Ballast circuit

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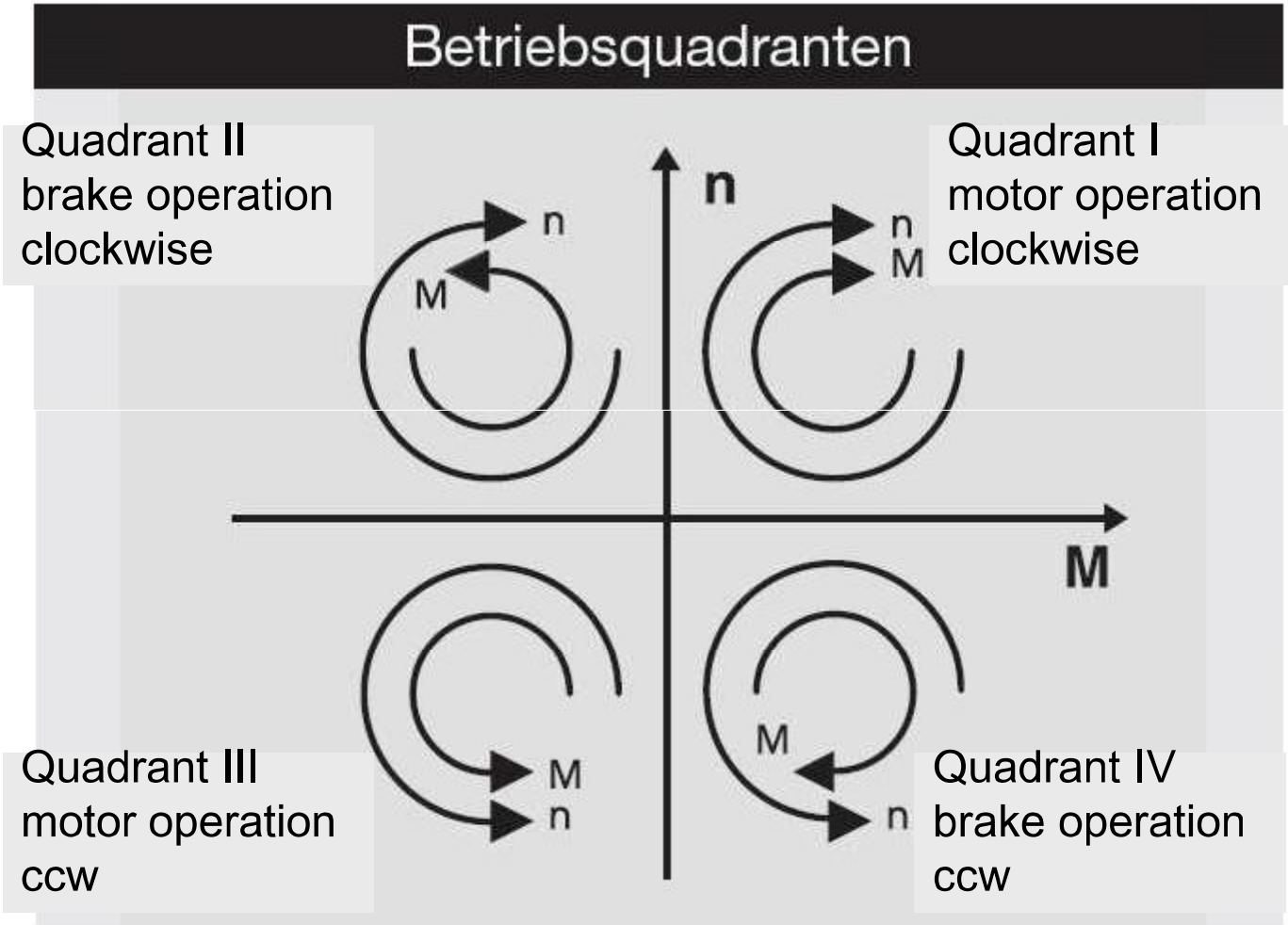
Ballast circuit

- By breaking down of motors, with servo controller for 4-quadrant drive, energy will be feeded back to the mains power supply
- Thereby, the motor voltage can be overvalued
- If there not be implemented suitable actions against those overvalued voltages, the motor or other connected consumers can be damaged

➲ Generatoreffect

Ballast circuit



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Ballast circuit

- By lesser amounts of energy, a intermediate storage of the braking energy in capacitors is effectual
- If this is not enough, you have to take energy out of the system
- A possibility that is established and easy to realize, is the use of a ballast resistor. From a adjustable voltage the ballast resistor will be switched on and transform the energy into heat

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Ballast circuit

- The capacitor is storing the overrun energy ➲ until capacity is reached
- This energy can be used to start –up the motor again
- The capacity of the capacitor is limited ☺
- **Peaks of the back feeded voltage, that not can be absorbed from the capacitor, have to be destroyed by a ballast resistor**
- **A established value for the max. voltage in the system is about 20% above the continuous voltage**

Ballast circuit – capacitor

- Calculation:

Energy in the capacitor: $E = \frac{1}{2} \cdot C \cdot U^2$

Needful capacity: $E_{brake} = \frac{1}{2} \cdot C \cdot U_{\max}^2 - \frac{1}{2} \cdot C \cdot U_{cont}^2$

$C = (2 \cdot E_{brake}) / (U_{\max}^2 - U_{cont}^2)$

Kinetic energy: $E_{kin} = \frac{1}{2} \cdot m \cdot v^2$

Own consumption: $E_{own} = U \cdot I \cdot t$

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Ballast circuit – capacitor

- Example:

