



Contents

This list comprises wirewound tubular fixed resistors as individual components in uncemented version FU as well as in cemented version FZ as the standard version. All the components can be integrated into other units. The assembled tubular fixed resistor units are available in different degrees of protection and mounting methods.

<i>maximum power</i>	<i>characteristics</i>	<i>type series</i>	<i>page</i>
	general survey		T102E
	technical details		T103-108E
1000 W	suitable for integration,	FZ/FU, FZB/FUB	T109-110E
44 W	for printed circuit board mounting	FZ...L /FU...L	T111E
300 W	with fastening brackets, loose and/or mounted	FZS /FUW	T112-113E
900 W	for vertical mounting	F..N /F..R /F..P	T114-115E
1000 W	with side-panels	FZ.H /FU.H	T116E
3000 W	with cover	FZ.A.	T117E
3000 W	with cover and terminals	FZ.M.	T118E
6000 W	with cover, terminals in terminal box	FZ.G. / FZ.C	T119-120E
6000 W	with thermal overload relay	FZ.T.	T121E
6000 W	with FRIZLEN DC-POWERSWITCH	FZ.X.	T122E

Properties

- **low temperature coefficient**
⇒ constant ohmic value over a large temperature range (s. p. T103E)
- **force locking fixation of wire using cementation**
⇒ good heat conducting properties
- **variable resistance value adjustable by clips**
⇒ change and/or adjustment or trimming by the user (s. type series description)
- **various diameters and lengths**
⇒ can be integrated, various possibilities for connection and mounting
- **enclosures made from hot galvanised steel sheet**
⇒ various protection and mounting types
- **low-noise and low-induction version available**
⇒ used for apartment buildings, hospitals, opera houses and theatres
- **thermal overload relay or temperature switch available**
⇒ integrated warning for high operating security (serialized with series FZ..Q and F..T)
- **intrinsically safe**
⇒ to switch off the resistor safely by FRIZLEN DC POWERSWITCH
- **UL-recognition for American and Canadian market (E212934)**
⇒ on request for type series FZ.P., FZ.M., FZ.C and FZ.T..











Applications

- braking resistors for frequency converters and DC drives, in low-noise version also for hospitals and theatres.
- load resistors for supply units, power packs, batteries, UPS units and generators
- resistors for current and voltage limitation e.g. for charging and discharging of capacitors
- field rheostats for generators
- protection and damping resistors



T 100 - Survey

type series	characteristics	FZ FU FZB FUB	FZ..x.L + FU..x.L	FZS FUS FZW FUW	F..N F..R F..P	FZ.H + FU.H	FZ.A	FZ.M	FZ.G + FZ.C	FZ.T	FZX
		page symbol	T109E/ T110E	T111E	T112E/ T113E	T114E/ T115E	T116E	T117E	T118E	T119E/ T120E	T121E
typical power from [W]		12	12	12	12	430	65	65	65	150	300
typical power up to[W]		1000	44	300	900	3000	3000	3000	6000	6000	6000
max. terminal / connection # (without adjustable tap and temperature switch)		2	2	2	6	2	2	2	2	2	2
degree of protection IP00	IP 00	X	X	X		X					
degree of protection IP20 - if mounted on an appropriate surface	IP 20 ^①						X	X	X	X	X
degree of protection IP20 terminals protected against contact	IP 20 ^②				X			X			
integration possible	E	X	X	X		X					
horizontal mounting							X	X	X	X	X
vertical mounting							X	X	X	X	X
vertical mounting on mounting sheet					X						
thermal overload relay										X	
adjustable clip available		X		X	X	X	X				
temperature switch (optional)		X		X	X	X	X	X	X		
FRIZLEN DC-POWERSWITCH											X
with  recognition					X (only FZ.P)			X	X (only FZ.C)	X	

Rights for improvements and modifications of our products reserved.
Modifications, errors and misprints justify no claim for damages.
We refer to our terms of sales and delivery.

**Technical details***Construction*

The basis are high quality ceramic or porcelain tubes with diameters of 16, 24, 35, 45 and 65 mm. We use round wires or bands that are made from various alloys, but mainly from CuNi 44 according to DIN 17471, 46460-1 and 46461 or NiCr 3020 and/or CrAl 25 5 according to DIN 17470.

