SITOR semiconductor fuses, connected in parallel

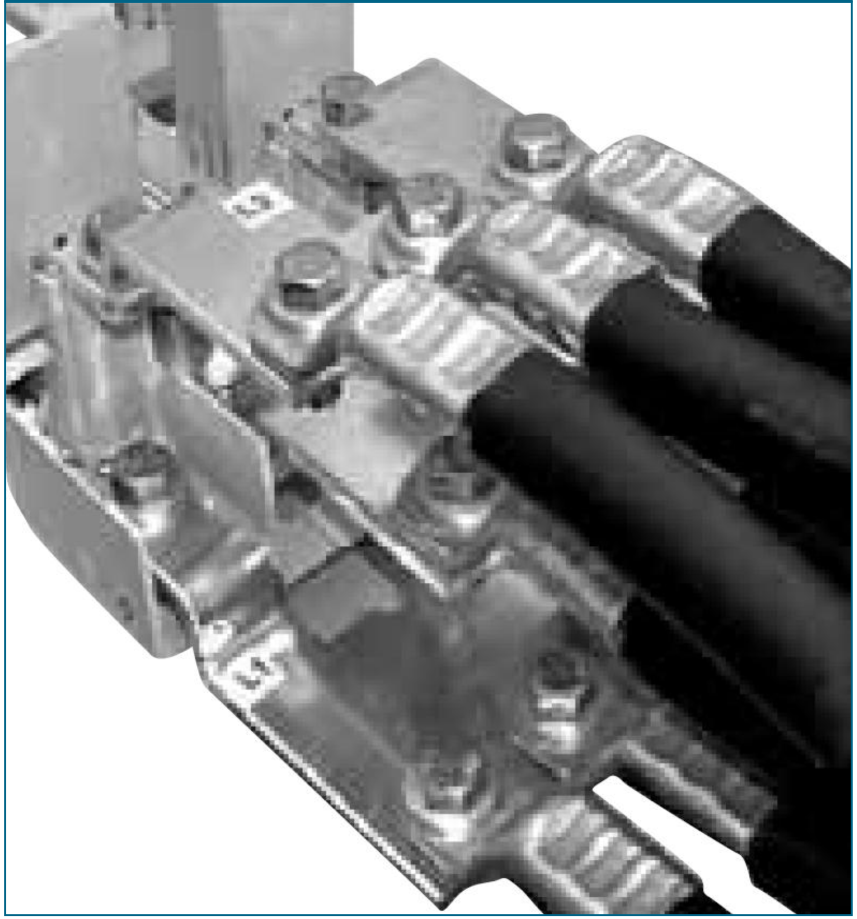
SENTRON

Parallel connection of SITOR fuses
Product training

- Parallel and series connection of fuses
- UL requirements for the parallel and series connection of fuses
- SITOR semiconductor fuses, connected in parallel
- Type series, technical specifications, designs und dimensions
- Customers, applications

Parallel and series connection of fuses

Cable connection range



The parallel connection of NH fuse systems is standard practice for extending the rated current range of a particular size. For example, a low-voltage distribution system can be configured more compactly if two NH 3 bars are used in parallel instead of one NH 4a bar as feeder unit for the busbar. Similarly, it is standard practice in wind turbines to connect several NH fuse bars in parallel for the feeder unit on the low-voltage side. And the parallel connection of NH fuses is also customary for semiconductor protection.

Parallel and series connection of fuses

If suitable fuse holders are not supplied already fitted by the manufacturer, it is essential to observe a number of important rules and instructions for the parallel connection of fuses and safety switching devices:

- The fuse links must have the same design, size and rated data, i.e. ideally they should be identical in construction.
- Incoming and outgoing lines should produce a uniform distribution of current. On long lines it is recommended to check the lengths. Alternatively, cables are connected together in parallel. In this case, however, the connected lines are not protected individually but only as a bundle.
- Parallel-connected NH fuse switch-disconnectors should have mechanically coupled operating levers and should have only moderate force to be actuated.
- The rated current of n parallel fuse links is always smaller than the sum of the rated currents n x $\mathbf{I}_n$ due to the non-uniform distribution of current.

Parallel and series connection of fuses

Exception: Several parallel-connected SITOR semiconductor fuses can be assigned to one semiconductor component without a reduction of current.

