CONTROLLO EDIZIONE

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Data: 20-06-2016	**Data: 20-06-2016**	**Data: 20-06-2016**

IL DESIGN DEI CARICABATTERIE È INDICATO NEL DOCUMENTO ANESSO

ALLEGATO 1: Design and calculation document BCG_IT

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Data: 06/03/2016

AX.02.V4.0007

AX.02.0G.0012.00 Battery charger (IVIESCA)

Design and calculation document

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1. ISSUE CONTROL AND DISTRIBUTION

ISSUE CONTROL

ISSUE	REASON	DATE
00_00	First version	07.08.2015
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DISTRIBUTION

PERSON	POSITION	COMPANY

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DT-00097

Progettazione e calcolo del Caricabatteria 6kW per l’upgrade delle Locomotive E402A di Trenitalia

DESCRIZIONE TECNICA	DT-00097	Edizione	1	Data	2016.03.06
ESEGUITO E CONTROLLATO DA	Cecilia de la Viesca S.	APPROVATO DA		Carlos de la Viesca E.M.	

TABELLA DELLE EDIZIONI E MODIFICHE

Edizione	Data	Descrizione della modifica	Modificato da	Controllato da	Approvato da
0	2015.07.16	Edizione base	CeVS	CVEM	CVEM
1	2016.03.06	Modificata fig.1, aggiunto capitolo 2.8 e F01 data-sheet	CeVS	CVEM	CVEM

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1 Obiettivo

Il Caricabatteria (BC) progettato in base alla nostra specifica tecnica numero ET-00142_V5.

Il BC alimentato da linee trifase.

La tensione nominale della linea operativa normale di 450V_{ac}/60Hz con un range da 360V a 495V.

È inoltre presente una seconda linea per il funzionamento nell'officina di manutenzione. Si tratta di un'alimentazione industriale trifase 400V 50Hz standard, con un range da 360V a 495V.

La tensione di uscita richiesta di 27 V_{dc} regolabile (25V_{dc}-29V_{dc}) per caricare una batteria da 24V e alimentare tutti i carichi a 24V_{dc}.

La potenza richiesta 6kW, 220A.

Ci sono 2 sistemi BC identici sulla locomotiva; emetteranno energia solo uno per volta.

Il calcolo del sistema stato fatto simulando il sistema con un PSIM e tenendo in considerazione tutti i valori rilevanti ottenuti.

Non stata realizzata la simulazione termica perch la concentrazione di calore nel dissipatore bassa.

Lo schema elettrico semplificato il seguente:

- I contattori K01 e K02 sono trifase e interbloccati meccanicamente ed elettricamente. Se l'alimentazione di terra 400V attiva, il BC operer direttamente da questo ingresso, senza prendere in considerazione nessun'altra condizione, questa caratteristica necessaria per far s che una batteria completamente scarica possa essere caricata. Normalmente il sistema operer sull'alimentazione 450V 60Hz;
- La tensione AC viene raddrizzata per ottenere da 480V_{dc} a 670V_{dc}. Da questa tensione, un convertitore a mezzo ponte ad alta frequenza generer i 24V_{dc};
- Vengono usati 2 sensori di corrente (TS01, TS02) e un contattore (K03) per alimentare i carichi fondamentali della batteria, e per collegare o scollegare i carichi non fondamentali; e
- Viene usato un fusibile (F01) per prevenire danni nel cablaggio in caso di corto circuito nello stadio di uscita.

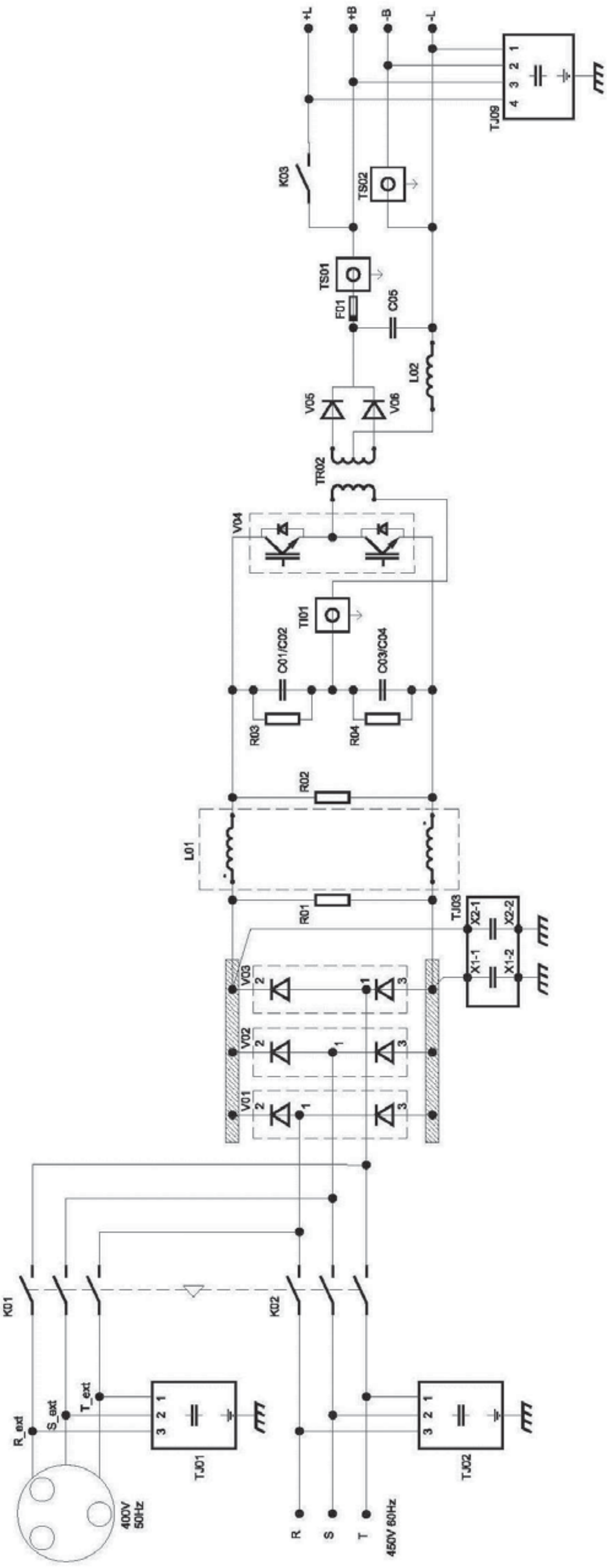

Figura 1: schema elettrico semplificato del BC

2 Simulazione e calcolo del Caricabatteria

2.1 *Dimensionamento del contattore K01 e K02*

La potenza apparente in ingresso del BC, quando questo eroga 6kW, considerando un'efficienza del 90% e un fattore di potenza di 0.86, pari a 7.75 KVA (12.4A_{rms} @360V)

I contattori scelti sono SCHNEIDER LC1D18BL (18A AC3/690V). Vedasi datasheet allegata.

2.2 *Dimensionamento del raddrizzatore trifase V01, V02 e V03*

Il raddrizzatore trifase composto da 3 moduli di 2 diodi ciascuno. I diodi sono classificati come a 105A 1600V.

Il calore dissipato dall'intero raddrizzatore pari a 34W; ci significa solamente una Δθ dalla giunzione al dissipatore pari a 2ºC.

I moduli selezionati sono SEMIKRON SKKD105F16. Vedasi datasheet allegata.

2.3 *Dimensionamento di C01, C02, C03 e C04*

I condensatori di ingresso forniscono un punto medio per il collegamento del trasformatore con il convertitore a mezzo ponte.

I condensatori selezionati sono ICAR LNK-P1X-45-70. Vedasi datasheet allegata.

La condizione peggiore quando essi funzionano con tensione di ingresso massima e la corrente di ripple massima.

Le forme d'onda di tensione e corrente sono:

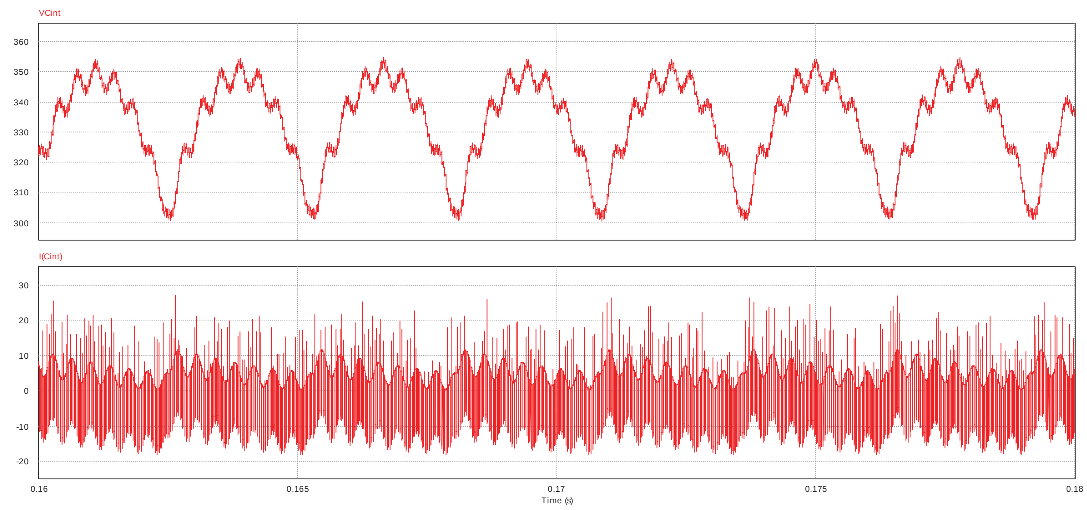

Figura 2. Forme d'onda di tensione e corrente attraverso i condensatori di ingresso

La tensione rms che passa attraverso ogni condensatore pari a 8.1A, ottenuta dalla simulazione.

La tensione nel condensatore molto bassa se paragonata alla tensione nominale permanente di 700V_{dc}.

Questa corrente genera dissipazione di energia nel condensatore $1.4m\Omega \times 8.1^2 = 0.09W$ che produce una $\Delta\theta = 0.08W \times 8^o C/W = 0.64^o C$. Dato che si considera che la temperatura massima dell'armadio pari a 70ºC, la temperatura massima del punto caldo sar di 71ºC.

2.4 *Dimensionamento del V04 (IGBT)*

L'elemento selezionato SEMIKRON SKM150GB12T4. Vedasi datasheet allegata.

Le peggiori condizioni operative si verificano con la tensione di ingresso massima e il carico massimo.

Le forme d'onda di tensione e corrente sono:

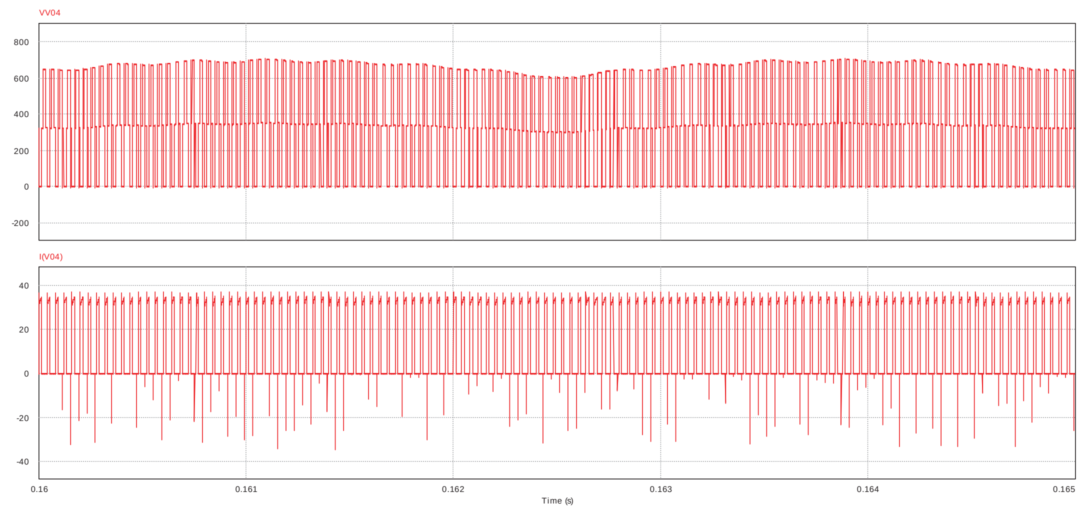

Figura 3: Forme d'onda di tensione e corrente degli IGBT

Da queste curve si ottiene:

I_{IGBT} media	10.3A
I_{IGBT} rms	18.4A
I_{IGBT} peak-off	35A
V_{IGBT} peak-av.	666V

Con questi valori e una frequenza di commutazione di 20kHz si ottiene:

Perdite di conduzione	12.3W
Perdite di switch-off	109W
Perdite di switch-on	Trascurabile
Perdite totali	***121W per IGBT*** ***242W per modulo***

La temperatura della giunzione raggiunta   di 35ºC superiore alla temperatura del dissipatore. Questi elementi ammettono una temperatura di esercizio della giunzione di 150ºC.

2.5 Dimensionamento del Trasformatore

Il trasformatore funzioner   a 20kHz, la tensione di ingresso sar   a onda quadra 240V alla tensione di ingresso minima (360V 50Hz), per tensioni pi   elevate ci sar   un'onda rettangolare, ma la tensione media raddrizzata applicata al primario sar   praticamente costante.