Type series FZ..

Above mentioned wires are wound with pitch and are used for cement coated fixed and adjustable resistors. (FZ..) Then they are fixed by a special cement coat. The selection of a tubular fixed resistor for continuous dissipation is only determined by the size of the surface, that means the size of tube, and by the maximum allowable temperature on the surface. We highly recommend this construction type for all standard applications as well as for short time operations with braking resistors.

Type series FU..

If a very high short time power should be dissipated on the smallest possible surface, this energy must be absorbed by the weight of the resistance material within the first second. For producing our uncemented tubular resistors we wind an oxidized wire without gap. Its oxidation functions as insulation. The wire is not protected by a cement coat. If you compare this type to the cemented one you will reach much higher wire weights on the very same surface. Therefore this version is constructed for a very high, not pulsating amount of energy during a short time, like during charging or discharging of capacitors. You will pick this version when you are dealing with single switching operations.

For slide resistors, please look at our technical list T400E.

*Resistance values/
Production tolerance/
Temperature dependency*

The resistance values in the column "production range" refer to our standard production range and appear in row E12*. Please select from there. Different values upon request. The normal tolerance is $\pm 10\%$. Smaller tolerances upon request. The resistance value will change slightly in dependency of the winding temperature. With $\Delta T \approx 300$ K the resistance will change compared to a cooled down condition as follows: with wires made of CuNi 44 approx. $\pm 1\%$, made of CrAl 25 5 approx. $+1\%$ and made of NiCr 3020 approx. $+10\%$. We select the alloys corresponding to the resistance values or to demand. You will find indications concerning temperatures on page T105E and T106E.

Preferred ohmic values

*E12: multiplication or division by integer potencies of 10 with the following values:
1,0 - 1,2 - 1,5 - 1,8 - 2,2 - 2,7 - 3,3 - 3,9 - 4,7 - 5,6 - 6,8 - 8,2

Time constant

The average thermal time constant is 300 s.

Adjustable clips

Tubular fixed resistors of different type series can be flexibly equipped with adjustable clips to adapt the resistance values (compare e.g. page T109E, T111E-114E, T116E and T117E). The clips may only be adjusted in a condition free of voltage and after sufficient loosening and cooling. All our adjustable clips are equipped with silver contacts. When selecting please consider that the maximum temperature on the surface should not exceed 300°C. Please mind the details on pages T106E and T107E, too.



Degrees of protection

IP 00
IP 20 ^①
IP 20 ^②

Correlation of type series and degrees of protection according to EN 60529 and/or DIN VDE 0470 part 1

Type series	Degree of protection	First digit degree of protection against access & solid foreign objects	Second digit degree of protection against water
FZ., FU. F.S., F.W., F.H.	IP 00	Non-protected – i.e. depending upon integration the user must provide a protection	Non-protected
F..A, F..C, F..G, F..M, F..T. F..X	IP 20 ^①	Protected against access to hazardous parts with a finger and against solid foreign objects of 12,5mm Ø and greater.	Non-protected
F..N, F..R, F..P	IP 20 ^②		Non-protected

^① if mounted on an appropriate surface – i.e. mounted on a surface according to degree of protection IP 20 or higher

^② Terminals are protected against access to hazardous parts according to BGV A2

Air and creepage distances

Air and creepage distances are rated according to IEC 664 (DIN EN 0110 part 1) for the overvoltage category III and degree of pollution 3 for grounded three-phase mains supplies up to 3 x 500 V. Testing voltage 2.5 kV AC.

These data are valid for all devices that are connected to mains voltage and derived voltages, as for example the intermediate circuit voltage of frequency converters.

Do not conclude from the calculated relation between the rated power and the maximum producible ohmic value to the rated voltage!

Protective measures

All our power resistors with degree of protection IP 20^① and IP 20^②, correspond to safety class I, i.e. connections for protective earth conductor according to EN 61140 are provided.



These devices also comply with the CE low voltage directive.

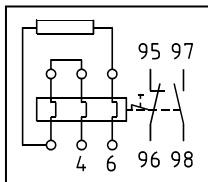
Power resistors being passive electrical or electrical units are not affected by the specific EMC standards. They do not produce any interfering radiations nor are they affected.