- The fusing integral of n parallel fuses equals approx. n^2 x I^2t of the individual fuses.
- The let-through current of n parallel fuses equals approximately n x I_c of the individual fuses for an unaffected short-circuit current of I_p / n.
- The breaking capacity of the combination cannot be assumed to exceed I_1 of the individual fuses.
- With NH partial-range fuses, the breaking range (minimum breaking current) does not begin below n x k_2I_n.
- To determine the temperature rise, the full operational current must be assumed for all n parallel switching devices because it is only a single load circuit.

Parallel and series connection of fuses

Advantages of energy monitoring

Unlike with parallel connection, the series connection of fuses does not as a rule increase the range of application and particularly not the rated voltage. Given the inevitable product tolerances it can be assumed that even with the series connection of identical fuses each single fuse will need to withstand the full recovery voltage after a power interruption.

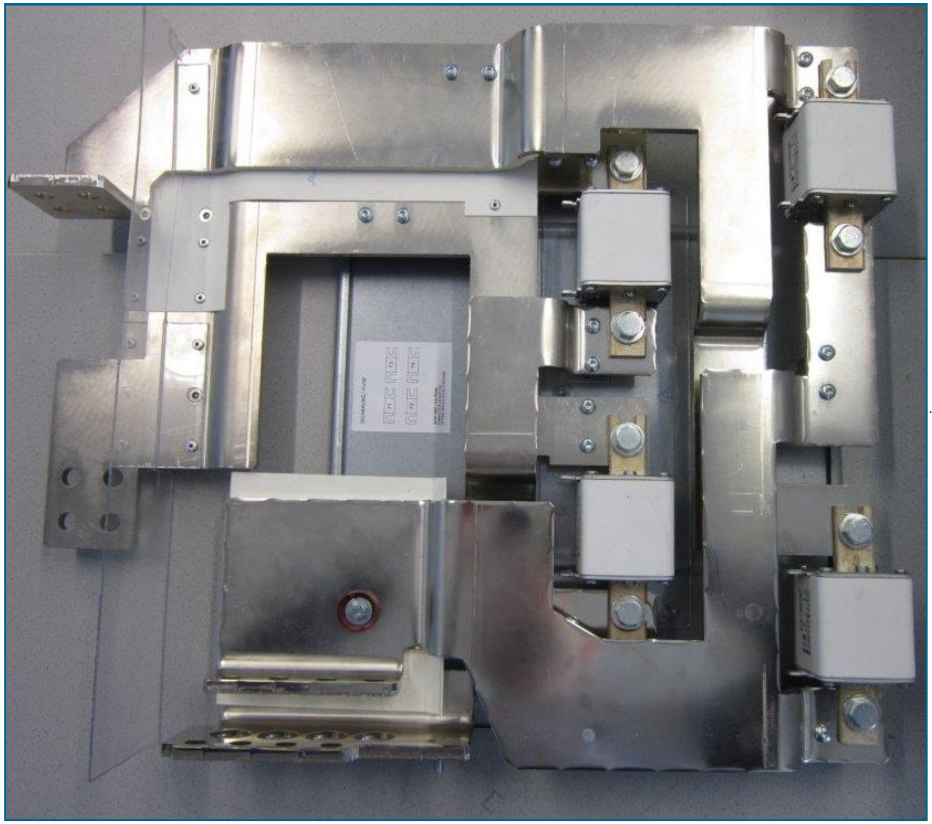
Exception

With SITOR semiconductor fuses, the voltage distribution can be assumed to be uniform if it is certain that the anticipated short-circuit current will lead to melting times of ≤ 10 ms.

Type-related data can be found in the SITOR configuration documents.

UL requirements for the parallel and series connection of fuses

UL no longer permits parallel / series connection of fuses and refers to a section in the NEC



„240.8 Fuses and circuit breakers shall be permitted to be connected in parallel where they are factory assembled in parallel and listed as a unit. Individual fuses, circuit breakers, or combinations thereof shall not otherwise be connected in parallel.“

Settings as seen in the picture on the left are, according to UL-regulations, not permitted but were widely used in the past.

