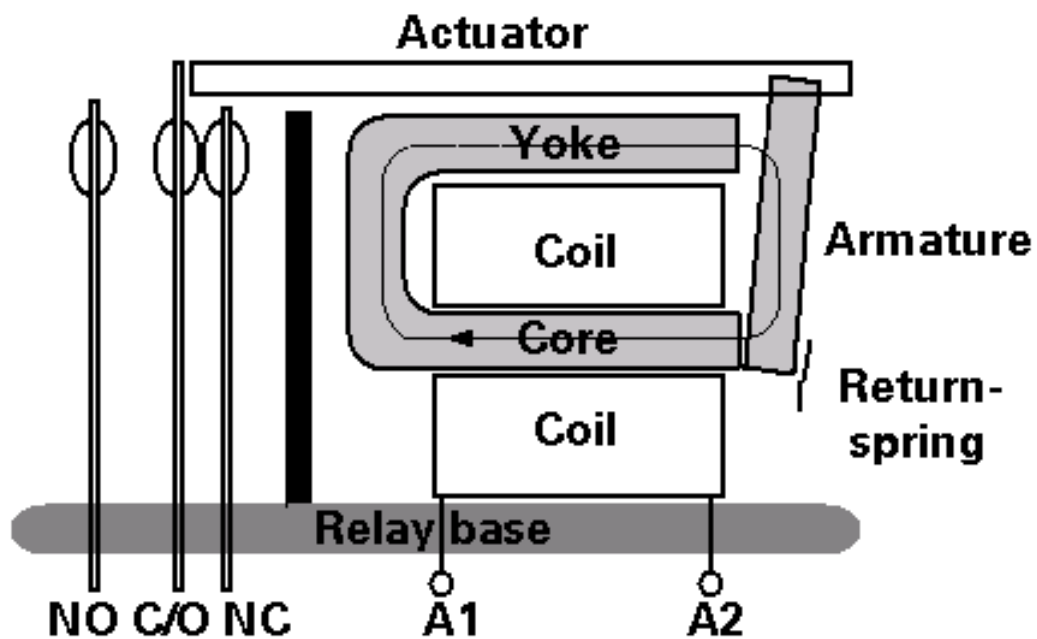
5V DC ... 300V DC

5V AC ... 230 / 400V AC

0.1A ... 30A

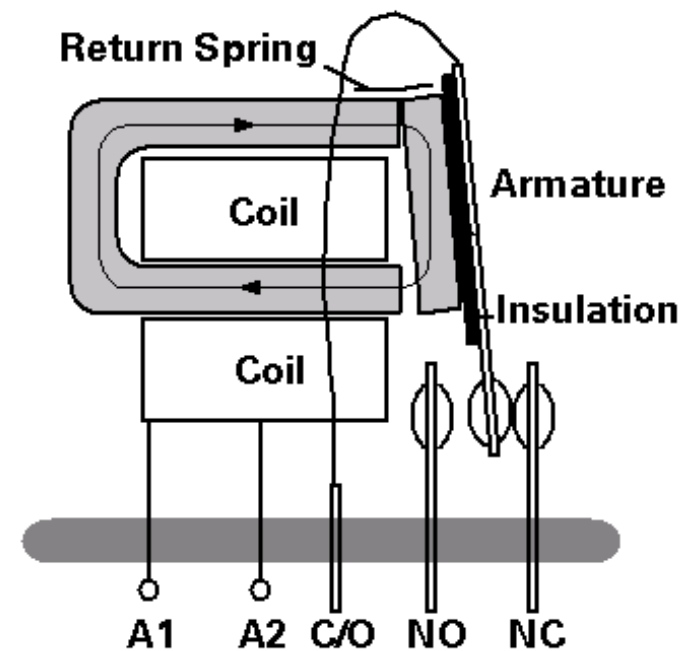


# Principal Designs



Method of connection:

**PCB**



Plug in (need a socket) or

**PCB**

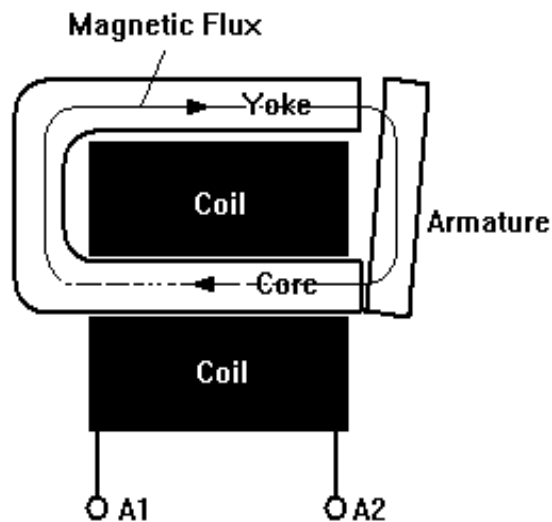
# Magnetic Systems - Coils

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DC-systems		AC-systems
monostable	bistable	

# DC - Relay Systems

## Monostable Relays



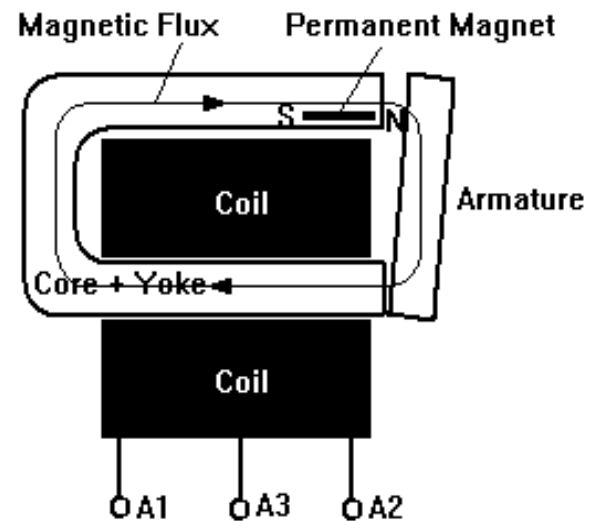
one coil

operated UA1-A2 = U<sub>in</sub>

released UA1-A2 = 0V

low power consumption 0.2 - 0.7W

## Bistable Relays



one or two coils

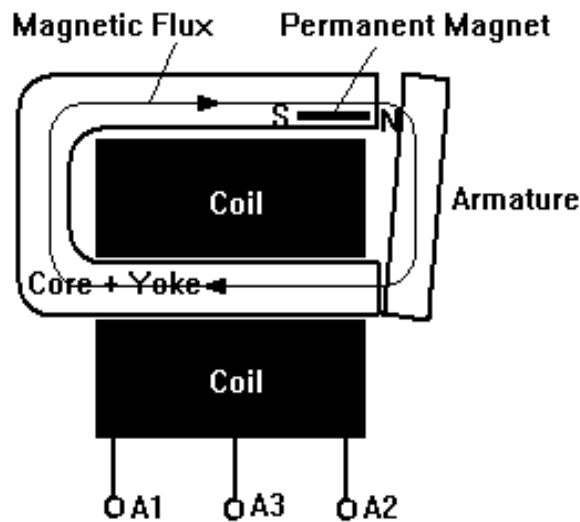
SET: UA2 (-) / A3 (+)