A 360V 50Hz, si ottiene:

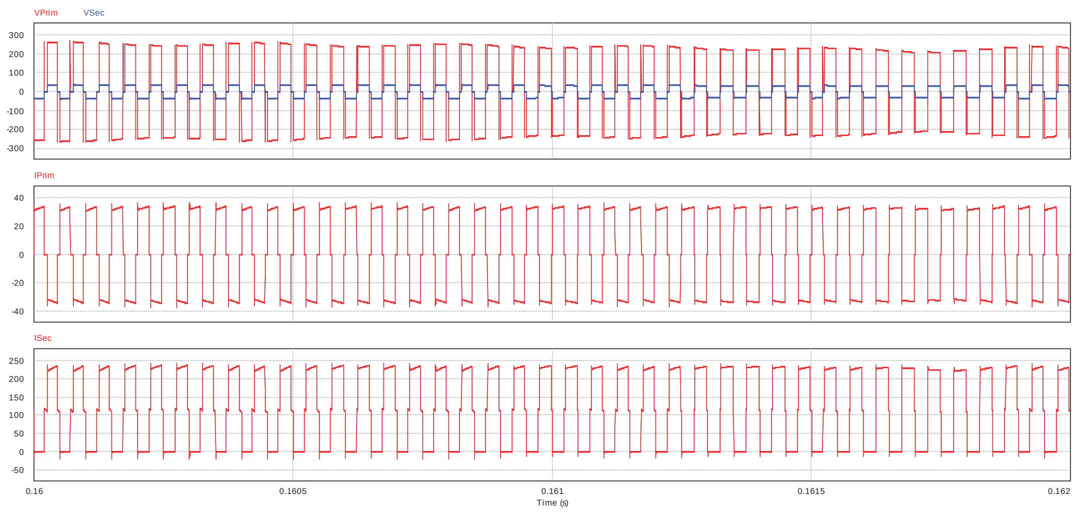

Figura 4: Forme d'onda di tensione e corrente del trasformatore a 360V 50Hz

A 495V 60Hz, si ottiene:

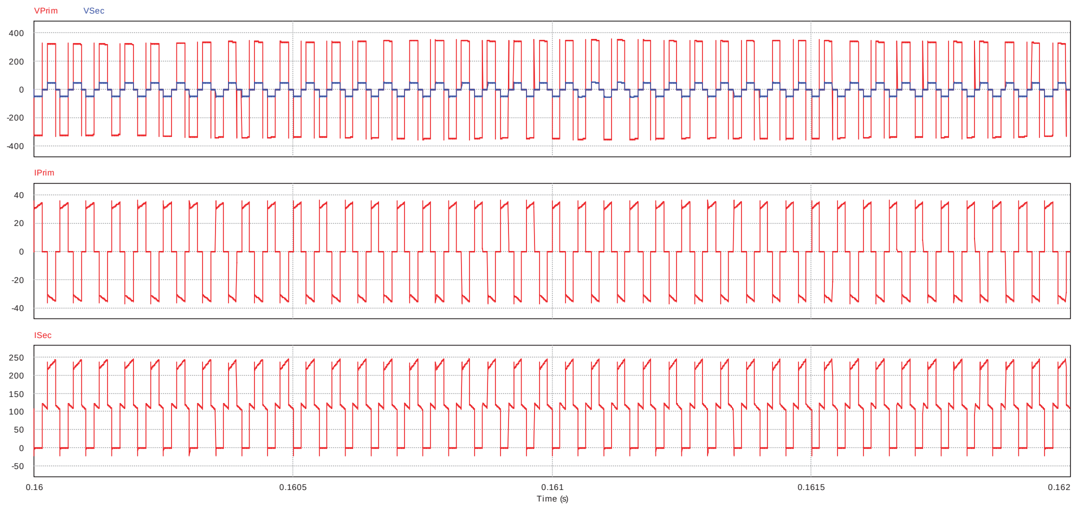

Figura 5: Forme d'onda di tensione e corrente del trasformatore a 495V 60Hz

Per quanto riguarda il trasformatore, vengono considerati i seguenti valori:

- ✓ Tensione primaria : 240V 20kHz Onda quadra
- ✓ Corrente primaria : 30.7A_{rms} Onda quadra
- ✓ Tensione secondaria : 2 avvolgimenti di 34.3V Onda quadra
- ✓ Corrente secondaria : 157A_{rms} raddrizzata onda quadra per avvolgimento
- ✓ Rigidit dielettrica da primario a secondario e intelaiatura: 2.5kV_{rms} 50Hz 1min
- ✓ Rigidit dielettrica da secondario a primario e intelaiatura: 1kV_{rms} 50Hz 1min
- ✓ Raffreddamento naturale a 70ºC
- ✓ Avvolgimento : Classe H
- ✓ Δθ massima : 60ºC per il nucleo di ferrite

2.6 *Dimensionamento del V05 e V06 (diodi raddrizzatori)*

Gli elementi selezionati sono VISHAY VSKCS409/150 diodi Schottky. Vedasi datasheet allegata.

Questi moduli sono 2 x 200A 150V. Per ogni ramo di diodi usiamo un modulo completo con i 2 diodi in parallelo.

Le peggiori condizioni operative si verificano con la tensione di ingresso massima e il carico massimo per la tensione del diodo, e con tensione di ingresso minima per la corrente del diodo.

Le forme d'onda di tensione e corrente sono le seguenti:

A 360V 50Hz si ottiene

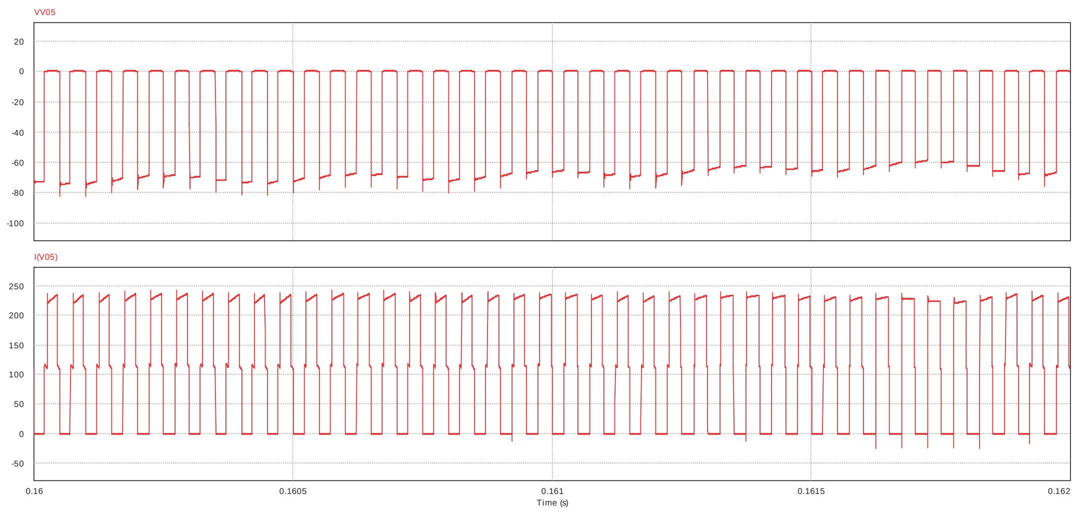

Figura 6:Forme d'onda di tensione e corrente dei diodi raddrizzatori a 360V 50Hz

A 495V 60Hz si ottiene:

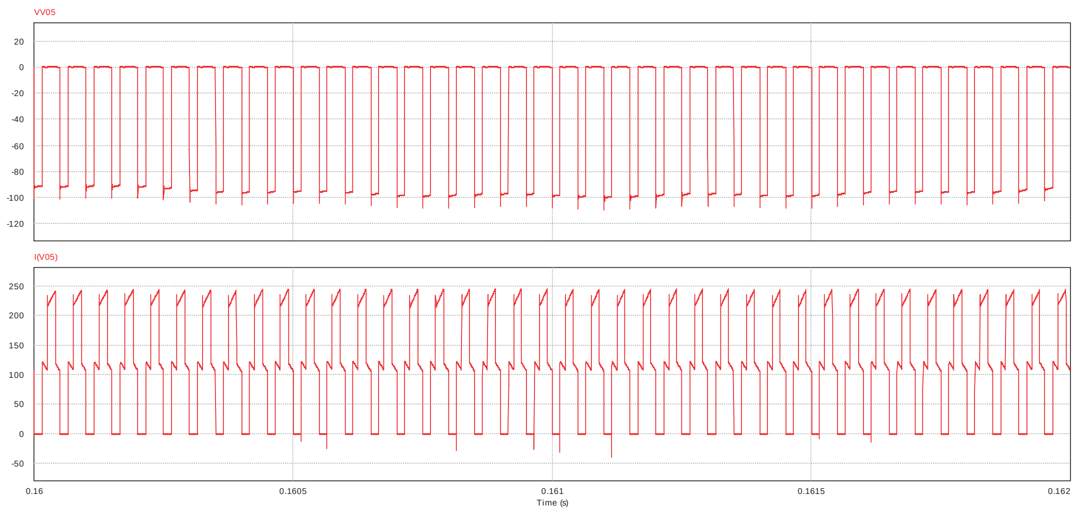

Figura 7: Forme d'onda di tensione e corrente dei diodi raddrizzatori a 495V 60Hz

Da queste curve si ottiene:

I_{DIODE} media	110A @360V/50Hz

I_{DIODE} rms	157A@360V/50Hz
I_{DIODE} picco	245A@495V/60Hz
V_{DIODE} picco	109V@495V/60Hz

Con questi valori e una frequenza di commutazione di 20kHz si ottiene:

Perdite di conduzione	82W per ramo
Perdite di commutazione	Trascurabili nei diodi Schottky
Perdite totali dei diodi	***164W***

La temperatura della giunzione raggiunta supera di 21ºC la temperatura del dissipatore. Questi elementi ammettono una temperatura di esercizio della giunzione di 175ºC.

2.7 Dimensionamento dell'induttore di uscita L02 e del condensatore C05

L'induttore funzioner a 40kHz, la tensione di ingresso sar un'onda rettangolare (impulsi), con un valore medio di $29V_{dc}$ (max). Le peggiori condizioni per l'induttore sono l'esercizio a $495V_{ac}$/60Hz con carico massimo. Il valore scelto per l'induttanza di 10 H.

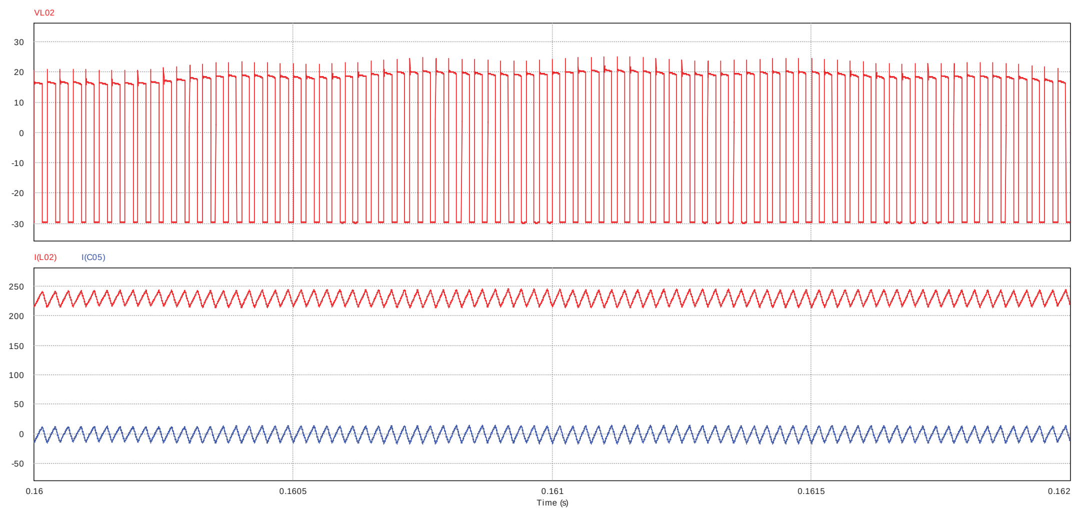

Figura 8: Forme d'onda tensione e corrente dell'induttore

Per l'induttore, vengono considerati i seguenti valori:

- ✓ Corrente RMS : $222A_{rms}$
- ✓ Corrente DC : $220A_{dc}$
- ✓ Correnti armoniche : $8.27A_{rms}$ @40kHz
- ✓ Corrente di picco : $245A_{p}$
- ✓ Rigidit dielettrica verso l'intelaiatura : $1kV_{rms}$ 50Hz 1min
- ✓ Raffreddamento naturale a 70ºC
- ✓ Avvolgimento : Classe H
- ✓ Δθ massima : 60ºC per il nucleo

Il condensatore C05 avr la corrente di ripple che passa attraverso l'induttore L02 ovvero $8,27A_{rms}$@40kHz.

Il condensatore selezionato di KEMET C4DEFPQ6380A8TK, ognuno da 380 F $400V_{dc}$. Vedasi datasheet allegata.

Questa corrente genera dissipazione di energia nel condensatore $0.81m\Omega \times 8.27^2 = 0.055W$ che produce una Δθ trascurabile. Dato che la temperatura massima dell'armadio sar inferiore a 70ºC, la temperatura massima del punto caldo sar di 70ºC.

2.8 *Dimensionamento dei fusibile F01*

Il riferimento del fusibile scelto F01 SIBA: S20 412 20,315, di 315A e la corrente massima del BC 220A.

Ha un coefficiente di applicazione in base alla temperatura di 0,74 a 75 C, quindi d 233A, che pi di 220A in modo che sia corretto.

E 'utilizzato per proteggere la linea della batteria contro BC interne cortocircuiti (V05-V06-C05).

2.9 *Dimensionamento del K03*

Il K03 il contattore per l'alimentazione dei carichi non-fondamentali, il modello selezionato lo SCHALTBAU C195 S/24EV-I2 ($200V_{dc}$/250A) unipolare. Vedasi datasheet allegata.

2.10 Calcolo del dissipatore

Il dissipatore selezionato il CONSTELLIUM (in precedenza ALCAN) HK-S400 RH120 con lunghezza pari a 450mm. Vedasi datasheet allegata.

La resistenza termica per questo dissipatore 0.07ºC/W a ventilazione naturale.