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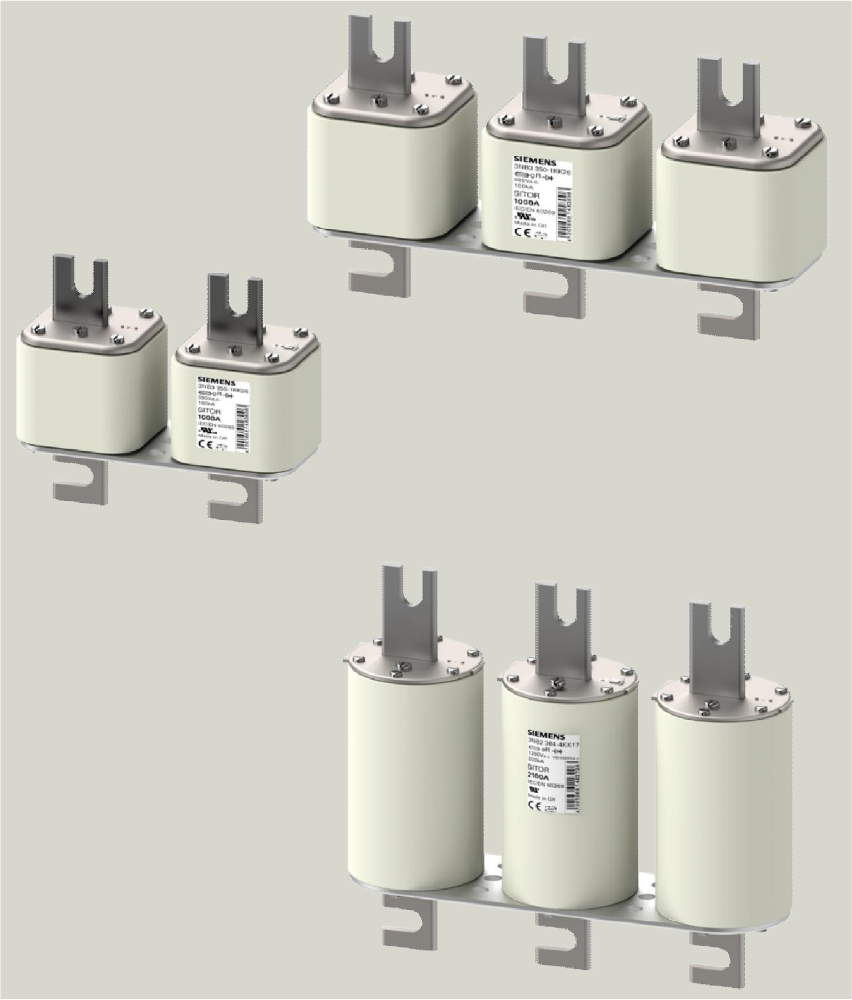
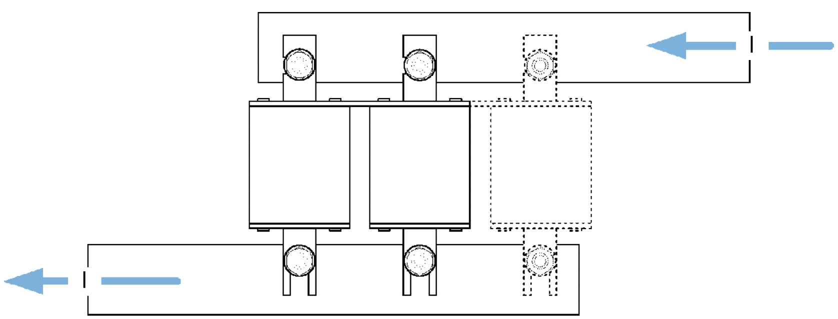


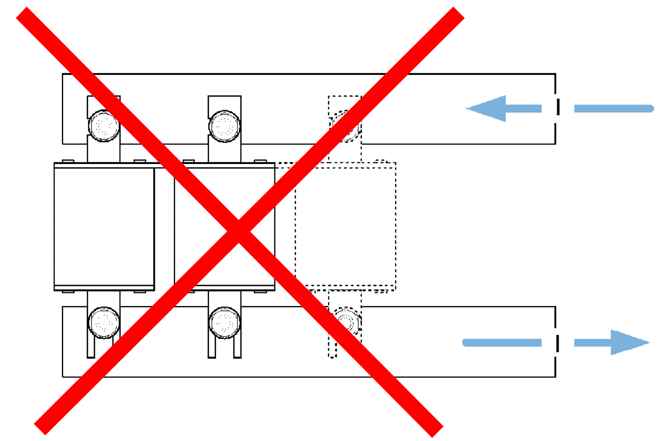
- Highest energy limit for protecting power semiconductors
- Extremely high current rise due to energy store (VSI-Rating)
- Rising converter power levels require higher currents and voltages
- DC currents up to **2400A at 1250V d.c.**
- AC currents up to **1900 A at 690V a.c.** viable
- According to UL 248-13 (UL Recognized) and IEC 60269-4.