UL-Recognition



Some important type series can be delivered in a version with UL-recognition both for the American and for the Canadian market. The devices are UL 508 approved, number E212934. This recognition is the same as a recognition according to CSA C22.2 No.14. For further information please check the UL-flyer. (Please ask for it or visit us at www.frizlen.com)

Excess current protection

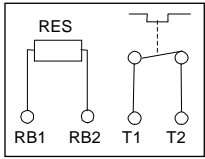


A protection of the resistors against overloading or excess temperature - as demanded in standards - can be realized with the help of a thermal overload relay provided by the user. The set current must correspond to the rated current of the resistor, that is calculated according to continuous duty power and resistance value corresponding to Ohm's law (formula: see "terminal details" p. T108E)

Concerning the series FZ..T the thermal overload relay is a component of the device - with exceeding of the rated current a signal contact is released. There will not be a disconnection of the resistor. Resetting by hand.



Excess temperature protection

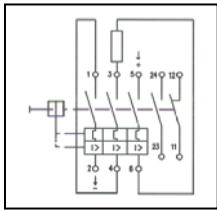


Another kind of the excess temperature monitoring, particularly suited for long-term overloading, is the equipment with a temperature switch. In IP 20-resistor devices it is wired on terminals, in IP 00 resistors the switch is directly connectable and releases a signal contact, when the set temperature is exceeded. There will not be a disconnection of the resistor.

You can inform yourself about function and restrictions by our data sheet „Tripping of monitoring devices“.

We can send it to you on request.

Intrinsically safe version with FRIZLEN DC-POWERSWITCH



Integrated overload switch for a maximum of 850 VDC to protect the resistor. It protects the integrated resistor against constant overload and against too high short time peak power, e.g. caused by a false operational mode or a fault by an short circuited chopper transistor. Possible damage in the environment by overheating and burning are effectively avoided.

So you receive an intrinsically safe resistor protection degree even for IP20[®]. The FRIZLEN DC-POWERSWITCH can also be integrated in the switch cabinet.

After a successful fault clearance the DC-POWERSWITCH can be switched on like a normal automatic cutout.

We can send you more technical details and characteristics on request.



Attention: FRIZLEN DC-POWERSWITCH are only suited for monitoring and disconnecting from DC-voltage with pure resistive load (DC1) up to 850 VDC.

Contact rating

Contact ratings of the signal contacts of temperature switches and thermal overload relays.

- 2 A / 24 VDC (DC11)
- 2 A / 230 VAC (AC11)

Contact ratings of the signal contacts of the DC-POWERSWITCH:

- 5 A / 24 VDC (DC11)
- 10 A / 230 VAC (AC11)

Storage temperature/ Operation temperature/ Installation altitude

Storage temperature: - 40° C to 80° C

Operation temperature: - 30° C to 40° C. If the ambient temperature is higher than 40°C, you have to decrease the continuous dissipation by 4% per 10 K temperature rise!

Installation altitude: 2000 m above sea level, you have to decrease the continuous dissipation for 10% per 1000 m altitude, maximum altitude 5000 m above sea level

Restrictions are to be made for the type series FZ.T. and FZ.X. because of the built-in monitoring device. Operation temperature: - 20° C to 40° C

Typical power/ Continuous dissipation/ Ventilation/ Temperatures

The given typical power values are valid for 100% duty cycle factor (DCF) (continuous dissipation) under the following conditions:

- temperature rise of 200 K at the surface of fixed resistor enclosures (degree of protection > IP00)
- temperature rise of 300 K at the surface of fixed resistor elements (degree of protection IP00)
- unhindered access of cooling air
- unhindered diverting of warmed up air (mind a minimum separation distance of approx. 200 mm to neighbouring components/walls and of approx. 300 mm to components above/ceiling)



Ventilation/ Temperatures

Since electrical energy is converted into heat, heating up of the exhaust air and of the enclosure at the air outlet is inevitable.