La potenza totale nel dissipatore :

V01, V02 e V03	34W
V04	242W
V05 e V06	164W
Potenza totale nel dissipatore	**440W**

La differenza di temperatura del dissipatore $\Delta\theta = 440W \times 0.07^{o}C/W = 30^{o}C$

La temperatura massima del dissipatore a una temperatura ambiente di 50ºC sar di $50^{o}C + 30^{o}C = 80^{o}C$

Riportando questo valore nel calcolo della temperatura della giunzione del semiconduttore si ottiene:

V01, V02 e V03 (raddrizzatore di ingresso)	80ºC + 2ºC =82ºC << 130ºC
V04 (IGBT convertitore a mezzo ponte)	80ºC + 35ºC = 115ºC <<150ºC
V05 e V06 (raddrizzatore a diodi Schottky in uscita)	80ºC + 21ºC =101ºC <<175ºC

<u>ALLEGATO 1</u>

DATASHEET DEL CARICABATTERIA

Type of contactor			LC1-D09…D18 DT20 & DT25	LC1-D25…D38 DT32…DT60	LC1-D40	LC1-D50…D95	LC1-D115 & LC1-D150
Environment							
Rated insulation voltage (Ui)	Conforming to EN 60947-4-1, overvoltage category III, degree of pollution: 3	V	690		1000		
	Conforming to UL, CSA	V	600				
Rated impulse withstand voltage (Uimp)	Conforming to EN 60947	kV	6		8		
Conforming to standards			IEC 947-1, 947-4-1, NFC 63-110, VDE 0660, BS 5424, JEM 1038, EN 60947-1, EN 60947-4-1. GL, DNV, PTB, RINA pending				
Product certifications			UL, CSA Complies with SNCF, Sichere Trennung recommendations				
Separation insulation	Conforming to VDE 0106 parts 101 and A1 (project 2/89)	V	400				
Degree of protection (1) (front face only)	Conforming to VDE 0106 Power connection		Protection against direct finger contact IP 2X				
	Coil connection		Protection against direct finger contact IP 2X (except LC1-D40…D80)				
Protective treatment	Conforming to IEC 68		"TH"				
Ambient air temperature around the device	Storage	C	- 60…+ 80				
	Operation	C	- 5…+ 60				
	Permissible	C	- 40…+ 70, for operation at Uc				
Maximum operating altitude	Without derating	m	3000				
Operating position	Without derating		30 possible, in relation to normal vertical mounting plane				
Flame resistance	Conforming to UL 94		V 1				
	Conforming to IEC 695-2-1	C	960				
Shock resistance (2) 1/2 sine wave = 11ms	Contactor open	gn	10	8	8	8	6
	Contactor closed	gn	15	15	10	10	15
Vibration resistance (2) 5…300 Hz	Contactor open	gn	2				
	Contactor closed	gn	4	4	4	3	4

(1) Protection ensured for the connection cross-sections shown on the next page and for connection via cable.
(2) In the least favourable direction, without change of contact state (coil supplied at Ue).

Selection:
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References:
pages 2/6 to 2/9

Dimensions:
pages 2/44 to 2/47

Schemes:
pages 2/48 and 2/49

TeSys contactors

Model d

Connections for power and control circuits

Type of contactor		LC1-	D09 & D12 DT20 & DT25	D18 (3P)	D25	D32	D38	D18 (4P) DT32…DT60	D40	D50 & D65	D80 & D95	D115 & D150

Power circuit connections

Connection via cable

Tightening			Screw clamps					2-input connector	Screw clamps	1-input connector		2-input connector
Flexible cable without cable end	1 conductor	mm^2	1…4	1.5…6	1.5…10	2.5…10		2.5…16	2.5…25	2.5…25	4…50	10…120
	2 conductors	mm^2	1…4	1.5…6	1.5…6	2.5…10		2.5…16	2.5…16	2.5…16	4…25	10…120 + 10…50
Flexible cable with cable end	1 conductor	mm^2	1…4	1…6	1…6	1…10		2.5…10	2.5…25	2.5…25	4…50	10…120
	2 conductors	mm^2	1…2.5	1…4	1…4	1.5…6		2.5…10	2.5…10	2.5…10	4…16	10…120 + 10…50
Solid cable without cable end	1 conductor	mm^2	1…4	1.5…6	1.5…6	1.5…10		2.5…16	2.5…25	2.5…25	4…50	10…120
	2 conductors	mm^2	1…4	1.5…6	1.5…6	2.5…10		2.5…16	2.5…16	2.5…16	4…25	10…120 + 10…50
Screwdriver	Phillips head		N 2	N 2	N 2	N 2		N 2	–	–	–	–
	Ø flat screwdriver		Ø 6	Ø 6	Ø 6	Ø 6		Ø 6	Ø 6…Ø 8	Ø6…Ø8	Ø6…Ø8	–
6 sided key			–	–	–	–		–	–	–	4	4
Tightening torque		N.m	1.7	1.7	2.5	2.5		2.5	5	5	9	12

Connection via spring terminals

Flexible cable without cable end	1 conductor	mm^2	2.5 (4: DT25)	4	4	4	–	– (10: DT32…DT60)	–	–	–	–
	2 conductors	mm^2	2.5 (4: DT25)	4	4	4	–	–	–	–	–	–

Connection via bars or lugs

Bar cross-section			–	–	–	–		–	–	–	3 x 16	5 x 25
Lug external Ø		mm	8	8	10	10		12	13	16	17	25
Ø of screw		mm	M3.5	M3.5	M4	M4		M5	M5	M6	M6	M8
Screwdriver	Phillips head		N 2	N 2	N 2	N 2		N 2	N 2	N 3	–	–
	Ø flat screwdriver		Ø 6	Ø 6	Ø 6	Ø 6		Ø 6	Ø 8	Ø 8	Ø 8	–
Key for hexagonal headed screw			–	–	–	–		–	–	–	10	13
Tightening torque		N.m	1.7	1.7	2.5	2.5		2.5	6	6	8	14

Control circuit connections

Connection via cable (tightening via screw clamps)

Flexible cable without cable end	1 conductor	mm^2	1…4	1…4	1…4	1…4		1…4	1…4	1…4	1…4	1…2.5
	2 conductors	mm^2	1…4	1…4	1…4	1…4		1…4	1…4	1…4	1…4	1…2.5
Flexible cable with cable end	1 conductor	mm^2	1…4	1…4	1…4	1…4		1…4	1…2.5	1…2.5	1…2.5	1…2.5
	2 conductors	mm^2	1…2.5	1…2.5	1…2.5	1…2.5		1…2.5	1…2.5	1…2.5	1…2.5	1…2.5
Solid cable without cable end	1 conductor	mm^2	1…4	1…4	1…4	1…4		1…4	1…4	1…4	1…4	1…2.5
	2 conductors	mm^2	1…4	1…4	1…4	1…4		1…4	1…4	1…4	1…4	1…2.5
Screwdriver	Phillips head		N 2	N 2	N 2	N 2		N 2	N 2	N 2	N 2	N 2
	Ø flat screwdriver		Ø 6	Ø 6	Ø 6	Ø 6		Ø 6	Ø 6	Ø 6	Ø 6	Ø 6
Tightening torque		N.m	1.7	1.7	1.7	1.7		1.7	1.2	1.2	1.2	1.2

Connection via spring terminals

Flexible cable without cable end	1 conductor	mm^2	2.5	2.5	2.5	2.5	–	–	–	–	–	–
	2 conductors	mm^2	2.5	2.5	2.5	2.5	–	–	–	–	–	–

Connection via bars or lugs

Lug external Ø		mm	(1)					–	8	8	8	8
Ø of screw		mm	(1)					–	M3.5	M3.5	M3.5	M3.5
Screwdriver	Phillips head		–	–	–	–		–	N 2	N 2	N 2	N 2
	Ø flat screwdriver		–	–	–	–		–	Ø 6	Ø 6	Ø 6	N 6
Tightening torque		N.m	–	–	–	–		–	1.2	1.2	1.2	1.2

(1) Spade connector or cable lug, see connection via cable above.

Selection: pages 1/6 to 1/35
References: pages 2/6 to 2/9
Dimensions: pages 2/44 to 2/47
Schemes: pages 2/48 and 2/49

Type of contactor		LC1-	D09	DT20	D12	DT25	D18	DT32	D25	DT40
Pole characteristics										
Rated operational current (Ie) (Ue ≤ 440 V)	In AC-3, θ ≤ 60 C	A	9		12		18		25	
	In AC-1, θ ≤ 60 C	A	25	20	25		32		40	
Rated operational voltage (Ue)	Up to	V	690		690		690		690	
Frequency limits	Of the operating current	Hz	25…400		25…400		25…400		25…400	
Conventional thermal current (Ith)	θ ≤ 60 C	A	25	20	25	25	32	32	40	40
Rated making capacity (440 V)	Conforming to IEC 947		250		250		300		450	
Rated breaking capacity (440 V)	Conforming to IEC 947		250		250		300		450	
Permissible short-time rating No current flowing for preceding 15 minutes at θ ≤ 40 C	For 1 s	A	210		210		240		380	
	For 10 s	A	105		105		145		240	
	For 1 min	A	61		61		84		120	
	For 10 min	A	30		30		40		50	
Protection by fuse against short-circuits (U ≤ 690 V)	Without thermal overload relay, fuse gG, type 1	A	25		40		50		63	
	Without thermal overload relay, fuse gG, type 2	A	20		25		35		40	
	With thermal overload relay	A	See pages 2/52 and 2/53, for aM or gG fuse ratings corresponding to the associated thermal overload relay							
Average impedance per pole	At Ith and 50 Hz	mΩ	2.5		2.5		2.5		2	
Power dissipation per pole for the above operating currents	AC-3	W	0.20		0.36		0.8		1.25	
	AC-1	W	1.56		1.56		2.5		3.2	
a.c. control circuit characteristics										
Rated control circuit voltage (Uc)	50/60 Hz	V	12…690							
Control voltage limits, 50 or 60 Hz coils	Operational		–							
	Drop-out		–							
Control voltage limits, 50/60 Hz coils	Operational		0.8…1.1 Uc on 50 Hz and 0.85…1.1 Uc on 60 Hz at 60 C							
	Drop-out		0.3…0.6 Uc at 60 C							
Average consumption at 20 C and at Uc, ~ 50 Hz	Inrush, 50 Hz coil	VA	–							
	Inrush, Cos φ		0.75							
	Inrush, 50/60 Hz coil	VA	70							
	Sealed, 50 Hz coil	VA	–							
	Sealed, Cos φ		0.3							
	Sealed, 50/60 Hz coil	VA	7							
~ 60 Hz	Inrush, 60 Hz coil	VA	–							
	Inrush, Cos φ		0.75							
	Inrush, 50/60 Hz coil	VA	70							
	Sealed, 60 Hz coil	VA	–							
	Sealed, Cos φ		0.3							
	Sealed, 50/60 Hz coil	VA	7.5							
Heat dissipation 50/60 Hz		W	2…3							
Operating time (3)	Closing "C"	ms	12…22							
	Opening "O"	ms	4…19							
Mechanical life in millions of operating cycles	50 or 60 Hz coil		–							
	50/60 Hz coil on 50 Hz		15							
Maximum operating rate at ambient temperature ≤ 60 C	In operating cycles per hour		3600							

(1) Protection ensured for the connection cross-sections shown on page 2/33 and for connection via cable.
(2) In the least favourable direction, without change of contact state (coil supplied at Ue).
(3) The closing time "C" is measured from the moment the coil supply is switched on to initial contact of the main poles. The opening time "O" is measured from the moment the coil supply is switched off to the moment the main poles separate.

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D32	DT60	D38	D40	D50	D65	D80	D95	D115	D150
32	32	38	40	50	65	80	95	115	150
50	60	50	60	80	80	125	125	200	200
690	690	690	1000	1000	1000	1000	1000	1000	1000
25…400	25…400	25…400	25…400	25…400	25…400	25…400	25…400	25…400	25…400
50	60	50	60	80	80	125	125	200	200
550	500	550	800	900	1000	1100	1100	1260	1660
550	500	550	800	900	1000	1100	1100	1100	1400
430	430	430	720	810	900	990	1100	1100	1400
260	260	310	320	400	520	640	800	950	1200
138	138	150	165	208	260	320	400	550	580
60	60	60	72	84	110	135	135	250	250
63	63	63	80	100	160	200	200	250	315
63	63	63	80	100	125	160	160	200	250
See pages 2/52 and 2/53, for aM or gG fuse ratings corresponding to the associated thermal overload relay									
2	2	2	1.5	1.5	1	0.8	0.8	0.6	0.6
2	2	3	2.4	3.7	4.2	5.1	7.2	7.9	13.5
5	5	5	5.4	9.6	6.4	12.5	12.5	24	24
12…690			24…660					24…500	
–			0.85…1.1 Uc at 55 C					0.85…1.1 Uc at 55 C	
–			0.3…0.6 Uc at 55 C					0.3…0.5 Uc at 55 C	
0.8…1.1 Uc on 50 Hz and 0.85…1.1 Uc on 60 Hz at 60 C			0.8…1.1 Uc on 50 Hz and 0.85…1.1 Uc on 60 Hz at 55 C					0.8…1.15 Uc on 50/60 Hz at 55 C	
0.3…0.6 Uc at 60 C			0.3…0.6 Uc at 55 C					0.3…0.5 Uc at 55 C	
–			200					300	–
0.75			0.75					0.8	0.9
70			245					280…350	280…350
–			20					22	–
0.3			0.3					0.3	0.9
7			26					2…18	2…18
–			220					300	–
0.75			0.75					0.8	0.9
70			245					280…350	280…350
–			22					22	–
0.3			0.3					0.3	0.9
7.5			26					2…18	2…18
2…3			6…10					3…8	3…4.5
12…22			20…26	20…26	20…26	20…35	20…35	20…50	20…35
4…19			8…12	8…12	8…12	6…20	6…20	6…20	40…75
–			16	16	16	10	10	8	–
15			6	6	6	4	4	8	8
3600			3600	3600	3600	3600	3600	2400	1200

2

d.c. control circuit characteristics

Type of contactor				LC1-D09…D38 DT20…DT60	LC1- or LP1-D40…D65	LC1 or LP1-D80	LC1-D115 & LC1-D150
Rated control circuit voltage (Uc)	⎓		V	12…440	12…440		24…440
Rated insulation voltage	Conforming to IEC 947-1		V	690			
	Conforming to UL, CSA		V	600			
Control voltage limits	Operational	Standard coil		0.7…1.25 Uc at 60 C	0.85…1.1 Uc at 55 C		0.75…1.2 Uc at 55 C
		Wide range coil		–	0.75…1.2 Uc at 55 C		–
	Drop-out			0.1…0.25 Uc at 60 C	0.1…0.3 Uc at 55 C		0.15…0.4 Uc at 55 C
Average consumption at 20 C and at Uc	⎓	Inrush	W	5.4	22	22	270 to 365
		Sealed	W	5.4	22	22	2.4…5.1
Average operating time (1) at Uc	Closing	“C”	ms	55	85…110	95…130	20…35
	Opening	“O”	ms	20	20…35	20…35	40…75
	Note: The arcing time depends on the circuit switched by the poles. For normal 3-phase applications, the arcing time is usually less than 10 ms. The load is isolated from the supply after a time equal to the sum of the opening time and the arcing time.						
Time constant (L/R)			ms	28	65	75	25
Mechanical life at Uc	In millions of operating cycles			30	20	20	8
Maximum operating rate at ambient temperature ≤ 60 C	In operating cycles per hour			3600	3600	3600	1200

Low consumption control circuit characteristics

Rated insulation voltage	Conforming to EN 60947-1		V	690
	Conforming to UL, CSA		V	600
Maximum voltage	Of the control circuit on ⎓			250
Average consumption d.c. at 20 C and at Uc	Wide range coil (0.7…1.25 Uc)	Inrush	W	2.4
		Sealed	W	2.4
Operating time (1) at Uc and at 20 C	Closing	“C”	ms	70
	Opening	“O”	ms	25
Voltage limits (θ ≤ 60 C) of the control circuit	Operational			0.7 to 1.25 Uc
	Drop-out			0.1…0.3 Uc
Time constant (L/R)			ms	40
Mechanical life	In millions of operating cycles			30
Maximum operating rate	At ambient temperature ≤ 60 C		ops/h	3600

(1) Operating times depend on the type of contactor electromagnet and its control mode.
The closing time “C” is measured from the moment the coil supply is switched on to initial contact of the main poles. The opening time “O” is measured from the moment the coil supply is switched off to the moment the main poles separate.
(2) In the least favourable direction, without change of contact state.

