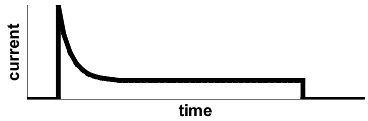
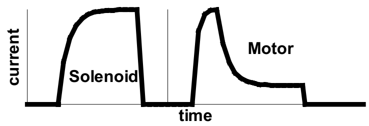
Automotive Applications

Typical Automotive Applications

Load	Application examples	Typical current curve
Resistive Loads	- Heatings (rear window heating, seat heating glow plug, air/water preheating)	
Capacitive Loads	- Lamps (front and rear beam, fog lights, flasher) - Filter capacitors in electronic modules (engine management module, ABS module)	
Inductive Loads	- Solenoids (vales, clutches, relay coils) - Motors and pumps (power window, central lock, cooling fan)	

Introduction

The range of applications can be classified into resistive loads, capacitive loads and inductive loads. The current curve of resistive loads is specified by the load voltage and load resistance. Capacitive loads have a high inrush current and a low steady current. Therefore lamps are counted to the capacitive loads, because the cold filament has a significantly lower resistance, than the hot filament. Inductive loads are characterized by an exponential current increase and a remarkable switch off arc, induced by the demagnetization of the magnetic circuit of the load. Power supply relays (clamp relays) can switch or feed a mixture of different loads.

The circuit design of resistive and capacitive loads is usually a simple switch on and switch off. Motor load circuits are often more complex. The most typical circuits are described hereafter.

Short-Circuit Brake

The short-circuit brake is used, wherever an electric motor must be braked (e.g. wiper). The short-circuit brake transforms the rotational energy of the motor into electrical energy. The short-circuit brake can be critical at higher load voltages. If the switch-off arc does not extinguish during the transition time of the movable contact, the arc creates a direct shortage of the power source. Particularly in 24VDC systems, the resulting extremely high arc current could cause almost instantly severe damage to the contacts and could destroy the entire relay.

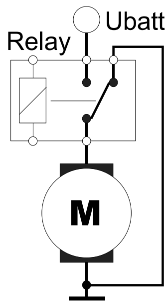


Fig. 1 Short-circuit brake

Motor-Reverse Circuit (H-Bridge)

The H-bridge is used to operate a motor in two directions (e.g. door lock, steering lock, power window, seat adjustment, etc.). The operation time is typically very short compared to the thermal time constant of the relay (e.g. door lock <1s, power window <10s). This means, H-bridge relays must be designed for high current-switching-capability, but not for high current-carrying-capability. Higher load voltages can be critical, due to possible short-circuit-arcs (see also short-circuit brake).

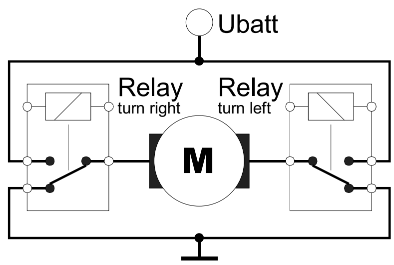


Fig. 2 H-bridge

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Wiper Circuits

To stop the wiper in the correct position, a short-circuit brake is used. This can be done either by an internal slipring (usually used for rear wiper) or with the normally closed contact of the relay (usually used for front wiper). This requires a high switching capability of the N/C-contact, especially in combination with intermittent wipe function or rain sensor control. Dual speed wipers have two windings, which are commuted by a second relay. There are also wiper systems without mechanical gear, which are electrically reversed with a H-bridge circuit.

Cooling Fan Circuits

Depending on the size of the engine, either one or two fans are used to cool the engine. There are different possibilities to control the speed of the fans. Single fan systems are usually controlled by one or more serial resistors. The disadvantage is the electrical power loss of the resistors. Double fan systems are normally controlled by switching them either in series (low speed) or in parallel (high speed). If more speed steps are needed, additional serial resistors are used. A more sophisticated method is a PWM-controlled brushless motor. In commercial vehicles the cooling fan is mostly driven directly by the motor shaft.