A sliding carriage of **20 kg** shall be braked down from 2 m/s in 2 sec. The continuous voltage is 24 V and the controller has a own consumption of 0,5 A.

$$E_{kin} = \tfrac{1}{2} \cdot m \cdot v^2 = \tfrac{1}{2} \cdot 20kg \cdot (2m/s)^2 = 40J$$

$$E_{own} = U \cdot I \cdot t = 24V \cdot 0{,}5A \cdot 2sek = 24J$$

$$C = (2 \cdot E_{brake}) / (U_{\max}{}^2 - U_{cont}{}^2) = (2 \cdot (40J - 24J)) / ((30V)^2 - (24V)^2) = 99mF$$

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Ballast circuit – capacitor

- Example:

A sliding carriage of **80 kg** shall be braked down from 2 m/s in 2 sec. The continuous voltage is 24 V and the controller has a own consumption of 0,5 A.

$$E_{kin} = \tfrac{1}{2} \cdot m \cdot v^2 = \tfrac{1}{2} \cdot 80kg \cdot (2m/s)^2 = 160J$$

$$E_{own} = U \cdot I \cdot t = 24V \cdot 0{,}5A \cdot 2sek = 24J$$

$$C = (2 \cdot E_{brake}) / (U_{\max}{}^2 - U_{cont}{}^2) = (2 \cdot (160J - 24J)) / ((30V)^2 - (24V)^2) = 840mF$$

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Ballast circuit – capacitor

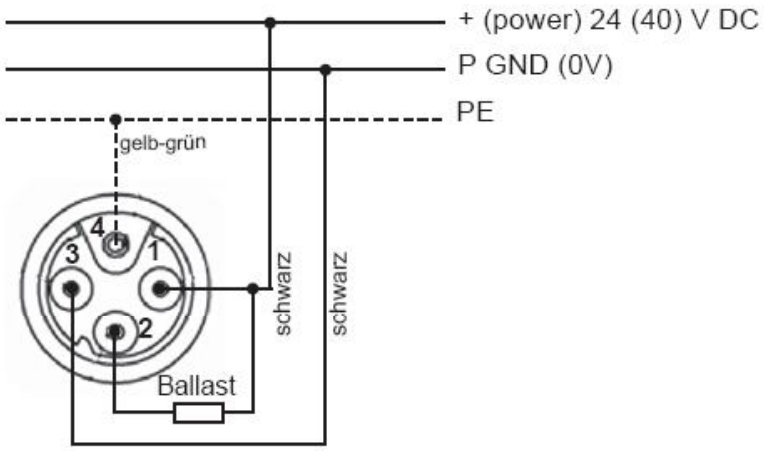
- **Calculative, you get relative high values for the capacity. In most cases the capacity has to be lesser, because the connected consumers have a own consumption and are discharging the capacitor**

- **Guiding values for the minimal capacity:**

  1000µF / Ampere motor current (instruction manual)

Ballast circuit – capacitor

- It makes sense, to combine the capacitor with the ballast circuit
- The capacitor stores a part of the back feeded voltage, that so can be used to start –up the motor again (between power 1 and GND 3)
- Peaks of the back feeded energy be destroyed by the ballast circuit



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Transform energy into lost heat by

- Via SW the ballast on-threshold can be adjusted

  BL75 40V: std. 53V
  BL75 24V: the ballast on-threshold should be adjusted t o 28V, if only one power supply is used (not allowed after the instruction manual.)

- If the voltage is exceeding the ballast on-threshold, a transistor is interconnecting

- The overrun voltage be conducted to the ballast resistor and transformed into lost heat

Dimensioning of the ballast resistor

- The minimum resistance value is defined by the maximum current, that may flow through the transistor of the ballast circuit

  ➲ by the BL75 e.g. 30A

  BL75 40V: 53V ballast on-threshold
  BL75 24V: 29V

- resultant resistance values

  40V: R = U / I = 53V / 30A = 1,77 Ω ➲ next highest norm value 2,2 Ω

  24V: R = U / I = 29V / 30A = 0,97 Ω ➲ next highest norm value 1,0 Ω

Dimensioning of the ballast resistor

- Impulse load of the resistor

  By activating of the resistor, very high impulse loads can be built up temporary. Those can be calculated as follows:

  40V: $P = U^2 / R = (53V)^2 / 2{,}2\ \Omega = 1267\ W$ (➲ min. 50 W)

  24V: $P = U^2 / R = (29V)^2 / 2{,}2\ \Omega = 383\ W$

- Temporary the resistors can be overloaded by factor 10 – 20 (wire_resistors)
- According to the application the resistors can be dimensioned lesser, because they can cool down after a short load

Ballast resistor – actions on the application (side)

- Limitation of the dynamic of the system

  the most economic solution, to limit the back feeded energy is to increase the braking period

  by combined supply of motor- and controller voltage as well as other electronic devices, you should use a ballast resistor (after the instruction manual, it's not allowed to combine the supply)

- Consideration of the efficiency factor of the gear

  the efficiency factor of the gear has to be considered by the dimensioning of the ballast resistor

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Ballast resistor – actions on the application (side)

- Acceleration and deceleration of different motors at the same time

  in many applications several motors be supplied by one power supply

  if one motor is decelerating while another motor is accelerating, the accelerating motor can use the back feeded energy from the decelerating motor

- External brake chopper

  according to the application, it can be necessary to use an external brake chopper , e.g. if there is required a independence from the controller supply
  ➲ plant safety by lift drives
  e.g.: miControl brake chopper