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Contactor integral auxiliary contact characteristics

Linked contacts conforming to draft standard IEC 947-4-5	Each contactor has 2 N/O and N/C contacts mechanically linked on the same movable contact holder		
Mirror contact	The N/C contact on each contactor represents the state of the power contacts and can be connected to a PREVENTA safety module		
Rated operational voltage (Ue)	Up to	V	690
Rated insulation voltage (Ui)	Conforming to IEC 947-1	V	690
	Conforming to UL, CSA	V	600
Conventional thermal current (Ith)	For ambient temperature ≤ 60 C	A	10
Operating current frequency		Hz	25…400
Minimum switching capacity $\lambda = 10^{-8}$	U min.	V	17
	I min.	mA	5
Short-circuit protection	Conforming to EN 60947-5-1		gG fuse: 10 A
Rated making capacity	Conforming to EN 60947-5-1, I rms	A	∿: 140, ⎓: 250
Short-time rating	Permissible for 1 s	A	100
	500 ms	A	120
	100 ms	A	140
Insulation resistance		MΩ	> 10
Non-overlap time	Guaranteed between N/C and N/O contacts	ms	1.5 on energisation and on de-energisation

Contact operating power conforming to EN 60947-5-1

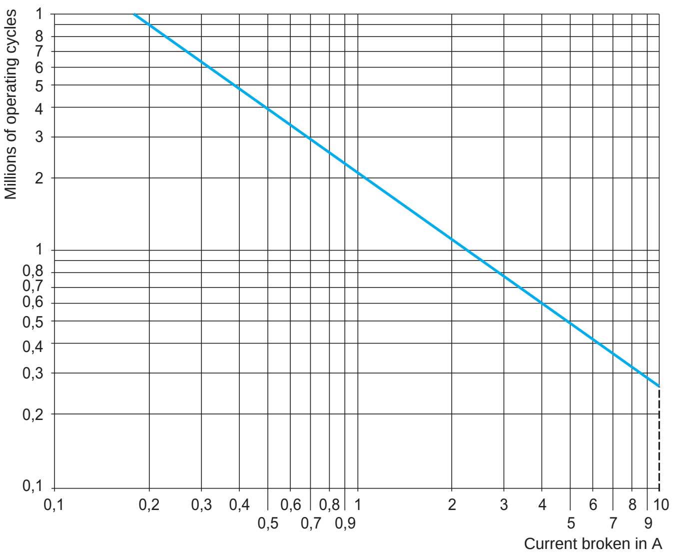
a.c. supply categories AC-14 and AC-15
Electrical life (valid for up to 3600 operating cycles/hour) on an inductive load such as the coil of an electromagnet: making power (cos φ 0.7) = 10 times the power broken (cos φ 0.4).

	V	24	48	115	230	400	440	600
1 million operating cycles	VA	60	120	280	560	960	1050	1440
3 million operating cycles	VA	16	32	80	160	280	300	420
10 million operating cycles	VA	4	8	20	40	70	80	100

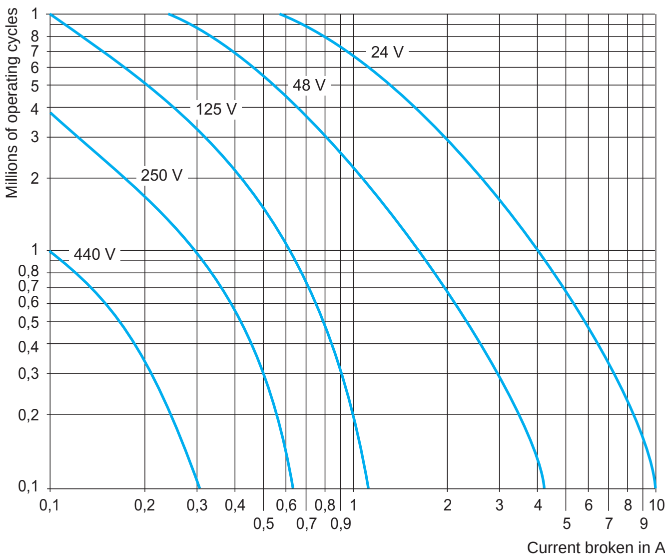
d.c. supply category DC-13
Electrical life (valid for up to 1200 operating cycles/hour) on an inductive load such as the coil of an electromagnet, without economy resistor, the time constant increasing with the load.

	V	24	48	125	250	440
1 million operating cycles	W	96	76	76	76	44
3 million operating cycles	W	48	38	38	32	–
10 million operating cycles	W	14	12	12	–	–

AC-15



DC-13



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TeSys contactors

Auxiliary contact blocks without dust and damp protected contacts for model d contactors

Contact block type			LAD-N or C	LAD-T & S	LAD-R	LAD-8
Environment						
Conforming to standards			IEC 947-5-1, NF C 63-140, VDE 0660, EN 60947-5-1			
Product certifications			UL, CSA			
Protective treatment	Conforming to IEC 68		“TH”			
Degree of protection	Conforming to VDE 0106		Protection against direct finger contact IP 2X			
Ambient air temperature around the device	Storage	C	- 60…+ 80			
	Operation	C	- 5…+ 60			
	Permissible for operation at Uc	C	- 40…+ 70			
Maximum operating altitude	Without derating	m	3000			
Cabling	Phillips N 2 and Ø 6 mm Flexible or solid cable with or without cable end	mm^2	Min.: 1 x 1; max.: 2 x 2.5			
Connection by spring terminals	Flexible or solid cable without cable end	mm^2	Max.: 2 x 2.5			
Instantaneous and time delay contact characteristics						
Number of contacts			1, 2 or 4	2	2	2
Rated operational voltage (Ue)	Up to	V	690			
Rated insulation voltage (Ui)	Conforming to EN 60947-5-1	V	690			
	Conforming to UL, CSA	V	600			
Conventional thermal current (Ith)	For ambient temperature ≤ 60 C	A	10			
Frequency of operational current		Hz	25…400			
Minimum switching capacity	U min.	V	17			
	I min.	mA	5			
Short-circuit protection	Conforming to EN 60947-5-1 and VDE 0660. gG fuse	A	10			
Rated making capacity	Conforming to EN 60947-5-1, I rms	A	∼: 140; ⎓: 250			
Short-time rating	Permissible for: 1 s	A	100			
	500 ms	A	120			
	100 ms	A	140			
Insulation resistance		MΩ	> 10			
Non-overlap time	Guaranteed between N/C and N/O contacts	ms	1.5 (on energisation and on de-energisation)			
Overlap time	Guaranteed between N/C and N/O on LAD-C22	ms	1.5	–	–	–
Time delay (LAD-T, R and S contact blocks) Accuracy only valid for setting range indicated on the front face	Ambient air temperature for operation	C	–	- 40…+ 70	- 40…+ 70	–
	Repeat accuracy		–	2 %	2 %	–
	Drift up to 0.5 million operating cycles		–	+ 15 %	+ 15 %	–
	Drift depending on ambient air temperature		–	0.25 % per C	0.25 % per C	–
Mechanical durability	In millions of operating cycles		30	5	5	30
Operational power of contacts			See page 2/40			

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TeSys contactors

Auxiliary contact blocks with dust and damp protected contacts for model d contactors

Contact block type			LA1-DX	LA1-DX		LA1-DY
				protected	non protected	
Environment						
Conforming to standards			IEC 947-5-1, VDE 0660			
Product certifications			UL, CSA			
Protective treatment	Conforming to IEC 68		"TH"			
Degree of protection	Conforming to VDE 0106		Protection against direct finger contact IP 2X			
Ambient air temperature	Storage and operation	C	- 25…+ 70			
Cabling	Phillips N 2 and Ø 6 mm Flexible or solid cable with or without cable end	mm^2	Min.: 1 x 1 Max.: 2 x 2.5			
Number of contacts			2	2	2	2
Contact characteristics						
Rated operational voltage (Ue)	Up to	V	50	50	690	24
Rated insulation voltage (Ui)	Conforming to IEC 947-5-1	V	250	250	690	250
	Conforming to UL, CSA	V	–	–	600	–
Conventional thermal current (Ith)	For ambient temperature ≤ 40 C	A	–	–	10	–
Maximum operational current (Ie)		mA	50	50	10	50
Frequency of operational current		Hz	–	–	25…400	–
Minimum switching capacity	U min.	V	3	3	17	3
	I min.	mA	0.3	0.3	5	0.3
Short-circuit protection	Conforming to EN 60947-5-1. gG fuse	A	–	–	10	–
Rated making capacity	Conforming to EN 60947-5-1, I rms	A	–	–	∼: 140; ⎓: 250	–
Short-time rating	Permissible for: 1 s	A	–	–	100	–
	500 ms	A	–	–	120	–
	100 ms	A	–	–	140	–
Insulation resistance		MΩ	> 10	> 10	> 10	> 10
Mechanical durability	In millions of operating cycles		5	5	30	5
Materials and technology used for dust and damp protected contacts			Gold - Single break with crossed bars	Gold - Single break with crossed bars	–	Gold - Single break with crossed bars

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TeSys contactors

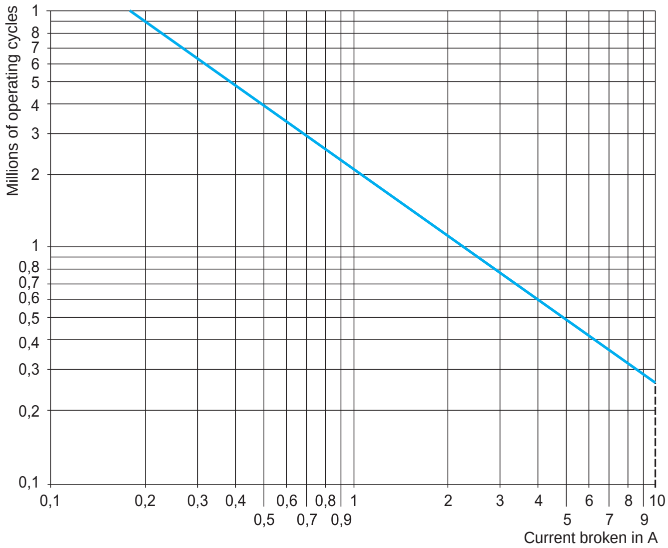
Auxiliary contact blocks with dust and damp protected contacts for model d contactors

Operational power of contacts (conforming to EN 60947-5-1)

a.c. supply, categories AC-14 and AC-15

Electrical durability (valid up to 3600 operating cycles/hour) on an inductive load such as the coil of an electromagnet: making power (cos φ 0.7) = 10 times the power broken (cos φ 0.4).

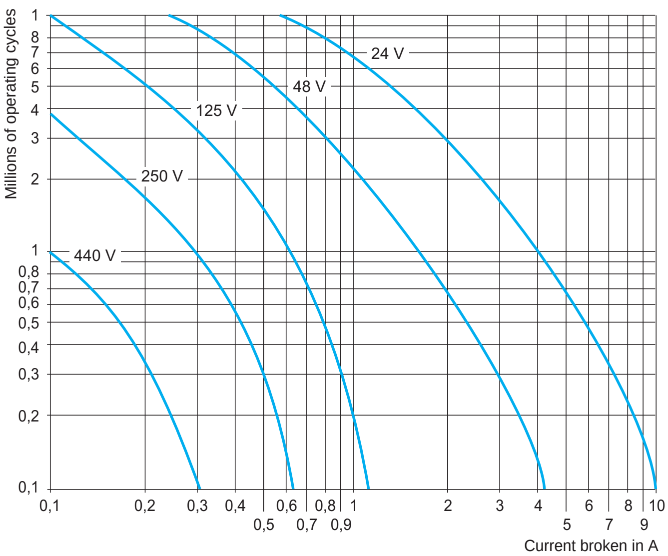
	V	24	48	115	230	400	440	600
1 million operating cycles	VA	60	120	280	560	960	1050	1440
3 million operating cycles	VA	16	32	80	160	280	300	420
10 million operating cycles	VA	4	8	20	40	70	80	100



d.c. supply, category DC-13

Electrical durability (valid up to 1200 operating cycles/hour) on an inductive load such as the coil of an electromagnet, without economy resistor, the time constant increasing with the power.