RESET: UA1(-) / A3 (+)

Hold by permanent magnet or remanent core

# DC - Bistable Relay Systems

## Bistable Polarized Relays



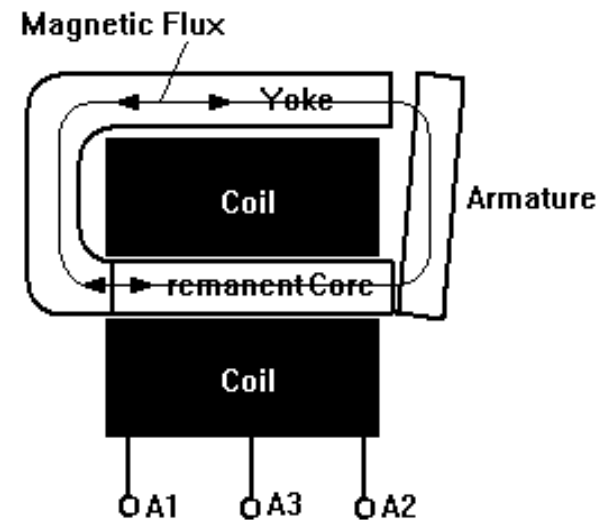
one or two coils

SET: UA2 (-) / A3 (+)

RESET: UA1 (-) / A3 (+)

low power consumption approx.0.4W

## Bistable Remanent Relays



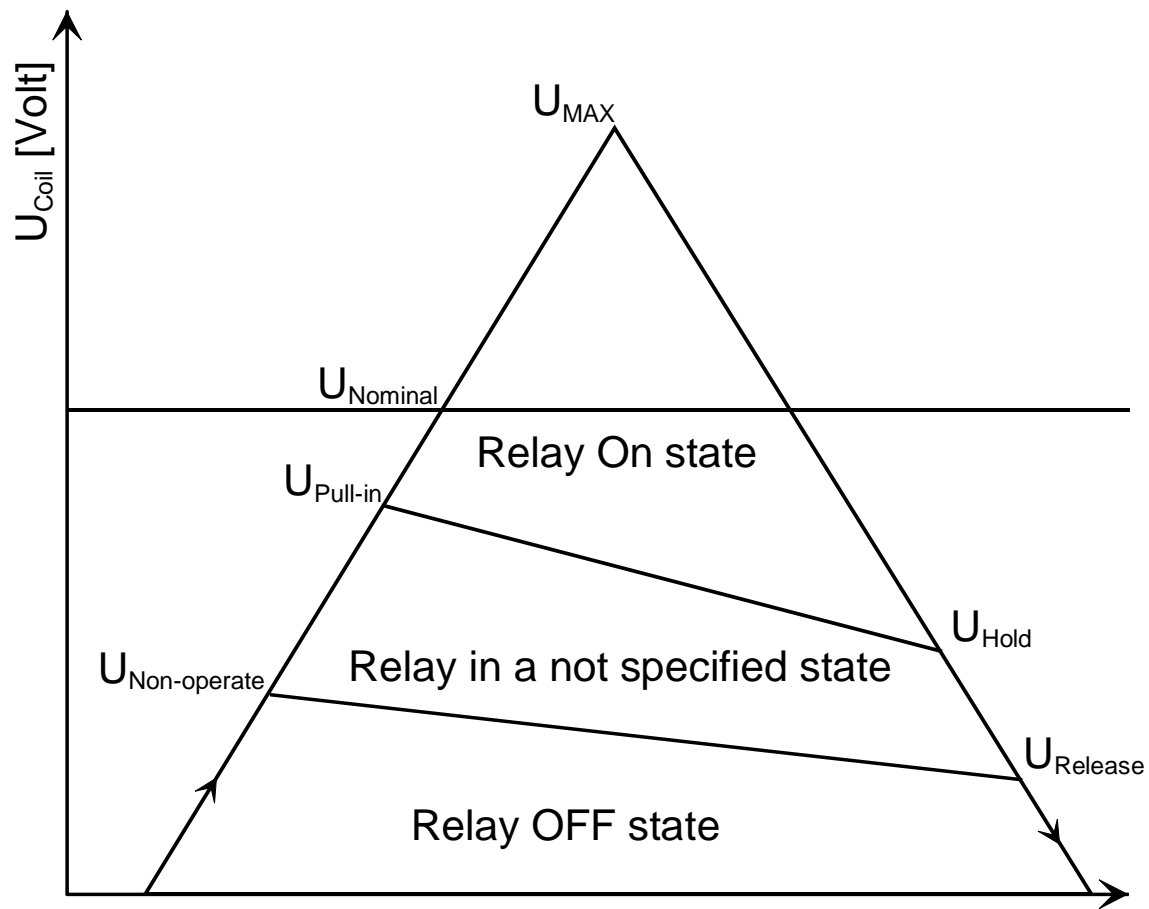
one or two coils

SET: UA2 / A3 (+/-/+)

RESET: UA1 / A3 (-+/-+)