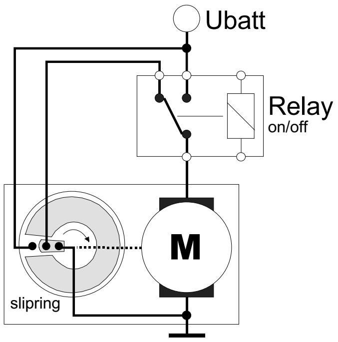

Fig. 3 Wiper with slipring

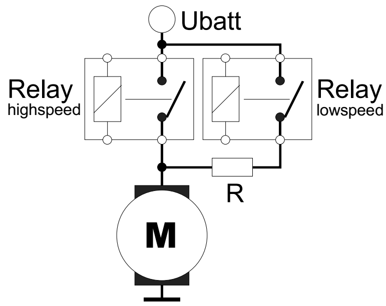

Fig. 5 Single fan circuit

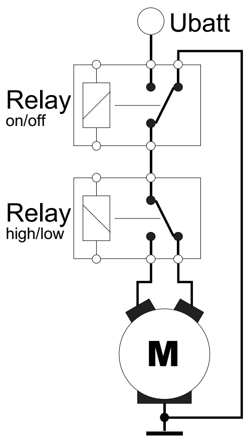

Fig. 4 Dual speed wiper-circuit

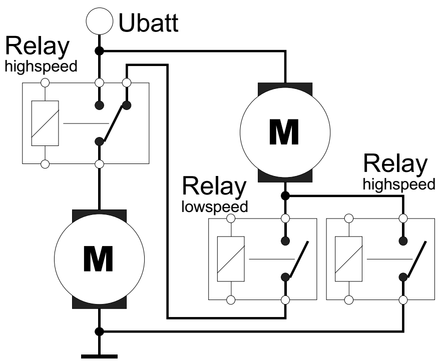

Fig. 6 Double fan circuit

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Coil Suppression Circuits

The disconnection of the relay coil generates a transient voltage peak, which is only limited by the parasitic inductivity and capacity of the electrical system. In most of the cases it is necessary to suppress the transient voltage peak to typically 60VDC – 100VDC for the protection of the relay driver or the vehicle electrical system. Any voltage suppression of the relay coil influences the dynamics of the electromechanical system and can reduce the lifetime.

The best protection method for the driver is a diode in parallel to the relay coil. But this method has the worst influence on lifetime of the relay. Typical suppression methods are a resistor in parallel to the coil (preferably as internal component in plug-in relays) or a Zener diode in parallel to the relay driver (preferably for PCB relays).

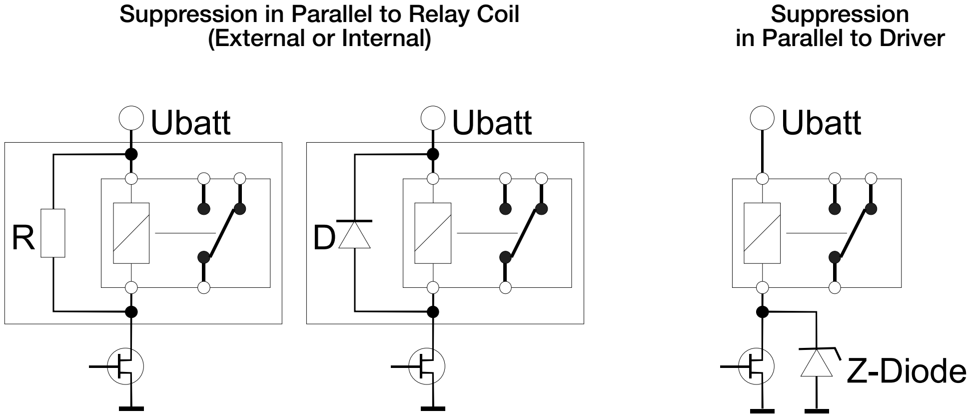

Fig. 7 Coil suppression circuits

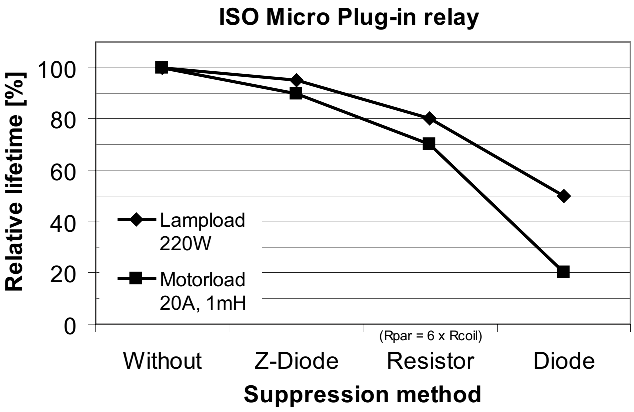

Fig. 8 Influence of coil suppression on the lifetime