	V	24	48	125	250	440
1 million operating cycles	W	120	90	75	68	61
3 million operating cycles	W	70	50	38	33	28
10 million operating cycles	W	25	18	14	12	10



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TeSys contactors

Control modules, coil suppressor modules
and mechanical latch blocks
for model d contactors

Environment

Conforming to standards			IEC 947-5-1
Product certifications			UL, CSA
Protective treatment	Conforming to IEC 68		"TH"
Degree of protection	Conforming to VDE 0106		Protection against direct finger contact IP 2X
Ambient air temperature around the device	Storage	C	- 40…+ 80
	Operation	C	- 25…+ 55
	Permissible for operation at Uc	C	- 25…+ 70

"Auto - Man - Stop" control modules

Recommendation	The Auto - Man selector switch must only be operated with the Start - Stop ("O" "I") switch in position "O"		
Rated insulation voltage	Conforming to EN 60947-5-1	V	250
Rated operational voltage	Conforming to EN 60947-5-1	V	250
Protection	Against electric shocks	kV	2
Built-in protection	Contactor coil suppression		By varistor
Indication	By integral LED		Illuminates when the contactor coil is energised
Electrical durability	In operating cycles		20,000

Coil suppressor modules

Module type			LA4-DA LAD-4RC	LA4-DB LAD-4T	LA4-DC	LA4-DE LAD-4V
Type of protection			RC circuit	Bidirectional peak limiting diode	Diode	Varistor
Rated control circuit voltage (Uc)		V	~ 24…415	~ or ⎓ 24…72	⎓ 12…250	~ or ⎓ 24…250
Maximum peak voltage			3 Uc	2 Uc	Uc	2 Uc
Natural RC frequency	24/48 V	Hz	400	–	–	–
	50/127 V	Hz	200			
	110/240 V	Hz	100	–	–	–
	380/415 V	Hz	150	–	–	–

Mechanical latch blocks

Mechanical latch block type			LA6-DK10	LAD-6K10	LA6-DK20
For mounting on contactor			LC1D40…D65, LP1-D65	LC1-D09…D38, DT20…DT60	LC1-D80…D150 LP1-D80 and LC1-D115
Certification			UL, CSA		UL, CSA
Rated insulation voltage	Conforming to IEC 947-5-1	V	690		690
Rated control circuit voltage	~ 50/60 Hz and ⎓	V	24…415		24…415
Power required	For unlatching ~	VA	25		25
	⎓	W	30		30
Maximum operating rate	In operating cycles/hour		1200		1200
On-load factor			10 %		10 %
Mechanical durability at Uc	In millions of operating cycles		0.5		0.5

Unlatching can be manually operated locally or electrically controlled for remote operation.
The LA6-DK or LAD-6K latch coil and the LC1-D operating coil must not be energised simultaneously. The duration of the LA6-DK or LAD-6K and LC1-D control signals must be ≥ 100 ms.

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TeSys contactors

Electronic serial timer modules
for model d contactors

Module type			LA4-DT (On-delay)	LA4-DR (Off-delay) for LC1-D

Environment

Conforming to standards			IEC 255-5	
Product certifications			UL, CSA	
Protective treatment	Conforming to IEC 68		“TH”	
Degree of protection	Conforming to VDE 0106		Protection against direct finger contact IP 2X	
Ambient air temperature around the device	Storage	C	- 40…+ 80	
	Operation	C	- 25…+ 55	
	For operation at Uc	C	- 25…+ 70	
Rated insulation voltage (Ui)	Conforming to EN 60947-5-1	V	250	
Cabling	Phillips N 2 and Ø 6 mm Flexible or solid cable with or without cable end	mm^2	Min.: 1 x 1 Max.: 2 x 2.5	

Control circuit characteristics

Built-in protection	On input		By varistor	By varistor
	Suppression of contactor		By varistor	By bidirectional peak limiting diode
Rated control circuit voltage (Uc)		V	∼ or ⎓ 24…250	∼ 24…250
Permissible variation			0.8…1.1 Uc	0.8…1.1 Uc
Type of control			By mechanical contact only	By mechanical contact only, connecting cable < 10 m

Time delay characteristics

Timing ranges		s	0.1…2; 1.5…30; 25…500	0.1…2; 1.5…30; 25…500
Repeat accuracy	0…40 C		3 % (10 ms minimum)	3 % (10 ms minimum)
Reset time	During the time delay period	ms	150	225
	After the time delay period	ms	50	–
Immunity to micro-breaks	During the time delay period	ms	10	20
	After the time delay period	ms	2	–
Minimum control pulse duration		ms	–	40
Indication of time delay	By LED		Illuminates during time delay period	Illuminates during time delay period

Switching characteristics (solid state type)

Maximum power dissipated		W	2	3.5
Leakage current		mA	< 5	< 5
Residual voltage		V	3.3	3.3
Overvoltage protection			3 kV; 0.5 joule	3 kV; 0.5 joule
Electrical durability	In millions of operating cycles		30	30

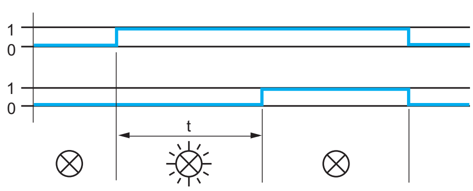
Operating diagrams

LA4-DT “On-delay” electronic timers

U supply
(A1-A2)

Time delay output
Contactor coil

Red LED



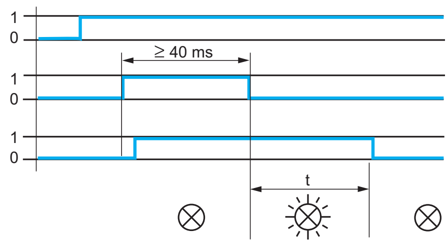
LA4-DR “Off-delay” electronic timers

U supply
(A1-A2)

Control
(A2-B2)

Time delay output
Contactor coil

Red LED



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TeSys contactors

Interface modules
for model d contactors

Environment

Conforming to standards			IEC 255-5
Product certifications			UL, CSA
Protective treatment	Conforming to IEC 68		"TH"
Degree of protection	Conforming to VDE 0106		Protection against direct finger contact IP 2X
Ambient air temperature around the device	Storage	C	- 40…+ 80
	Operation	C	- 25…+ 55
	Permissible for operation at Uc	C	- 25…+ 70

Other characteristics

Module type			LA4-DFBQ	LA4-DFB	LA4-DFE	LA4-DLB	LA4-DLE	LA4-DWB
			With relay	With relay	With relay	With relay + override		Solid state
Rated insulation voltage	Conforming to EN 60947-5-1	V	5	250				
Rated operational voltage	Conforming to EN 60947-5-1	V	415	250				
Indication of input state	By integral LED which illuminates when the contactor coil is energised							
Input signals	Control voltage (E1-E2)	V	⎓ 24	⎓ 24	⎓ 48	⎓ 24	⎓ 48	⎓ 24
	Permissible variation	V	17…30	17…30	33…60	17…30	33…60	5…30
	Current consumption at 20 C	mA	25	25	15	25	15	8.5 for 5 V 15 for 24 V
	State "0" guaranteed for U	V	< 2.4	< 2.4	< 4.8	< 2.4	< 4.8	< 2.4
	I	mA	< 2	< 2	< 1.3	< 2	< 1.3	< 2
	State "1" guaranteed for U	V	17	17	33	17	33	5
Built-in protection	Against reverse polarity		By diode					
	Of the input		By diode					
Electrical durability at 220/240 V	In millions of operating cycles		3	10	10	3	3	20
Maximum immunity time to micro-breaks		ms	4	4	4	4	4	1
Power dissipated	At 20 C	W	0.6	0.6	0.6	0.6	0.6	0.4
Direct mounting without contactor	With coil: ~ 24…250 V		–	LC1-D40…D150				–
	~ 100…250 V		–	–				LC1-D40…D115
	~ 380…415 V		LC1-D40…D150	–				–
Mounting with cabling adaptor LAD-4BB	With coil: ~ 24…250 V		–	LC1-D09…D38, DT20…DT60				LC1-D09…D38, DT20…DT60
	~ 380…415 V		LC1-D09…D38, DT20…DT60	–				–

Total operating time at Uc (of the contactor)

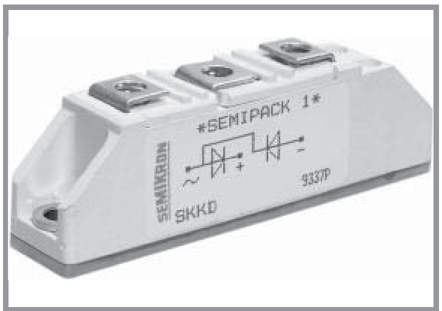
Operating times depend on the type of contactor electromagnet and its control mode.
The closing time "C" is measured from the moment the coil supply is switched on to initial contact of the main poles.
The opening time "O" is measured from the moment the coil supply is switched off to the moment the main poles separate.

			LC1-D09…D38, DT20…DT60	LC1-D40…D65	LC1-D80 and D95
With LA4-DF, DL	N/O	ms	20…30	28…34	28…43
	N/C	ms	16…24	20…24	18…32

Cabling	Phillips N 2 and Ø 6 mm	mm^2	Min.: 1 x 1
	Flexible or solid cable with or without cable end	mm^2	Min.: 2 x 2.5

References:
page 2/21
Dimensions:
pages 2/44 and 2/45
Schemes:
pages 2/48 and 2/49

SKKD 105F, SKMD 105F, SKND 105F



SEMIPACK 1

Fast Diode Modules

SKKD 105F

SKMD 105F

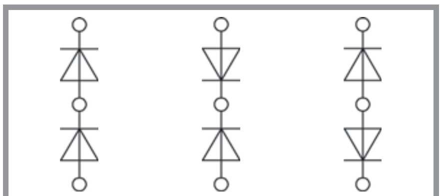
SKND 105F

Features

- Heat transfer through ceramic isolated metal baseplate
- Hard soldered joints for high reliability
- SKKD half bridge connection; centre tap connections: SKMD common cathode, SKND common anode
- UL recognized, file no. E 63 532

Typical Applications*

- Self-commutated inverters
- DC choppers
- AC motor speed control
- Inductive heating
- Uninterruptible power supplies
- Electronic welders
- General power switching applications



SKKD SKMD SKND

V_{RSM} V	V_{RRM} V	I_{FRMS} = 200 A (maximum value for continuous operation) I_{FAV} = 105 A (sin. 180; T_c = 83 °C)		
800	800	SKKD 105F08	SKMD 105F08	SKND 105F08
1000	1000	SKKD 105F10	SKMD 105F10	SKND 105F10
1200	1200	SKKD 105F12	SKMD 105F12	SKND 105F12
1600	1600	SKKD 105F16		

Symbol	Conditions	Values	Units
I_{FAV}	sin. 180; T_c = 85 (100) °C	102 (65)	A
I_{FSM}	T_{vj} = 25 °C; 10 ms	2500	A
	T_{vj} = 130 °C; 10 ms	2100	A
i²t	T_{vj} = 25 °C; 8,3 ... 10 ms	31250	A²s
	T_{vj} = 130 °C; 8,3 ... 10 ms	22000	A²s
V_F	T_{vj} = 25 °C; I_F = 300 A	max. 2,05	V
$V_{(TO)}$	T_{vj} = 130 °C	max. 1,2	V
r_T	T_{vj} = 130 °C	max. 2,5	mΩ
I_{RD}	T_{vj} = 25 °C; V_{RD} = V_{RRM}	max. 1	mA
I_{RD}	T_{vj} = 130 °C; V_{RD} = V_{RRM}	max. 30	mA
Q_{rr}	T_{vj} = 130 °C, I_F = 100 A,	50	µC
I_{RM}	-di/dt = 50 A/µs, V_R = 30 V	53	A
t_{rr}		1890	ns
E_{rr}		0,8	mJ
$R_{th(j-c)}$	per diode / per module	0,24 / 0,12	K/W
$R_{th(c-s)}$	per diode / per module	0,2 / 0,1	K/W
T_{vj}		- 40 ... + 130	°C
T_{stg}		- 40 ... + 125	°C
V_{isol}	a. c. 50 Hz; r.m.s; 1 s / 1 min.	3600 / 3000	V~
M_s	to heatsink	5 ± 15 %	Nm
M_t	to terminals	3 ± 15 %	Nm
a		5 * 9,81	m/s²
m	approx.	120	g
Case	SKKD	A 10	
	SKMD	A 33	
	SKND	A 37	