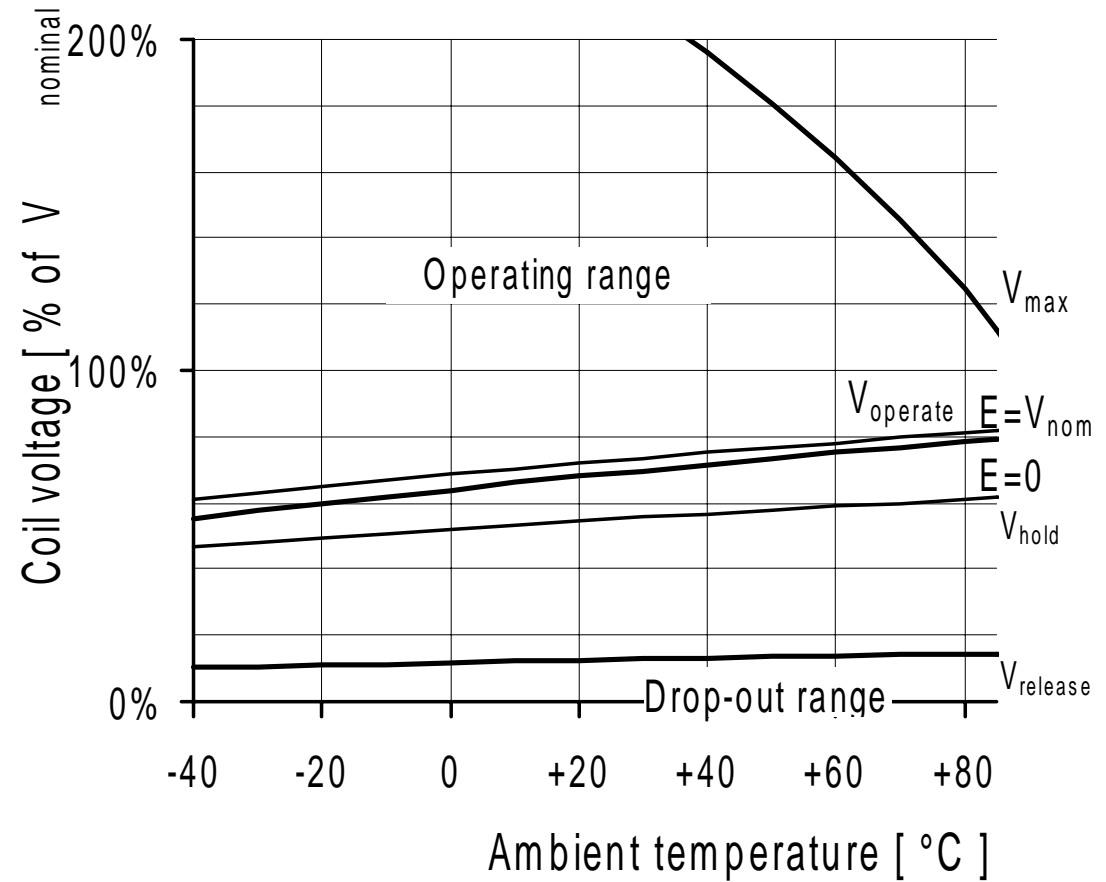
high power consumption 1.2W

# Operating Voltages -Terms



# Coil Operating Range

Voltage range depends on ambient temperature



# Electrical Contact, Designation

Contact Number	Designation	D	GB	USA	Symbol
Single Pole	Make Contact Normally Open Contact (N/O) Schließer	1	A	SPST-NO	
	Break Contact Normally Closed Contact (N/C) Öffner	2	B	SP	
	Changeover Contact (C/O) Double Throw Wechsler	21	C	C/O or SPDT	
	Double Make Brückenschließer (D/M)		X	SPST-NO DM	
Double Pole	Make Contact Normally Open Contact (2N/O) Schließer		2A	2SPST-NO	
	All other configuration like 1pole possible				

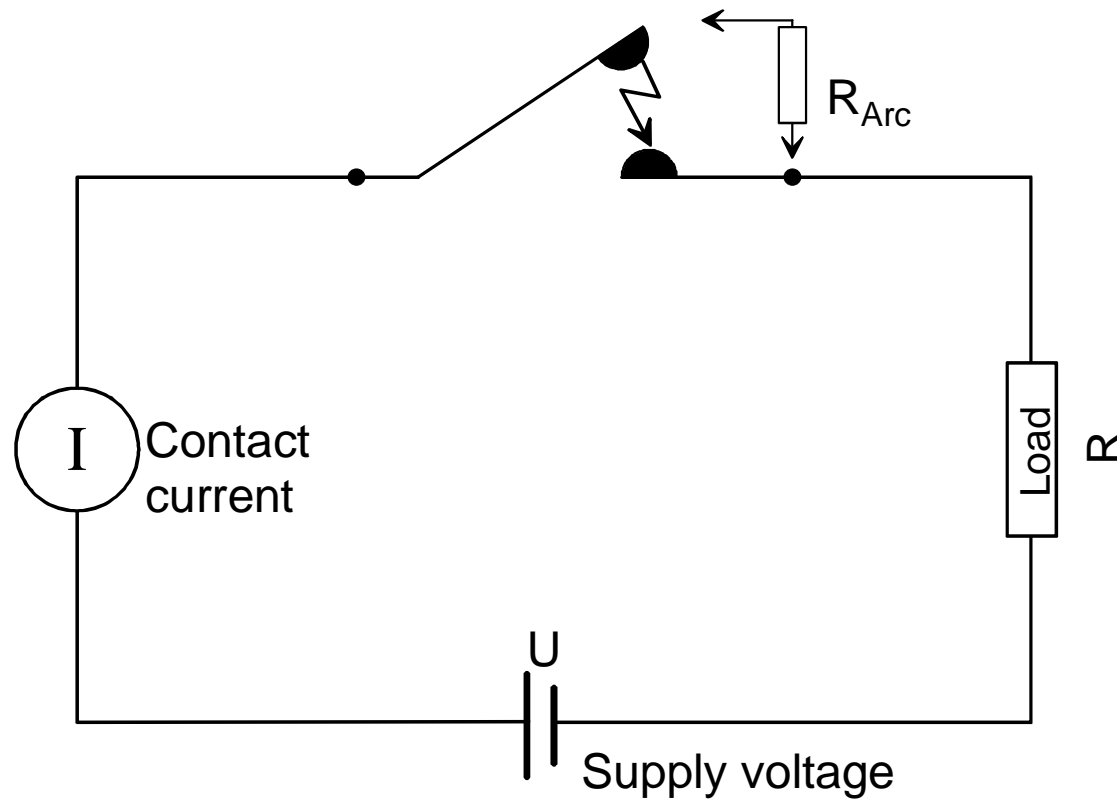
## Influences on Electrical Contact

Influences	Parameters	Effect
electrical	<ul style="list-style-type: none"> <li>• current</li> <li>• voltage</li> </ul>	heating, melting, material migration, chemical reactions, fritting, electrical discharge, contact resistance
thermal	<ul style="list-style-type: none"> <li>• arc</li> </ul>	melting of contact material, material migration
mechanical	<ul style="list-style-type: none"> <li>• friction</li> <li>• pressure</li> </ul>	deformation, wear, cold welding, contact resistance
ambient conditions	<ul style="list-style-type: none"> <li>• dust</li> <li>• gases</li> </ul>	increased wear, particles, formation of chemical layers an corrosion
chemical	<ul style="list-style-type: none"> <li>• oxidation</li> </ul>	contact resistance, inorganic and organic layers, corrosion