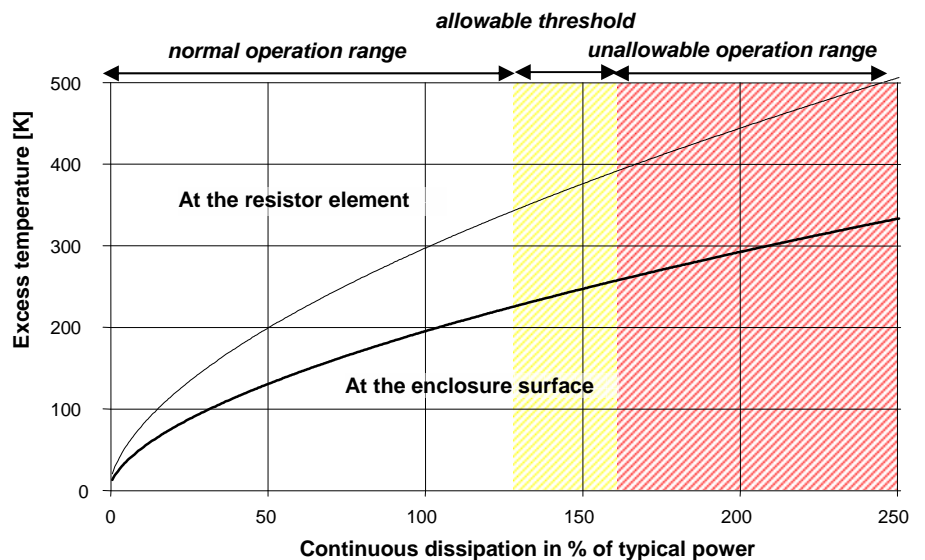
The highest temperature at typical power may be maximum 200°C above the ambient temperature. Since the cooling of the devices is accomplished by convection, the above mentioned aspects have absolutely to be considered.



In cases of insufficient cooling or false mounting the resistor or the surrounding devices could be overheated or ruined.

Depending upon use it can be possible to increase the continuous dissipation of the resistors, if higher temperatures are accepted. With an increase of e.g. 130% of the typical power you will have a rise in temperature of 350K at the surface of the resistor. In other cases of application the continuous dissipation must be reduced, for example with temperature sensitive devices in the surrounding area. The dependence between temperature rise and actual continuous dissipation is shown in the diagram below.

Excess temperature in dependence of continuous dissipation



Normal operation range (up to 130%):

Recommended operation range for maximum product life and failure free operation

Allowable threshold (up to 160%):

Allowable operation range, danger of shorter product life and higher failure probability

Unallowable operation range (more than 160%):

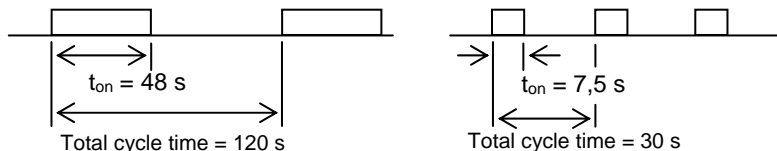
Danger of excessive heat and destruction of resistor and neighbouring components



Short time dissipation/
Total cycle time/
Duty cycle factor(DCF)

At many applications resistors are not loaded in continuous but in short time operation. In the following you will find indications, how to calculate the allowable short time dissipation with the help of the duty cycle factor (DCF) and the overload factor (OLF). If the DCF factor is not known, it can be calculated as follows:

$$Duty\ cycle\ factor(DCF) = \frac{Switch\ on\ time(t_{on})}{Total\ cycle\ time}$$