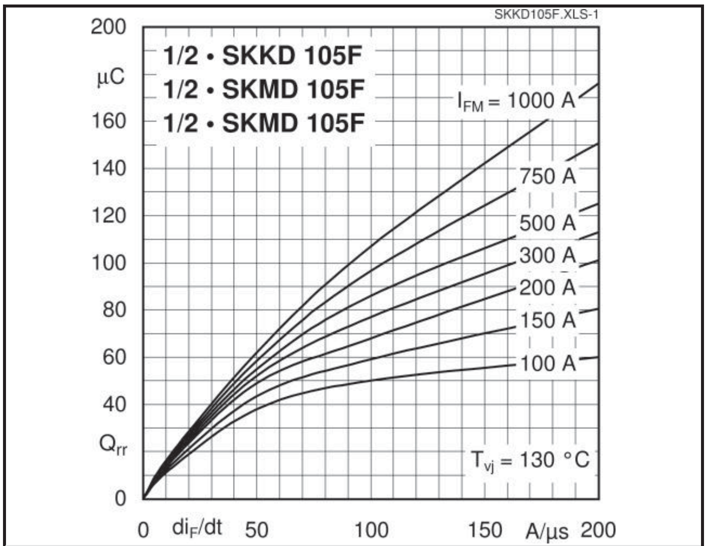


Fig. 1 Typ. recovery charge vs. current decrease

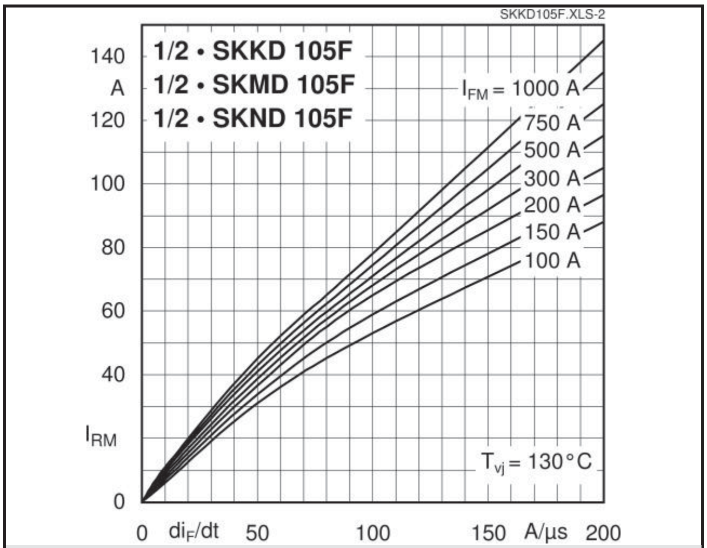


Fig. 2 Peak recovery current vs. current decrease

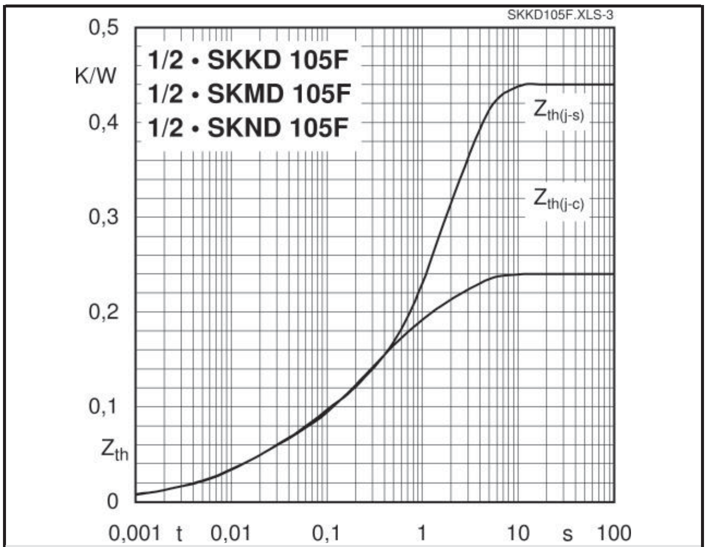


Fig. 3 Transient thermal impedance vs. time

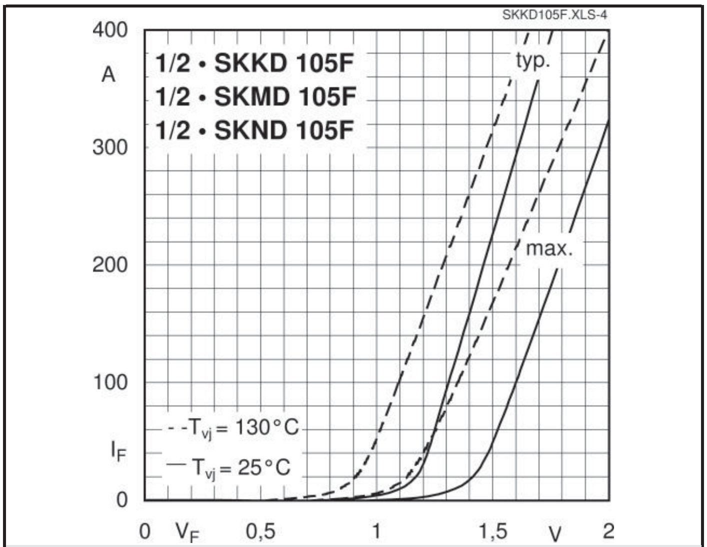


Fig. 4 Forward characteristics

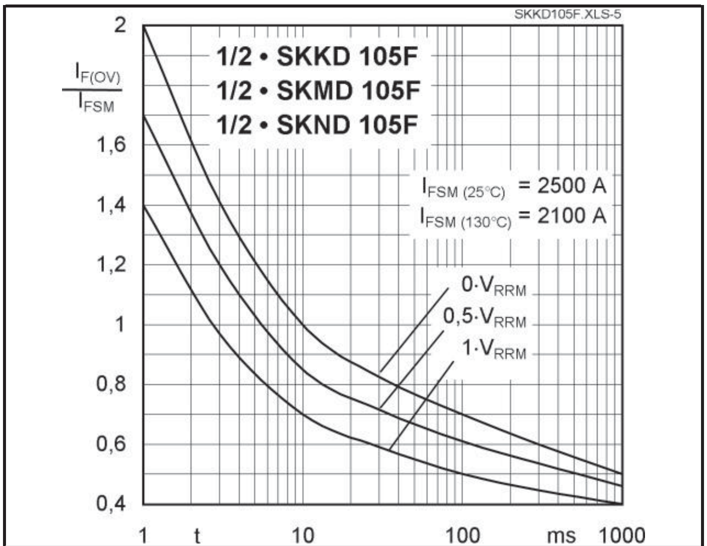
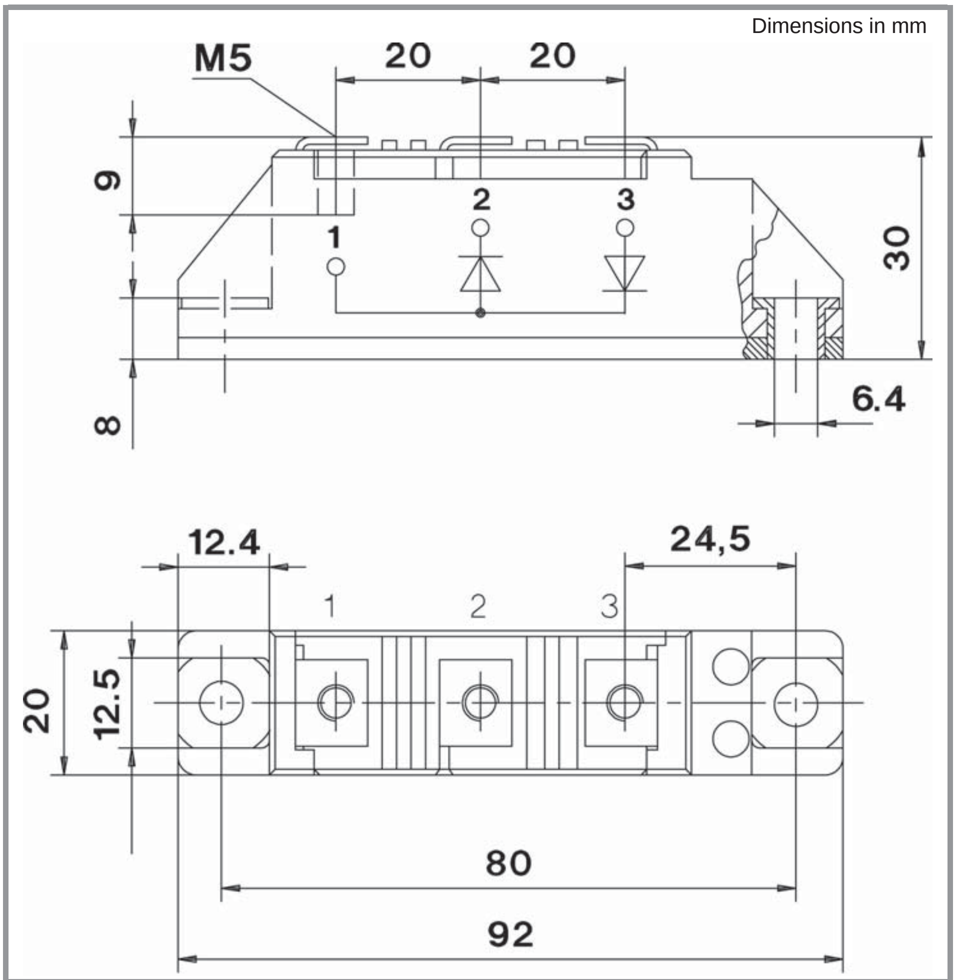
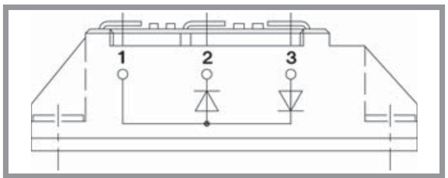


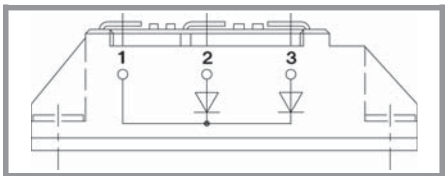
Fig. 5 Surge overload current vs. time



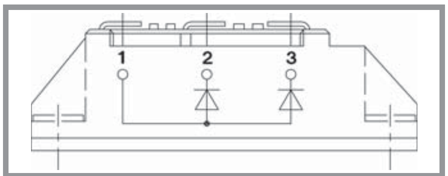
Case A 10



Case A 10 SKKD



Case A 33 SKMD



Case A 37 SKND

* The specifications of our components may not be considered as an assurance of component characteristics. Components have to be tested for the respective application. Adjustments may be necessary. The use of SEMIKRON products in life support appliances and systems is subject to prior specification and written approval by SEMIKRON. We therefore strongly recommend prior consultation of our personal.

LNK

METALLIZED POLYPROPYLENE
D.C. LINK CAPACITORS

ICAR

Technology Looking Ahead

Issue 031027

Via Isonzo 10, 20052 Monza (Mi) Italy

Replacement of Electrolytic Capacitors by Metallized Polypropylene Film Capacitors in DC Link application.

A typical industrial drive basically consist of two parts :

- An AC / DC section which convert the AC voltage of the industrial network at fixed frequency (50 ÷ 60 Hz) into a DC voltage.
- A DC / AC section that supply a motor at variable frequency.

These two parts are connected a DC bus (*Link circuit*) and capacitors are used in this section to filter the high frequency component (*DC Link Capacitors*) . The most important requirements for these capacitors are :

- the capability in withstanding high current at frequencies above 1000 Hz,
- the high energy density (*Joule / dm³*) .

Usually Electrolytic Capacitors are used up to a voltage around 2000 V . Beside the advantage of having a very large capacitance value per can the limits for Electrolytic capacitors are :

- The maximum working voltage across each capacitor which is around 450 ÷ 500 V
- The current , especially at high frequency , is limited by their high ESR (*Equivalent Series Resistance*) .

Consequently, in most of the cases , Electrolytic Capacitors have to be connected in series/parallel to form banks to reach the requested performances in terms of Voltage and Current.

Seen the above , in order to reduce the ripple current , the banks are often designed with a very large equivalent capacitance which is normally easy to get with electrolytics capacitors. In other words the equivalent capacitance of these banks can be much lower whenever the capacitors would be able to handle an higher current . Another important point to keep into account in assembling Electrolytic Capacitor banks is to pay attention at the connection in order to keep the inductance as low as possible.

In many cases it is possible to replace favourably Electrolytic Capacitors with Metallized film capacitors.

Under certain conditions the saving become evident already at 500 V and it is more and more important as well as the voltage increase.
As commented , there is no availability of Electrolytic Capacitors above 450 ÷ 500 V, on the opposite it is quite normal to manufacture Metallized Film Capacitors which can work at several thousands of Volts .
Moreover, since Metallized Film Capacitors can handle, with the same capacitance, much higher current than Electrolytic , it is possible , and also convenient, to reduce the total equivalent capacitance of the bank.

Here are the main reasons to choice a Metallized Film Capacitors :

- Much higher current per capacitance (A/μF) i.e. possibility of using a lower capacitance bank.
- Higher voltage per element i.e. there is no need of series connection.
- Higher capability to wistand to overvoltages , up to 2 times the rated voltage.
- More than 10 years lifetime in the temperature range -25 ÷ +70 ºC .
- Non polar dielectric.

Beside the above mentioned advantages typical of all the Metallized Film Capacitors ***ICAR,*** exploiting the 50 years experience in capacitor manufacturing , has developed this new range of DC Link capacitors **LNK series** with further advantages.

- By using a new metallizing process (patented) on polypropylene film ***ICAR*** can offer capacitors which size is less than one half if compared with the traditionally Metallized capacitors .
- The use of polypropylene make the dielectric losses extremely low at any frequency ,(i.e. very low ESR) this make this kind of capacitor extremely valid at the very high frequency typical of the last generation of IGBT inverters.

LNK construction consist of a completely dry resin filled capacitor, plastic casing , self extinguish. No more leakage problems, no more dangerous electrolytes.

Issue 031027

Via Isonzo 10, 20052 Monza (Mi) Italy

LNK SERIES ICAR CAPACITORS

General Technical Characteristics

Environmental:

Operating temperature:

ϑ_{min} : - 25°C ϑ_{max} : + 70°C

Storage temperature

ϑ_{min} : - 40°C ϑ_{max} : + 85°C

Ratings:

Capacitance tolerance: ± 10%

Useful life (at 70°C hot-spot): 100000 hrs.

Reliability: 300 FIT.

Casing:

Self extinguishing, low smoke plastic material.

Filler / impregnant:

Self extinguishing resin.

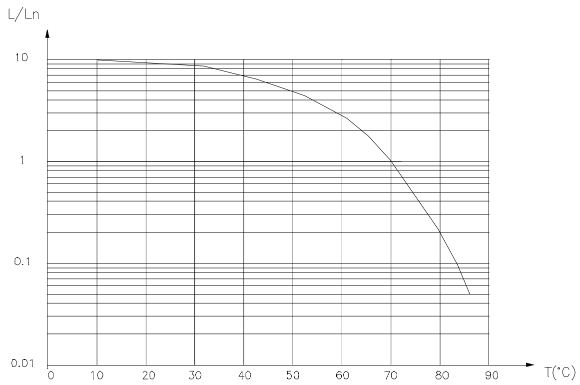
Standard of reference:

IEC 61071 – 60068 - 61881

With the new LNK series a new level of safety for the DC capacitors has been reached:

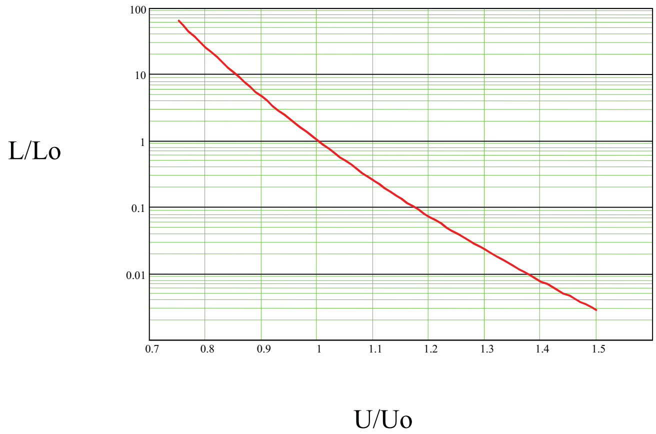
- ***Active safety:*** When the capacitor is stressed within the specifications, Icar patented metalization is designed to bring capacitor to an open circuit at the end of life.
- ***Passive safety:*** In case of failure the gas generated in not trapped in a sealed aluminium case but has a safe way out given by breaking of the casting resin. The risk of explosion is then dramatically reduced.
- ***Fire prevention:*** Casting resin and case material are flame retardant

Expected life versus hot spot temperature at rated voltage



Ln = expected life with hot spot temperature of 70°C
L = expected life with hot spot temperature T

Useful life versus voltage



Ln = expected life at rated voltage Un
L = expected life at U

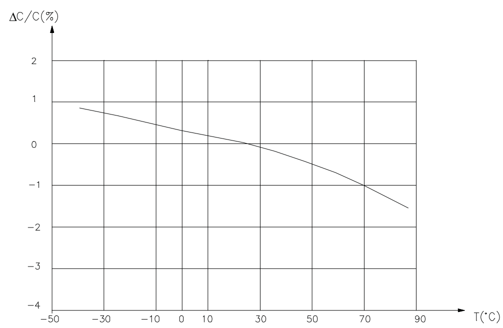
LNK SERIES

METALLIZED POLYPROPYLENE D.C. LINK CAPACITORS

Replacing Electrolitycs Capacitors by Metallized Polypropylene Film Capacitors.