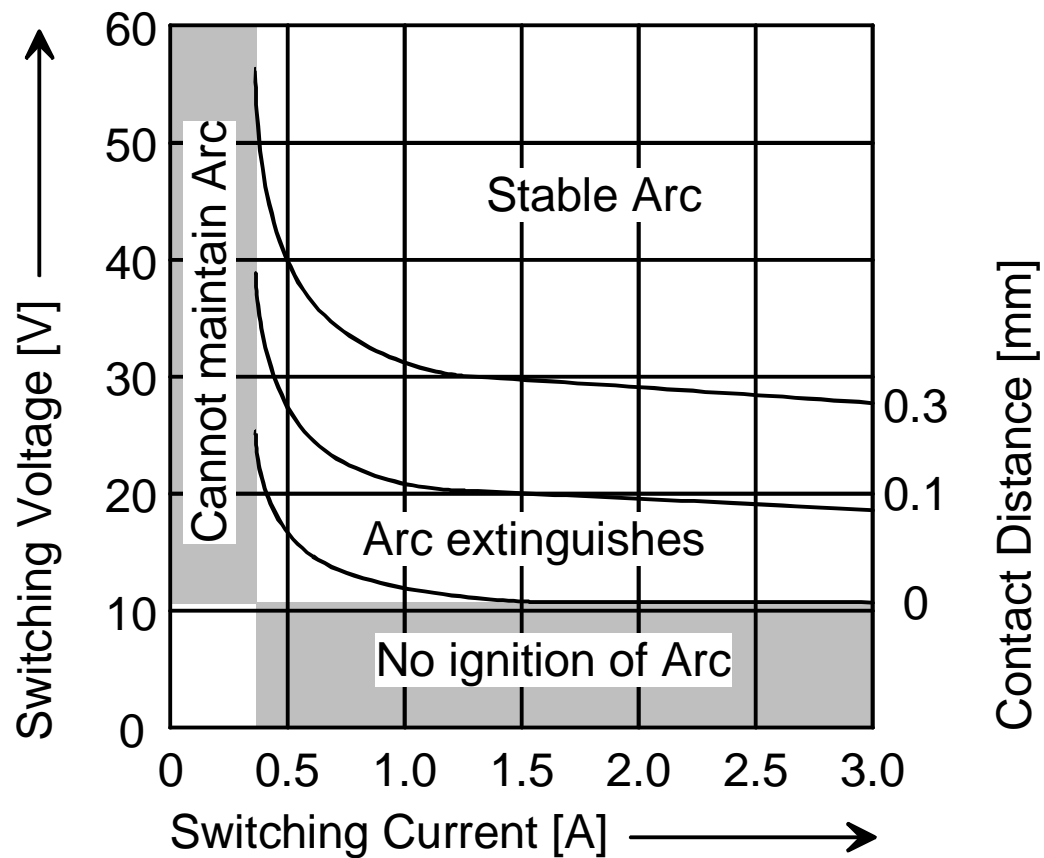
## Influences on Switching Contact Depending on Load Range

Load range	Main influences	Contact material	Considerations
dry circuit <100mV, <10mA lowlevel switching <1V, <10mA	<ul style="list-style-type: none"> <li>• mechanical</li> <li>• chemical</li> </ul>	<ul style="list-style-type: none"> <li>• gold plated materials</li> </ul>	contact resistance, sealed relays, wipe movement, twin contacts, outgas free and wear resistance plastic material
intermediate level <15V, <300mA	<ul style="list-style-type: none"> <li>• mechanical</li> <li>• chemical</li> <li>• electrical</li> </ul>	<ul style="list-style-type: none"> <li>• AgNi 0.15</li> <li>• AgNi 10</li> <li>• (AgSnO<sub>2</sub>)</li> <li>• (AgCdO)</li> </ul>	sealed relays, fritting, material transfer, contact resistance, outgassing
power contacts 10-400V 300mA-30A	<ul style="list-style-type: none"> <li>• chemical</li> <li>• electrical</li> </ul>	<ul style="list-style-type: none"> <li>• AgNi 0.15</li> <li>• AgNi 10</li> <li>• AgSnO<sub>2</sub></li> <li>• AgCdO</li> </ul>	electrical life, contact welding, electrical wear, high temperatures, isolation properties, corrosion for sealed relays