$$DCF_1 = \frac{48s}{120s} = 0,4 = 40\%$$

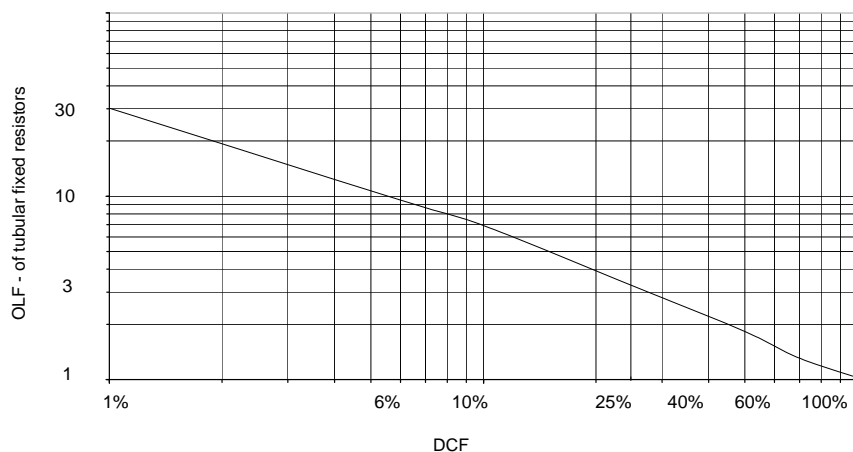
$$DCF_2 = \frac{7,5s}{30s} = 0,25 = 25\%$$

Warning: The total cycle time may be **maximum 120 s** - shorter total cycle times are possible. The total cycle times for motors are mostly higher than 120 s

Overload factor(OLF)

By comparison of the known DCF-factor with the following diagram or table you can work out the overload factor (OLF) and/or the continuous and the short time dissipation.

Overload factor (OLF) in dependence of duty cycle factor (DCF)
(Total cycle time = 120s)



DCF	1%	3%	6%	15%	25%	40%	60%	80%	100%
OLF	30	15	9,5	5,0	3,2	2,2	1,5	1,12	1,0

The continuous and the short time dissipation can be calculated as follows:

$$Short\ time\ dissipation = Continuous\ dissipation \times OLF$$

$$Continuous\ dissipation = \frac{Short\ time\ dissipation}{Overload\ factor(OLF)}$$

Calculation example
given:

- Resistor with a short time dissipation of 2,5 kW for 18 s and a total cycle time of 120s

wanted:
continuous dissipation

- The duty cycle factor (DCF) is 18 s : 120 s x 100% = 15%
- Overload factor (OLF) for 15% DCF, according to table it is 5,0
- The continuous dissipation is 2,5 kW : 5,0 = 0,5 kW;
You need a resistor with a continuous dissipation of at least 0,5 kW!



*Terminal details/
Monitoring devices/
Cross section*

Rated current and cross section of terminals and monitoring types.

Type	abbreviation	rated current in A with 100% DCF	rated current in A up to 40% DCF	Maximum cross section
porcelain terminal	PK	20	25	up to 2,5 mm ²
ceramic flat terminal	FK	35	44	2,5 - 10 mm ²
device terminal out of polyamide (PA)	G 5	30	38	0,5 – 2,5 (4) mm ² AWG 24 - 12
	G 10	60	75	0,5 – 10 (16) mm ² AWG 20 - 6
cage clamp terminal out of PA	ST2,5	20	25	up to 2,5 mm ² AWG 16 - 12
	ST 4	30	38	up to 4,0 mm ² AWG 20 - 10
thermal overload relay	signal contact	2	-	up to 2,5 mm ² ; AWG 16-12
	main connection	up to 17/24	21/30	2,5/6 mm ² ; AWG 20 - 10
DC-POWER-SWITCH FPS	signal contact	10	-	up to 2,5 mm ² AWG 16 - 12
	main connection	40	50	up to 16 mm ² ; AWG 4

The rated current is calculated in each case due to Ohm`s law as follows:

$$I = \sqrt{\frac{P}{R}}$$

whereas
P is the power of the resistor and
R is the value of the resistance

Wiring

If terminals are delivered by us, the connections are wired with flexible, heat resistant, silicone-insulated wire on terminals (further wires on request).
If the wiring is accomplished by the customer, make sure that a heat resistant wire is used.

Low-noise and low-inductive version

By means of a bifilar winding we are able to provide a low-noise and low-inductive version for operations in noise sensible areas, such as braking resistors for frequency converters for lift motors in hospitals or apartment houses. The same is valid for hoist motors on theatre stages.

Mounting

Please mind the mounting indications of the corresponding type series!
You will find these icons in the data sheets.



Allowable: On horizontal surfaces



Allowable: On vertical surfaces, terminals at the bottom



Allowable: Mounting vertical to the mounting sheet, terminals at the bottom



Not allowable: On vertical surfaces, terminals at the top, left or right



Not allowable: On horizontal surfaces, terminals at the top