- **No series connections for higher Voltage (Up to 4000 Vdc).**
- **Extremely low losses even at very high frequencies.**
- **Higher ripple current.**
- **Plastic case**
- **Lower E.S.R.**
- **Dry , environmental friendly construction.**

Capacitance variation versus temperature



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SELECTING THE CORRECT CAPACITOR

VOLTAGE

The first check should be done on the working voltage: The surge voltage U_S, the rated voltages U_N and U_{rms} should be not higher than the operating values.
Also the sum of the ripple and the dc component of the voltage should not be beyond the rated voltage U_N.
Although it is possible to work above the rated voltage, this will mean a reduction of the expected life; this can be evaluated through the correspondent graph.

CURRENT LIMITATION

The I_{rms} current must not exceed the maximum current I_{max}. The current must also be compatible with the maximum power that can be dissipated.
The I_{mxx} values in the schedules was been calculated supposing irrelevant the dielectric losses (Q" tan δ_0)and they correspond with a difference of temperature (θ_n – θ_0)of about 20°C. As a consequence, to have an expected life of 100.000 at the maximum current, the ambient temperature has not to exceed of 50°C.
If not the expected life will be calculated again using the graph on the following page.
The thermal check, here indicated, will be done in any case.
In case of forced air cooling the thermal resistance will be reduced of 30%.

THERMAL CHECK

First of all the power due to the internal losses of the capacitor should be calculated.
These power losses consist of the dielectric losses and series losses (R_S * I^2_{rms}) i.e. those due to the resistance of the armatures and the connections.
The total power can be calculated as follows:
$P = Q \tan \delta_0 + R_S I^2_{rms}$
It is now possible to calculate the hot spot temperature as:
$\vartheta_h = R_{th} * P + \vartheta_0$.
The expected life for these capacitors is actually calculated with the assumption the hot spot temperature is 70°C. In these conditions, at rated voltage the expected life is calculated as 100000 hours, with a failure rate of 300 FIT.
Using the enclosed graphs and other data here given the designer can calculate the expected life of the in the actual working conditions.

WARNING

This thermal check supposes that only the heat generated into the capacitor is transmitted to the environment through the case surface. Eventual localised overheating (poor connections, hot components in the nearby etc.) would then likely bring the capacitor to a dramatic reduction of the expected life.

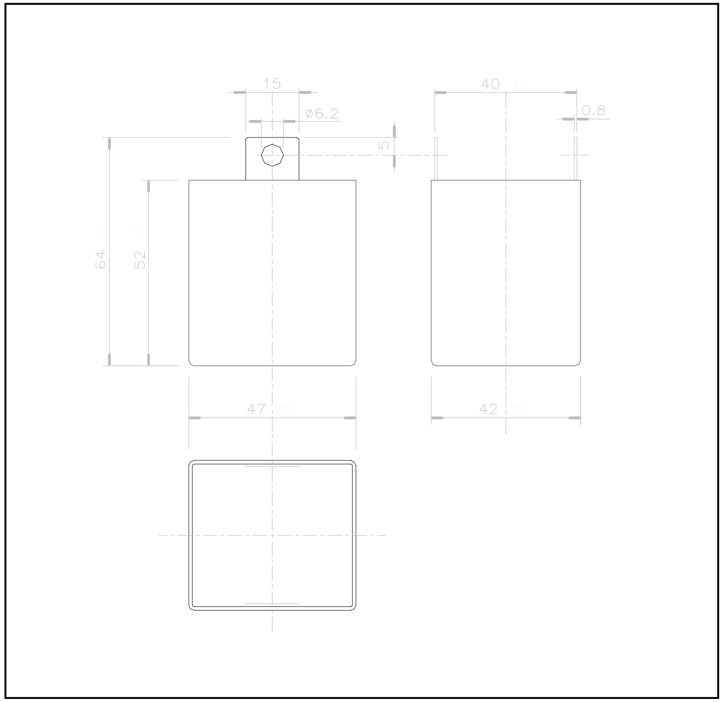
DEFINITIONS

C_N	Rated Capacitance.
U_N	Rated (repetitive peak) voltage.
U_{rms}	Rated rms. voltage.
U_S	Surge (not repetitive) peak voltage.
I_{max}	Maximum rms. current value for continuous operation.
Q	Reactive power = 2 * π * F * C * U²rms
F	Fundamental frequency.
R_S	Series resistance i.e. the resistance responsible for the current heat losses ($I^2 R_S$) in the capacitor.
ESR	Equivalent Series Resistance defined as $ESR = R_S + \tan \delta_0 / 2*\pi*f*C$
tan δ_0	Dielectric dissipation factor. It can be considered as constant in the normal working frequency range. Typical value for polypropylene is $2*10^{-4}$.
tan δ	Dissipation factor calculated as: $\tan \delta_0 + 2*\pi*C*F*R_S$.
dv/dt	Maximum slope of the voltage waveshape.
I_{PK}	Peak current $I_{PK} = C * dv/dt$.
P	Total power dissipated in the capacitor.
R_{th}	Thermal resistance between the hot-spot in the winding and the environment (natural cooling), so that: $P = (\vartheta_h - \vartheta_0) / R_{th}$
ϑ_h	Hottest point in the capacitor winding.
ϑ_0	Operating ambient temperature. It is the air temperature measured under steady conditions, measured at 0,1 m from capacitor case.
L_0	Expected life at rated voltage U_0 and hot-spot temperature of 70°C
L	Expected life at the actual working conditions, obtained from the enclosed graph.
L_S	Self inductance of the capacitor. It is due to the internal connections, terminals, winding characteristics and physical dimensions.

Via Isonzo 10, 20052 Monza (Mi) Italy

LNK – P1X - … Series

Very low inductance, small size.



Model	Capacitance	Rated DC Voltage	Rated AC Voltage	Paek Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with natural cooling	Full current Max Working frequency**	Weight	Box quantity
	C (µF)	Un (V)	Urms (V)	Us (V)	Imax (A)	(V / µs)	L (nH)	Rs (m W)	Rthn (°C/W)	(kHz)	(kg)	(pcs)
LNK-P1X –45-70	45	700	200	1400	40	50	10	1.40	8	50	0.15	100
LNK-P1X –30-90	30	900	250	1800	35	70	10	1.70	8	50	0.15	100
LNK-P1X –25-100	25	1000	300	2000	35	100	10	1.80	8	50	0.15	100
LNK-P1X –22-110	22	1100	350	2200	35	85	10	1.90	8	50	0.15	100
LNK-P1X –16-125	16	1250	400	2500	25	100	10	2.28	8	50	0.15	100
LNK-P1X –10-145	10	1450	400	2900	20	110	10	3.00	8	50	0.15	100
LNK-P1X –7.5-180	7.5	1800	450	3600	15	140	10	3.25	8	50	0.15	100

**In case of doubt regarding maximum working frequency, please contact Icar Tech. Dept. for de-rating according to current spectrum

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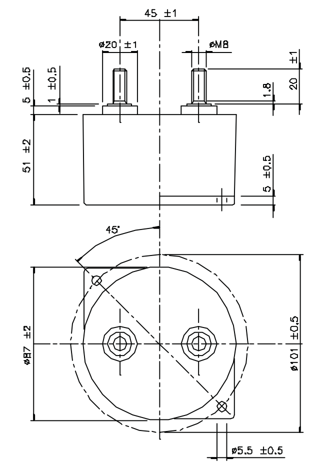
LNK – P2X - … Series

High current for heatsink mounting



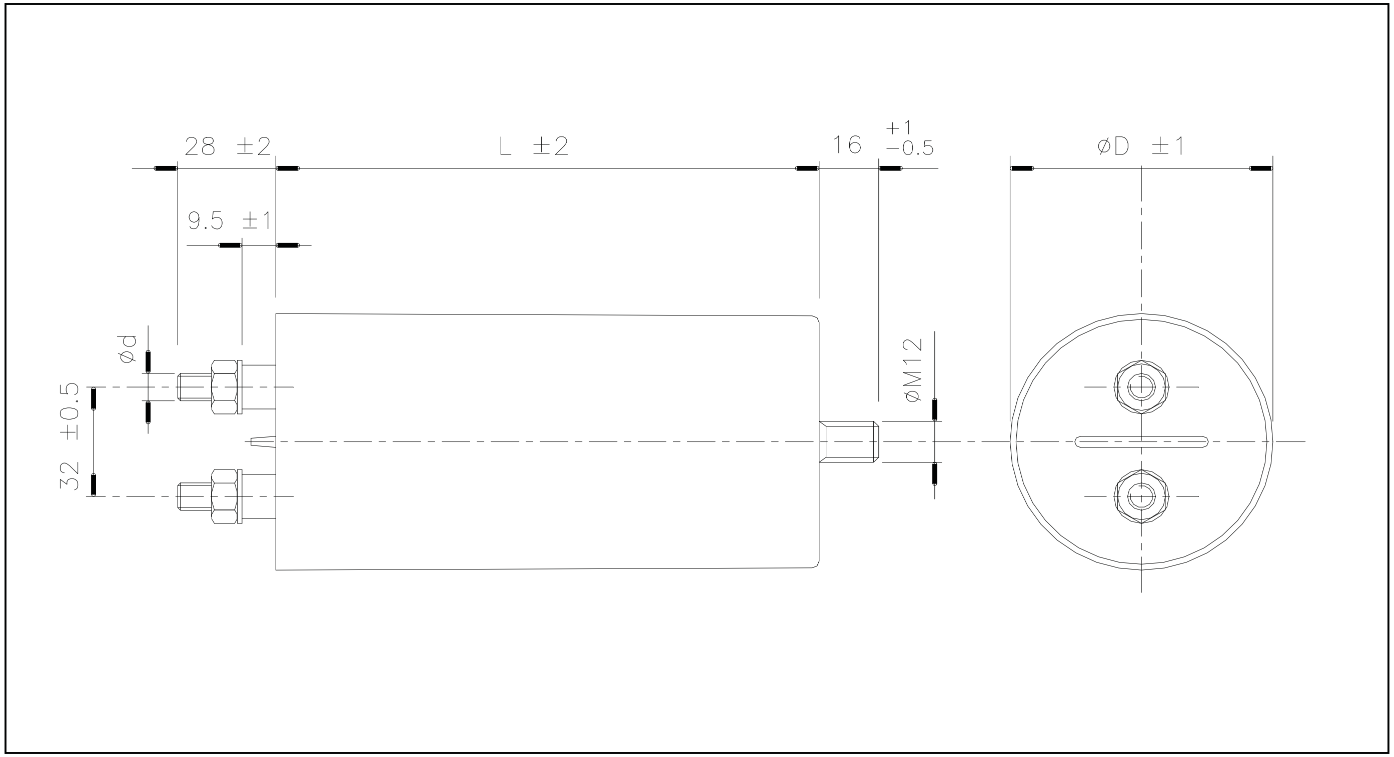
Model	Capacitance	Rated DC Voltage	Rated AC Voltage	Peak Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with natural cooling	Full current Max Working Frequency**	Tightening Torque	Weight	Box qty
	C (µF)	Un (V)	Urms (V)	Us (V)	Imax (A)	(V / µs)	L (nH)	Rs (m W)	Rthn (°C/W)	(kHz)	(Nm)	(kg)	(pcs)
LNK-P2X-150-70	150	700	200	1400	100	55	<30	0.4	5	20	10	0.5	16
LNK-P2X-100-90	100	900	250	1800	80	70	<30	0.55	5	20	10	0.5	16
LNK-P2X-80-100	80	1000	300	2000	80	75	<30	0.6	5	20	10	0.5	16
LNK-P2X-70-110	70	1100	350	2200	80	80	<30	0.65	5	20	10	0.5	16
LNK-P2X-50-125	50	1250	400	2500	80	95	<30	0.75	5	20	10	0.5	16
LNK-P2X-40-145	40	1450	400	2900	80	110	<30	0.8	5	20	10	0.5	16
LNK-P2X-25-180	25	1800	450	3600	60	140	<30	1	5	20	10	0.5	16

* Thermal resistance is calculated with the capacitor installed on a heatsink through an heat conductive paste, In case this is not be done thermal resistance should be considered as the double so that the current rating should be consequently reduced.

** In case of doubt regarding maximum working frequency, please contact Icar Tech. Dept. for de-rating according to current spectrum