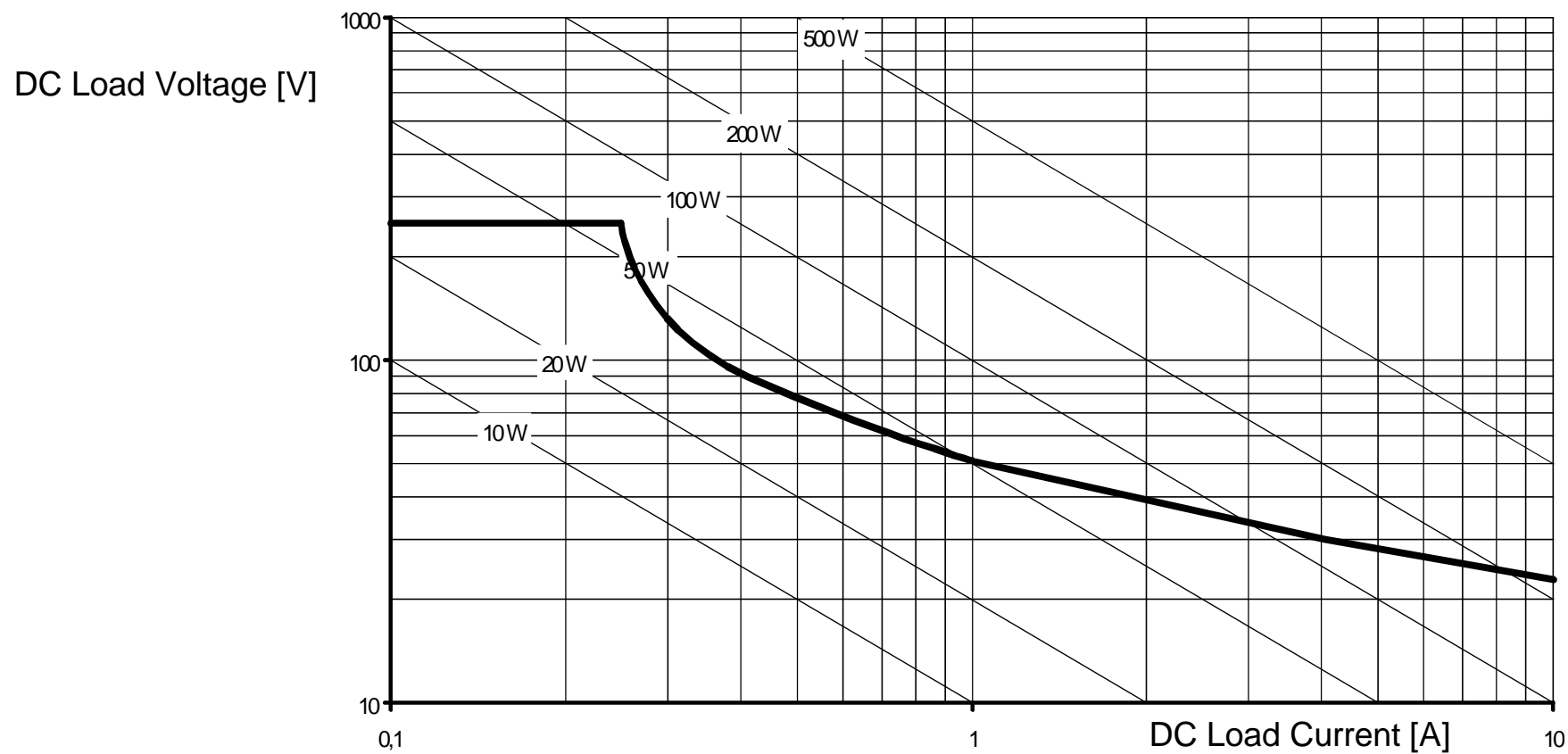
# Electrical Arc



# Electrical Arc - Effects with Ag Contacts



# DC Breaking Capacity



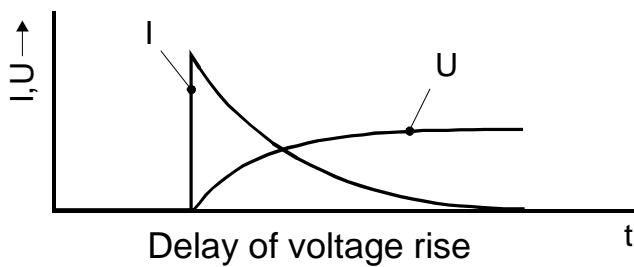
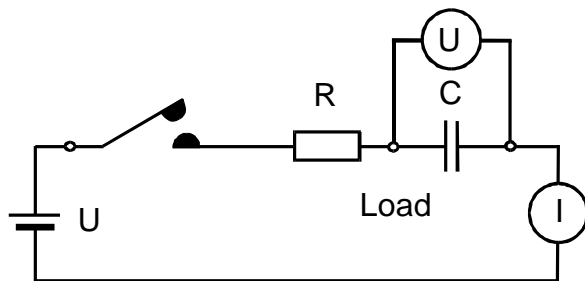
## Typical Loads for General Purpose Relays

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- Cooking plates, oven heatings
- Heatings, valves and motors in washing machines and dish washers
- Compressor motors for refrigerator or air condition
- Valves, ignition transformers, pumps in oil or gas heating systems
- Building control: several lamp loads, elevators, rolling shutters