SITOR semiconductor fuses, connected in parallel

Correct connection



Non-permissible connection



Sub-project 1
DC fuses

								P_v		ΔT_{Kont}				
MLFB	I_n	U_n	IR	Char.	Size	AØ Cu	Base	@ I_n	@0.7I_n	@I_n	@0.7In	Ic@100kA	^2t_s	i^2t_{aus}@1500V
3NB1 126 4KK11	200A	1250Vdc	100kA	aR	1L	95mm²	Bar	50W	21W	53K	24K	7.3kĀ	10,700	39,000
3NB1 128 4KK11	250A	1250Vdc	100kA	aR	1L	120mm²	Bar	51W	21W	53K	25K	9.4kĀ	24,500	80,500
3NB1 231 4KK11	315A	1250Vdc	100kA	aR	2L	185mm²	Bar	63W	27W	55K	27K	11.0kĀ	41,000	129,000
3NB1 234 4KK11	400A	1250Vdc	100kA	aR	2L	240mm²	Bar	68W	29W	56K	26K	14.8kĀ	96,000	290,000
3NB1 337 4KK11	500A	1250Vdc	100kA	aR	3L	300mm²	Bar	89W	36W	55K	26K	18.3kĀ	195,000	600,000
3NB1 345 4KK11	800A	1250Vdc	100kA	aR	3L	500mm²	Bar	135W	53W	76K	26K	28.0kĀ	770,000	1,910,000

								P_v		ΔT_{Kont}				
MLFB	I_n	U_n	IR	Char.	Size	AØ Cu	Base	@ I_n	@0.7I_n	@I_n	@0.7In	Ic@100kA	^2t_s	i^2t_{aus}@1500V
3NB2 345 4KK16	800A	1250Vdc	150kA	aR	2x2L	500mm²	Bar	160W	68W	74K	27K	27.5kĀ	375,000	1,150,000
3NB2 128 4KK16	1000A	1250Vdc	150kA	aR	2x3L	600mm²	Bar	195W	77W	87K	39K	34.1kĀ	787,000	2,250,000
3NB2 231 4KK16	1400A	1250Vdc	150kA	aR	2x3L	1200mm²	Bar	250W	96W	89K	39K	46.5kĀ	2,150,000	5,100,000
3NB2 234 4KK16	1600A	1250Vdc	150kA	aR	2x3L	1600mm²	Bar	275W	110W	76K	39K	52.7kĀ	3,500,000	7,450,000
3NB2 337 4KK17	2100A	1250Vdc	150kA	aR	3x3L	1800mm²	Bar	365W	160W	77K	39K	61.0kĀ	5,750,000	11,950,000
3NB2 345 4KK17	2400A	1250Vdc	150kA	aR	3x3L	2000mm²	Bar	445W	165W	89K	48K	69.1kĀ	9,050,000	18,100,000

The types are now available and will be delivered within the stated time of delivery.

Sub-project 2
AC fuses

								P_v		ΔT_{Kont}				
MLFB	I_n	U_n	IR	Char.	Size	AØ Cu	Base	@ I_n	@0.7I_n	@I_n	@0.7In	Ic@100kA	^2t_s	i^2t_{aus}@690V
3NB3 350 1KK26	1000A	690Vac	100kA	gR	2xBG3	600mm²	Bar	138W	57W	101K	56K	34.7kÂ	298,000	1,400,000
3NB3 351 1KK26	1100A	690Vac	100kA	gR	2xBG3	700mm²	Bar	110W	44W	96K	39K	44.9kÂ	680,000	3,000,000
3NB3 352 1KK26	1250A	690Vac	100kA	gR	2xBG3	800mm²	Bar	104W	46W	38K	19K	48.9kÂ	897,000	4,100,000
3NB3 354 1KK26	1350A	690Vac	100kA	gR	2xBG3	900mm²	Bar	126W	55W	44K	23K	51.2kÂ	1,100,000	4,800,000
3NB3 355 1KK26	1400A	690Vac	100kA	gR	2xBG3	1000mm²	Bar	127W	55W	48K	23K	52.9kÂ	1,150,000	5,200,000
3NB3 357 1KK26	1600A	690Vac	100kA	gR	2xBG3	1100mm²	Bar	152W	64W	57K	27K	58.5kÂ	1,550,000	6,900,000
3NB3 358 1KK26	1700A	690Vac	100kA	gR	2xBG3	1200mm	Bar	143W	62W	57K	26K	66.9kÂ	2,370,000	10,000,000