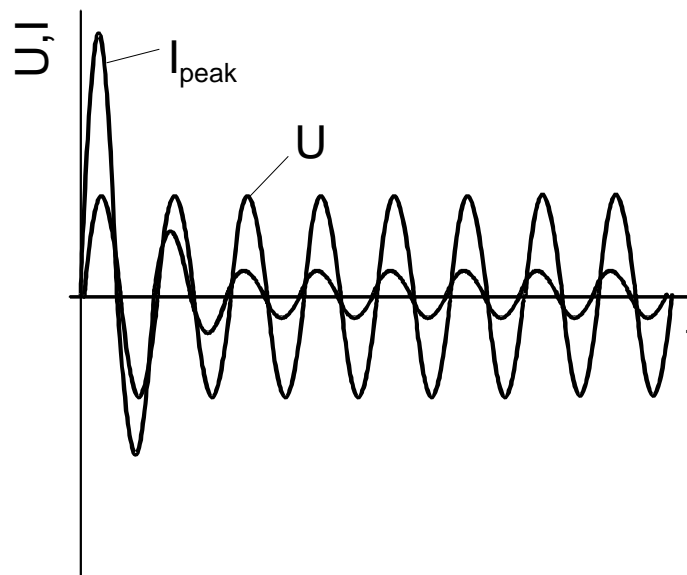
# Capacitive Load

## Capacitive DC-Load



$$I = \frac{U}{R} e^{-t/\tau} \quad \tau = RC \text{ rise time in ms}$$

## Capacitive AC-Loads



### Preferred contact material:

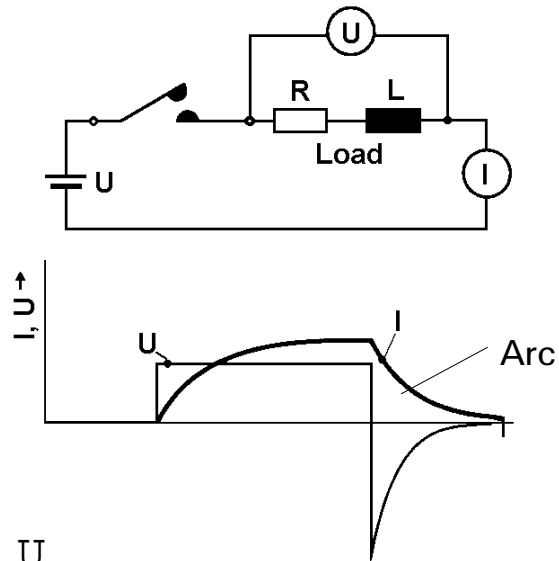
DC-Loads AgSnO, AgNi90/10

AC-Loads AgSnO, AgNi90/10

# Inductive Load

## Inductive DC-Loads

Delay of current rise

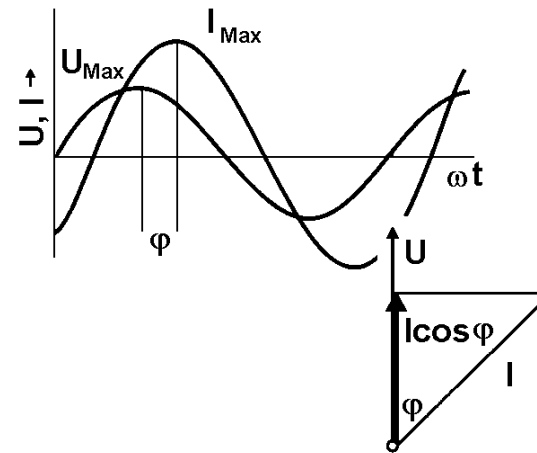


$$I = \frac{U}{R (1 - e^{-t/T})}$$

$$\tau = \frac{L}{R} \quad \text{rise time in ms}$$

## Inductive AC-Loads

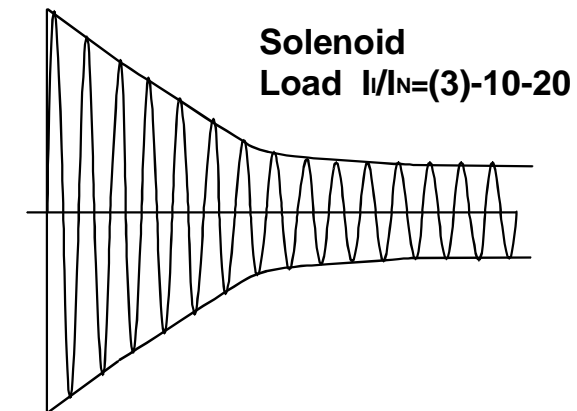
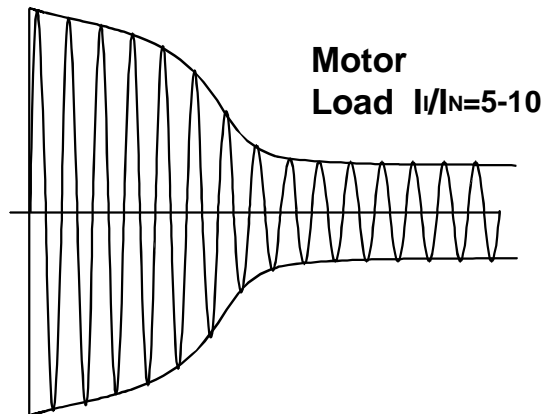
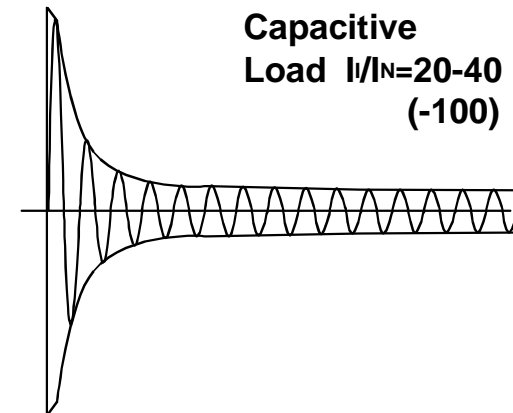
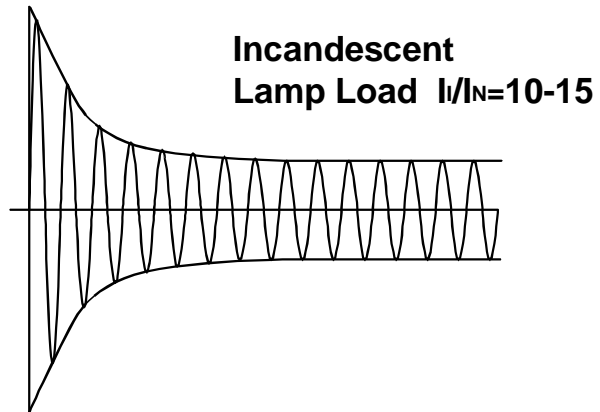
Phase Shift



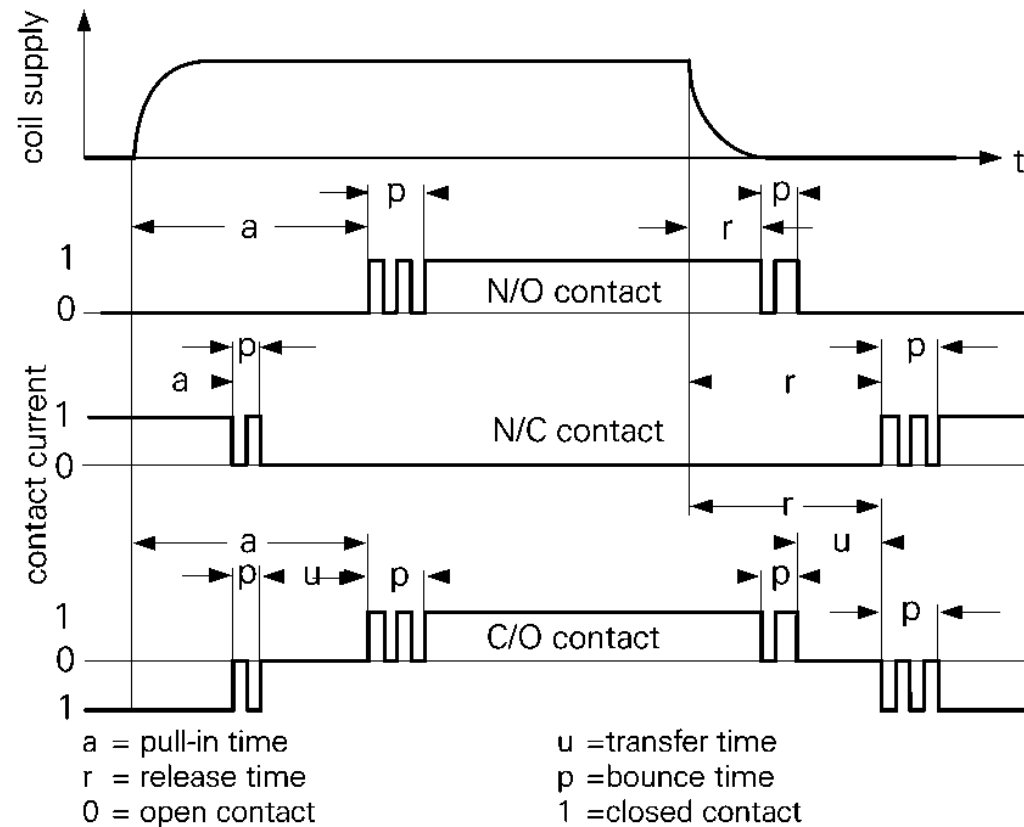
### Preferred contact material:

DC-Loads AgNi, (AgSnO)  
 AC-Loads AgCdO, AgSnO

# Load Characteristics



# Relay Switching Behaviour



S0342-A

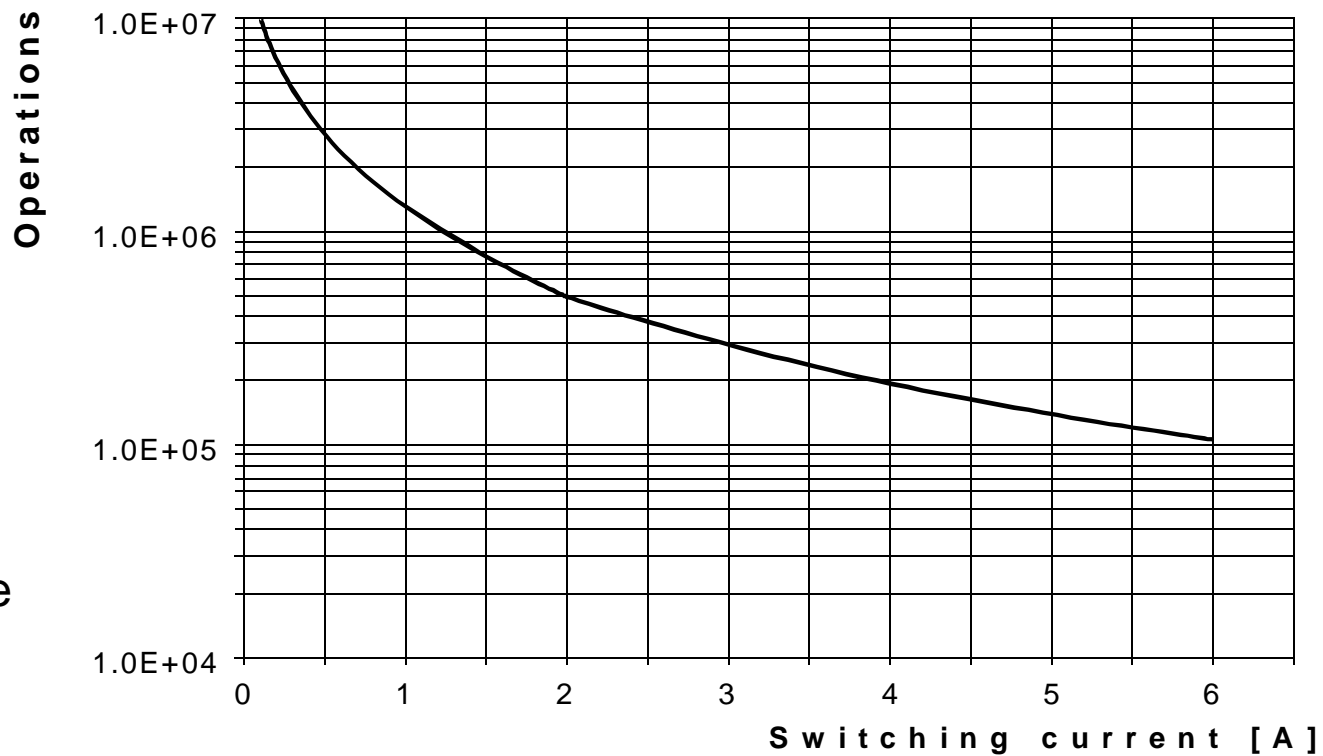
# Contact Lifetime

## Main influences:

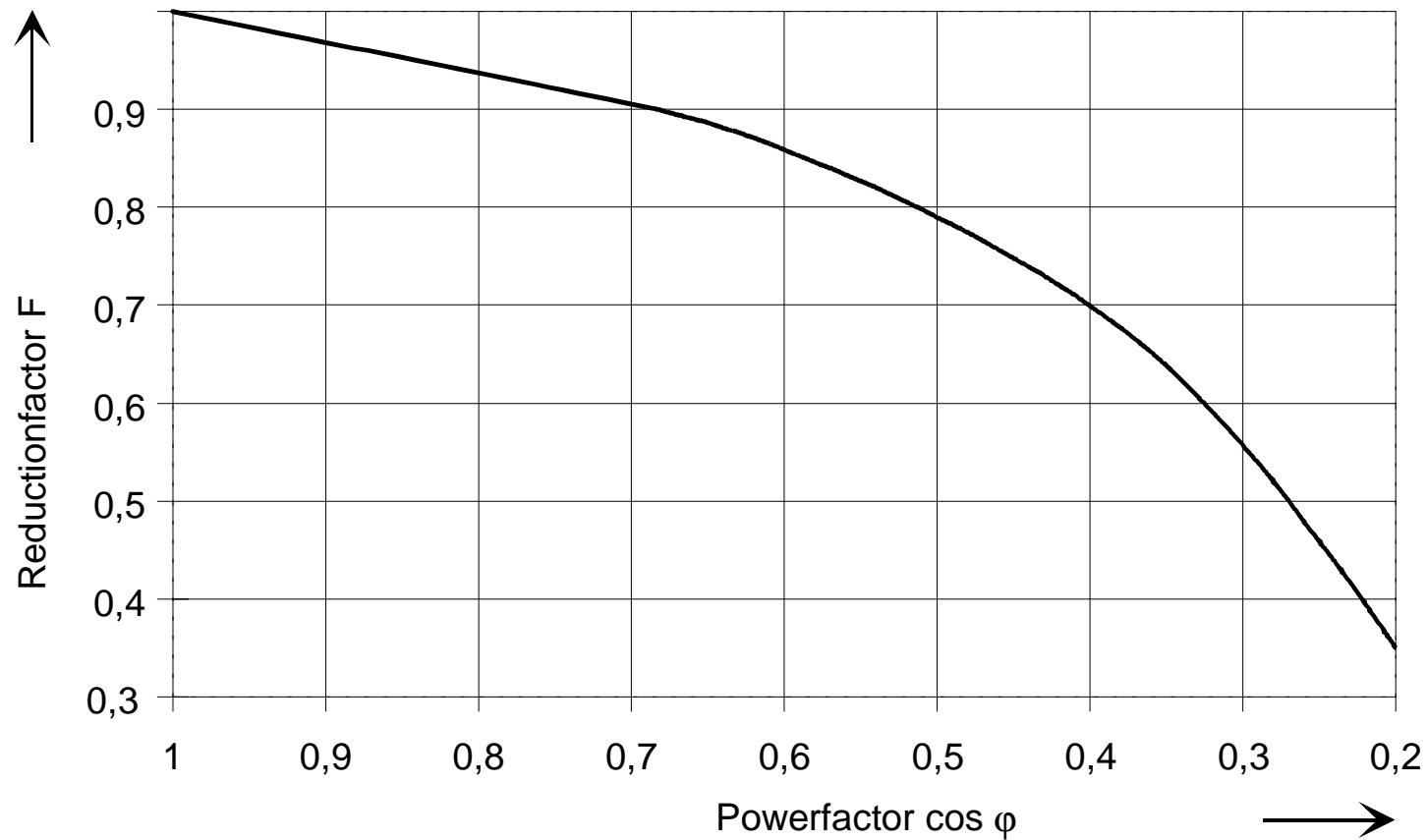
- Switching current

## Parameter:

- Load voltage
- Inrush current
- Power factor
- Ambient temperature
- Switching cycle



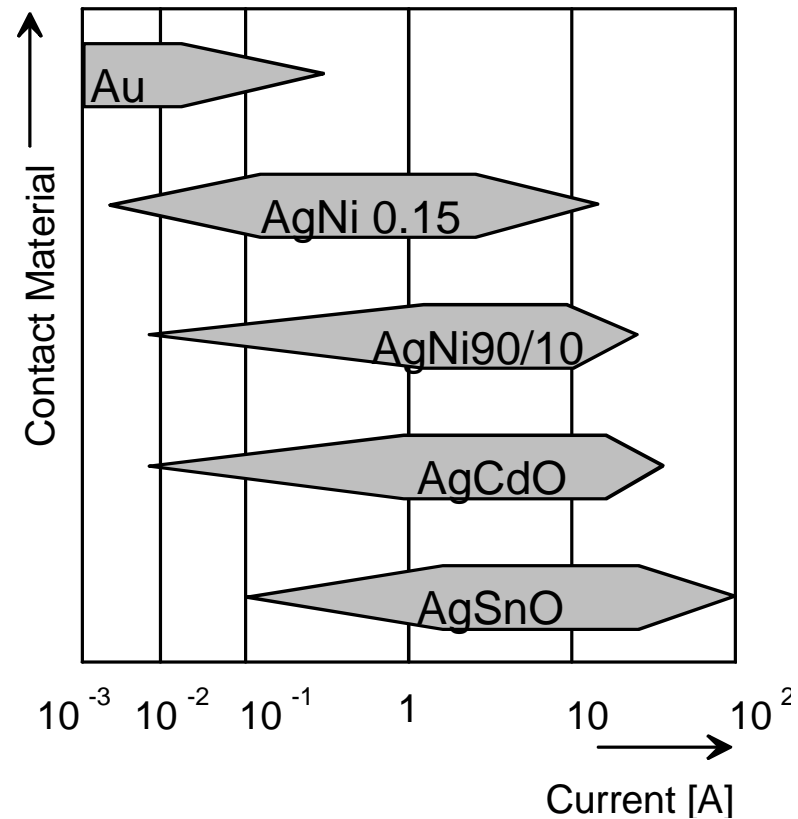
## Reduction of Lifetime at inductive AC-Loads