								P_v		ΔT_{Kont}				
MLFB	I_n	U_n	IR	Char.	Size	AØ Cu	Base	@ I_n	@0.7I_n	@I_n	@0.7In	Ic@100kA	^2t_s	i^2t_{aus}@690V
3NB3 358 1KK27	1700A	690Vac	100kA	gR	3xBG3	1200mm²	Bar	179W	77W	64K	30K	57.5kÂ	1,550,000	16,400,000
3NB2 362 1KK27	1900A	690Vac	100kA	gR	3xBG3	1600mm²	Bar	196W	84W	70K	33K	61.9kÂ	1,850,000	8,200,000

The types are now available and will be delivered within the stated time of delivery.

Customers, applications

- **Converters**
- **Rectifiers**
- **Inverters**
- Solid-state switching devices
- Soft starters
- Heating control systems
- **Power semiconductors**
- Solid-state motor starters
- Power supply units (UPS)
- **Wind turbines**
- **Energy stores**

Process automation

Application
- Plastic injection technology
- Water, waste water

Manufacturing automation

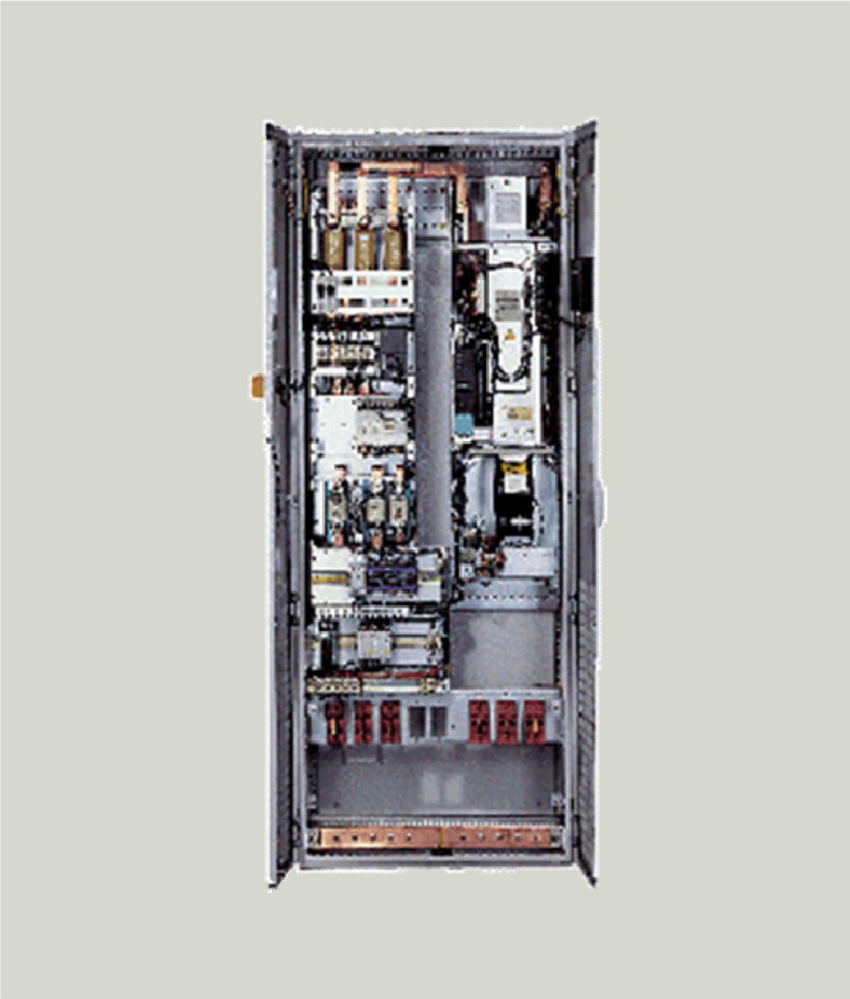
Application
- Automotive industry
- UPS
- Airports and conveyor systems

Electrical equipment

Application
- Solar energy and heating systems

SITOR semiconductor fuses, connected in parallel - Customers, applications

SIEMENS



Main applications

- Large drives
- Energy stores
- DC bus systems