# Range of Application for Different Contact-Materials

Application range of different contact materials overlaps

Choice of contact material is optimized according to relay construction



## Strength of Contact-Materials

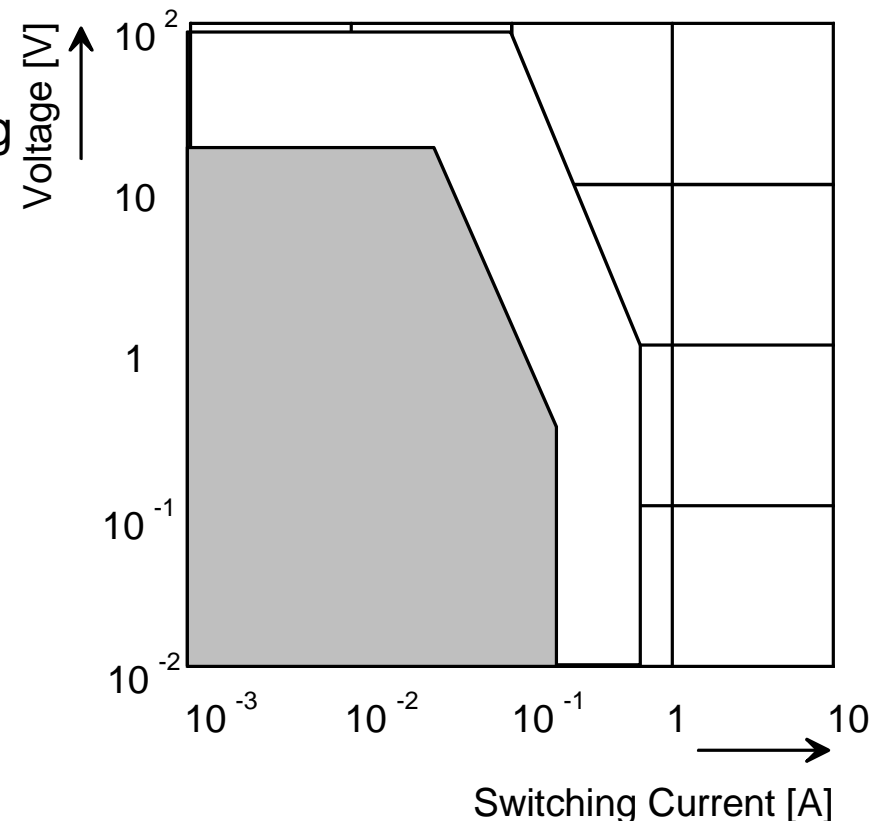
Load Character	AgNi0,15	AgNi 90/10	AgCdO	AgSnO2
DC resistiv	++	+		
DC-inrush				++
DC-inductiv	++	+		
DC / AC-low level	++	+		
AC-medium	+	+	++	+
AC-heavy		+	++	+
AC-inrush				++
AC-inductiv		+	++	+
Enviromental aspects	0	0	--	0

# Application Range Silver Alloy Gold Plated

- Suitable for low level loads
- Limited use at main loads according base contact material

**Grey range:**  
No electrical wear

**White range:**  
Permanence of gold plating depends on number of operations



## Insulation Terms and Classification

Insulation characteristic	Purpose
<ul style="list-style-type: none"> <li>• Basic insulation</li> </ul>	<p>Insulation for :</p> <ul style="list-style-type: none"> <li>• Contact-contact in one circuit</li> <li>• Insulation between different contact circuits</li> </ul> <p>Insulation Class 0 and Class 1 between :</p> <ul style="list-style-type: none"> <li>• - Control and load circuit</li> </ul>
<ul style="list-style-type: none"> <li>• Supplementary insulation together with basic insulation</li> <li>• Double insulation</li> <li>• Reinforced insulation</li> </ul>	<p>Insulation Class II for :</p> <ul style="list-style-type: none"> <li>• Protection against electrical shock</li> <li>• Safe separation of load and control circuit at safety extra low voltage</li> </ul>

## Insulation Terms and Classification

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Contact behaviour	Purpose
Relays with micro contact gap	Switching of load, under insulation aspects the load circuit is to see like closed
Air-gap relay, cut-off relay (3mm contact gap)	For separation of load and voltage supply
Safety relays	Defined behaviour in case of failure

# Insulation Requirements

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Insulation is determined by application standards and depends on

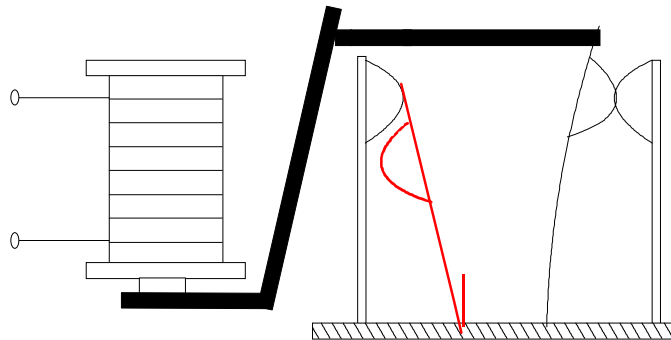
- Length of clearance
- Length of creepage
- Material data (CTI = Comparative Tracking Index)
- Environmental influence / pollution degree
- Control and load voltages

# Safety Relays

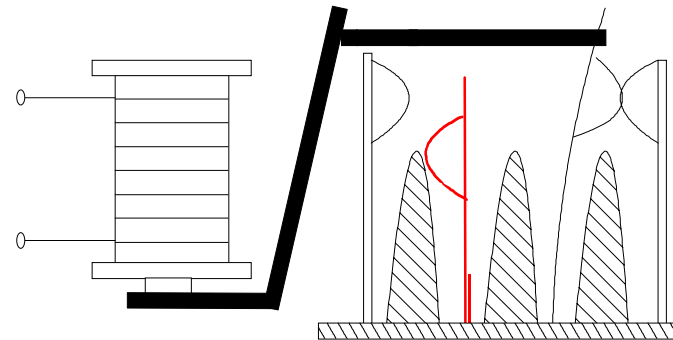
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N.O. and N.C. contacts shall not close at the same time also when a spring breaks

„Normal“ relay



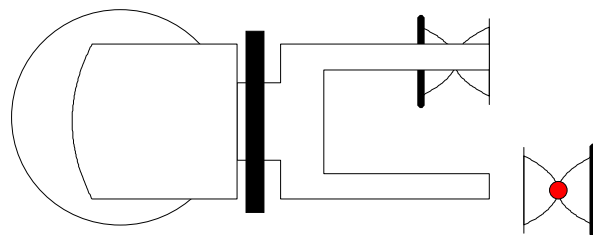
Safety relay



# Safety Relays

N.O. and N.C. contacts shall not close at the same time when N.O. is welded

„Normal“ relay



Safety relay