LNK – P3X - … Series

For an easier replacement of electrolytic capacitors



LNK – P3X - … Series

For an easier replacement of electrolytic capacitors

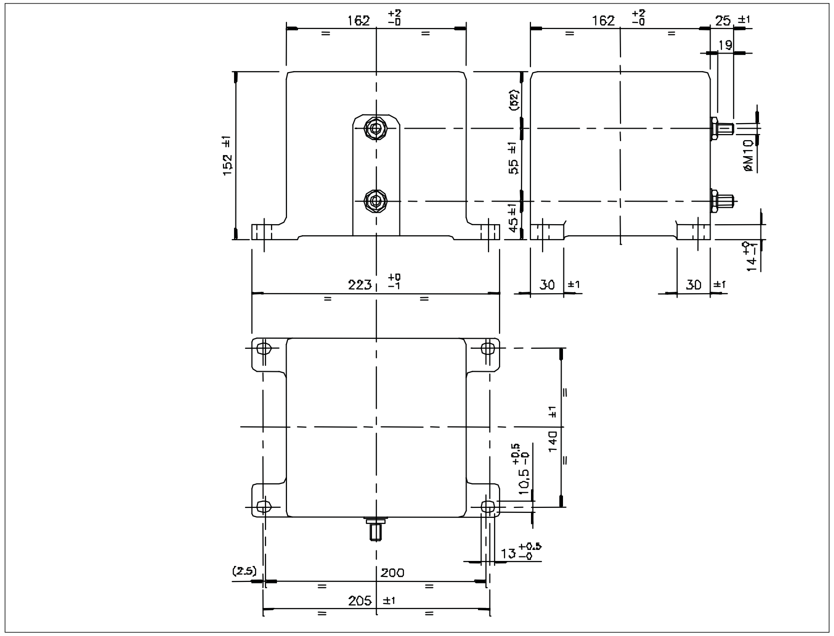
Model	Capacitance	Reted DC Voltage	Rated AC Voltage	Peak Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with natural cooling	Full current Max Working Frequency**	Tightening Torque	Weight	d	D	L	Box qty
	C (µF)	Un (V)	Urms (V)	Us (V)	Imax (A)	(V / µs)	L (nH)	Rs (mΩ)	Rthn (°C/W)	(kHz)	(Nm)	(kg)	(mm)	(mm)	(mm)	(pcs)
LNK-P3X-200-70	200	700	200	1400	30	20	80	3.9	5.7	5	6	0.5	M6	60	140	36
LNK-P3X-400-70	400	700	200	1400	40	20	90	2.7	4.5	5	6	0.9	M6	75	155	16
LNK-P3X-750-70	750	700	200	1400	55	20	90	1.6	4.00	5	10	1.4	M8	100	155	9
LNK-P3X-140-90	140	900	250	1800	30	20	80	4.0	6.04	5	6	0.5	M6	60	140	36
LNK-P3X-250-90	250	900	250	1800	40	20	90	2.03	5.04	5	6	0.9	M6	75	155	16
LNK-P3X-500-90	500	900	250	1800	55	20	90	1.09	3.07	5	10	1.4	M8	100	155	9
LNK-P3X-120-100	120	1000	300	2000	30	20	80	4.02	6.03	5	6	0.5	M6	60	140	36
LNK-P3X-200-100	200	1000	300	2000	40	20	90	3.03	5.05	5	6	0.9	M6	75	155	16
LNK-P3X-400-100	400	1000	300	2000	55	20	90	2.00	3.07	5	10	1.4	M8	100	155	9
LNK-P3X-100-110	100	1100	350	2200	30	20	80	4.07	6.04	5	6	0.5	M6	60	140	36
LNK-P3X-190-110	190	1100	350	2200	40	20	90	3.03	5.01	5	6	0.9	M6	75	155	16
LNK-P3X-350-110	350	1100	350	2200	55	20	90	2.02	3.07	5	10	1.4	M8	100	155	9
LNK-P3X-75-125	75	1250	400	2500	30	30	80	5.04	6.03	5	6	0.5	M6	60	140	39
LNK-P3X-140-125	140	1250	400	2500	40	20	90	3.08	5.01	5	6	0.9	M6	75	155	16
LNK-P3X-250-125	250	1250	400	2500	55	20	90	2.05	3.07	5	10	1.4	M8	100	155	9
LNK-P3X-50-145	50	1450	400	2900	25	30	80	7.0	6.07	5	6	0.5	M6	60	140	36
LNK-P3X-100-145	100	1450	400	2900	30	30	90	4.06	5.03	5	6	0.9	M6	75	155	16
LNK-P3X-200-145	200	1450	400	2900	55	30	90	2.07	3.07	5	10	1.4	M8	100	155	9
LNK-P3X-33-180	33	1800	450	3600	20	40	80	8.05	6.06	5	6	0.5	M6	60	140	36
LNK-P3X-66-180	66	1800	450	3600	30	30	90	5.06	5.00	5	6	0.9	M6	75	155	16
LNK-P3X-125-180	125	1800	450	3600	45	30	90	3.03	3.07	5	10	1.4	M8	100	155	9

** In case of doubt regarding maximum working frequency, please contact Icar Tech. Dept. for de-rating according to current spectrum

Via Isonzo 10, 20052 Monza (Mi) Italy

LNK – P4X - ... Series

Sturdy construction for heavy duty



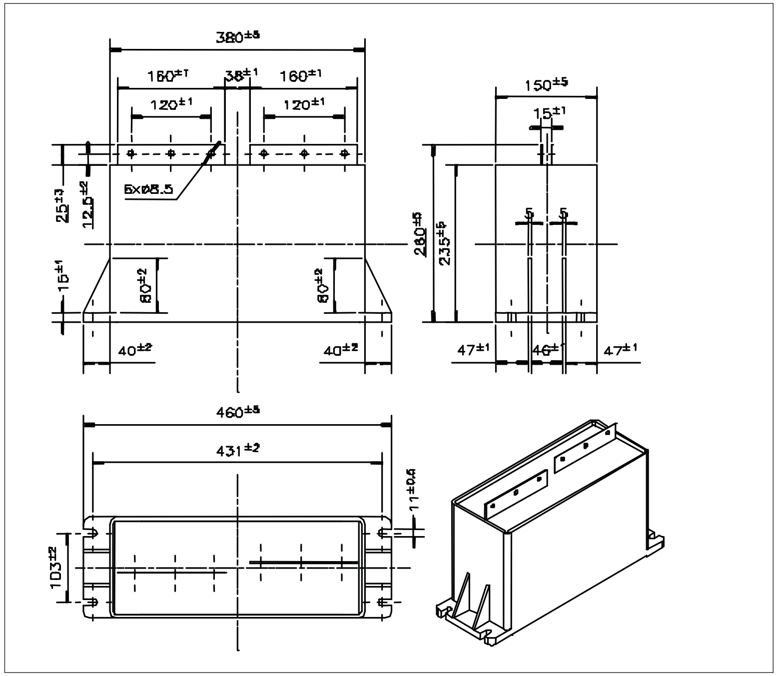
Model	Capacitance	Rated DC Voltage	Rated AC Voltage	Peak Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with natural cooling	Full current Max Working Frequency**	Tightening Torque	Weight	Box qty
	C (µF)	Un (V)	Urms (V)	Us (V)	Imax (A)	(V / µs)	L (nH)	Rs (mΩ)	Rthn (°C/W)	(kHz)	(Nm)	(kg)	(pcs)
LNK-P4X-2000-70	2000	700	200	1400	120	3	<30	0.5	2	20	20	5	4
LNK-P4X-1300-90	1300	900	250	1800	120	6	<30	0.6	2	20	20	5	4
LNK-P4X-900-110	900	1100	350	2200	120	10	<30	0.7	2	20	20	5	4
LNK-P4X-650-125	650	1250	400	2500	120	25	<30	0.8	2	20	20	5	4
LNK-P4X-500-145	500	1450	400	2900	100	30	<30	0.9	2	20	20	5	4
LNK-P4X-350-180	350	1800	450	3600	100	35	<30	1.1	2	20	20	5	4
LNK-P4X-220-220	220	2200	700	4400	120	85	<30	0.7	2	20	20	5	4
LNK-P4X-55-400	55	4000	1000	8000	60	150	<30	2.85	2	20	20	5	4
LNK-P4X-20-500	20	5000	1250	10000	50	280	<30	4.5	2	20	20	5	4

** In case of doubt regarding maximum working frequency, please contact Icar Tech. Dept. for de-rating according to current spectrum

Via Isonzo 10, 20052 Monza (Mi) Italy

LNK – P5X - … Series

High capacitance, low inductance connections



Model	Capacitance	Rated DC Voltage	Rated AC Voltage	Peak Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with natural cooling	Full current Max Working Frequency**	Weight	Box qty
	C (µF)	Un (V)	Urms	Us (V)	Imax (A)	(V / µs)	L (nH)	Rs (m Ω)	Rthn (°C/W)	(kHz)	(kg)	(pcs)
LNK-P5X-8000-70	8000	700	200	1400	300	4	<30	0.14	1.15	20	18	1
LNK-P5X-5000-90	5000	900	250	1800	300	4	<30	0.18	1.15	20	18	1
LNK-P5X-4200-100	4200	1000	300	2000	250	4	<30	0.19	1.15	20	18	1
LNK-P5X-3500-110	3500	1100	350	2200	250	5	<30	0.21	1.15	20	18	1
LNK-P5X-2600-125	2600	1250	420	2500	250	7	<30	0.24	1.15	20	18	1
LNK-P5X-2000-145	2000	1450	420	2900	200	8	<30	0.28	1.15	20	18	1
LNK-P5X-1600-160	1600	1600	420	3200	200	10	<30	0.31	1.15	20	18	1
LNK-P5X-1300-180	1300	1800	450	3600	200	10	<30	0.34	1.15	20	18	1
LNK-P5X-1000-200	1000	2000	600	4000	250	25	<30	0.19	1.15	20	18	1
LNK-P5X-850-220	850	2200	700	4400	250	30	<30	0.21	1.15	20	18	1
LNK-P5X-650-250	650	2500	800	5000	250	30	<30	0.23	1.15	20	18	1
LNK-P5X-500-290	500	2900	850	5800	200	38	<30	0.27	1.15	20	18	1
LNK-P5X-400-320	400	3200	900	6400	200	40	<30	0.3	1.15	20	18	1
LNK-P5X-300-360	300	3600	950	7200	200	45	<30	0.36	1.15	20	18	1

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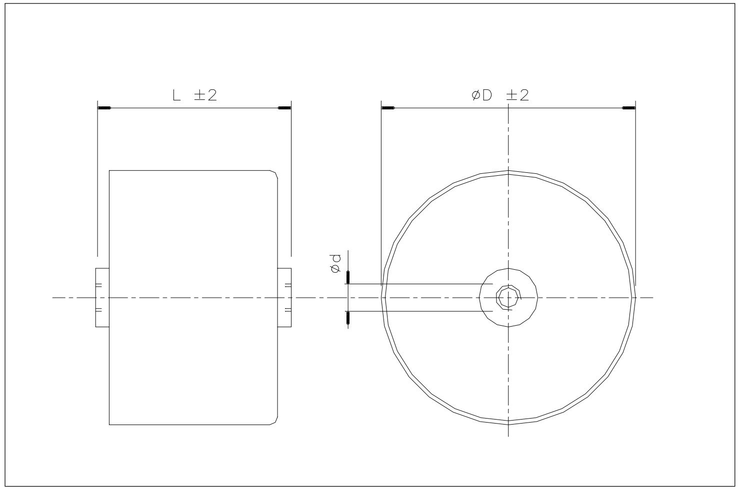
Via Isonzo 10, 20052 Monza (Mi) Italy

LNK – P6X - … Series

Axial, very low inductance



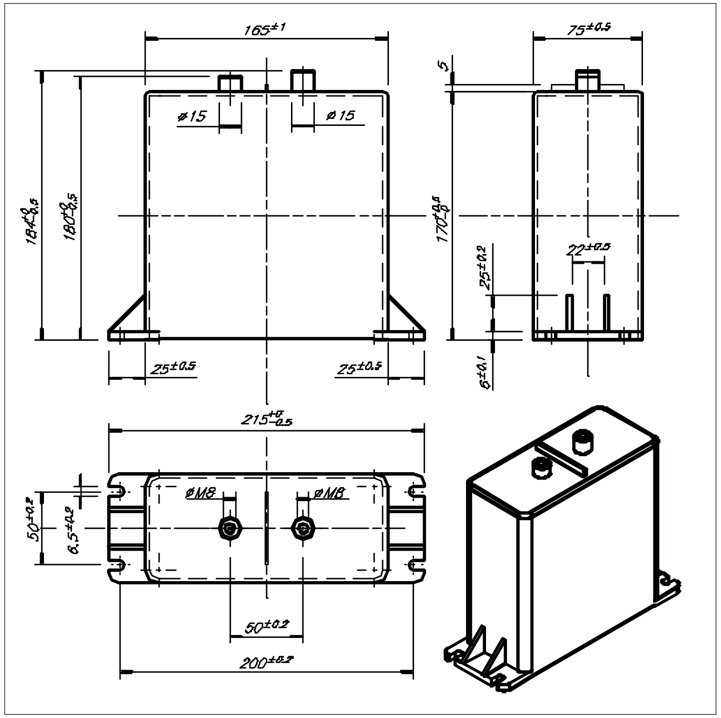
Model	Capacitance	Rated DC Voltage	Rated AC Voltage	Peak Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with natural cooling	Full current Max Working Frequency**	Tightening Torque	Weight	d	D	L	Box qty
	C (µF)	Un (V)	Urms (V)	Us (V)	Imax (A)	(V / µs)	L (nH)	Rs (mΩ)	Rthn (°C/W)	(kHz)	(Nm)	(kg)	(mm)	(mm)	(mm)	(pcs)
LNK-P6X-90-70	90	700	200	1400	80	30	10	0.7	3.5	30	6	0.27	M6	70	59	25
LNK-P6X-125-70	125	700	200	1400	80	30	10	0.5	3	30	10	0.41	M8	80	62	16
LNK-P6X-150-70	150	700	200	1400	80	30	10	0.4	2.5	30	10	0.47	M8	90	62	16
LNK-P6X-50-90	50	900	250	1700	50	30	10	1	3.5	30	6	0.27	M6	70	59	25
LNK-P6X-75-90	75	900	250	1700	70	30	10	0.7	3	30	10	0.41	M8	80	62	16
LNK-P6X-100-90	100	900	250	1700	80	30	10	0.5	2.5	30	10	0.47	M8	90	62	16
LNK-P6X-33-110	33	1100	350	2200	45	40	10	1.3	3.5	30	6	0.27	M6	70	59	25
LNK-P6X-50-110	50	1100	350	2200	55	40	10	0.9	3	30	10	0.41	M8	80	62	16
LNK-P6X-66-110	66	1100	350	2200	75	40	10	0.6	2.5	30	10	0.47	M8	90	62	16
LNK-P6X-30-125	30	1250	400	2500	30	50	10	1.6	3.5	30	6	0.27	M6	70	59	25
LNK-P6X-40-125	40	1250	400	2500	40	50	10	1.1	3	30	10	0.41	M8	80	62	16
LNK-P6X-50-125	50	1250	400	2500	50	50	10	0.8	2.5	30	10	0.47	M8	90	62	16
LNK-P6X-20-145	20	1450	400	2900	40	110	10	1.6	3.5	30	6	0.27	M6	70	59	25
LNK-P6X-30-145	30	1450	400	2900	50	110	10	1.1	3	30	10	0.41	M8	80	62	16
LNK-P6X-40-145	40	1450	400	2900	65	110	10	0.8	2.5	30	10	0.47	M8	90	62	16
LNK-P6X-15-180	15	1800	450	3600	40	130	10	1.7	3.5	30	6	0.27	M6	70	59	25
LNK-P6X-20-180	20	1800	450	3600	50	130	10	1.3	3	30	10	0.41	M8	80	62	16
LNK-P6X-25-180	25	1800	450	3600	60	130	10	1	2.5	30	10	0.47	M8	90	62	16

** In case of doubt regarding maximum working frequency, please contact Icar Tech. Dept. for de-rating according to current spectrum

Via Isonzo 10, 20052 Monza (Mi) Italy

LNK – P7X - … Series

High current, low inductance, for busbars connections



Model	Capacitance	Rated DC Voltage	Rated AC Voltage	Peak Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with Natural cooling	Full current Max Working Frequency**	Tightening Torque	Weight	Box qty
	C (µF)	Un (V)	Urms (V)	Us (V)	Imax (A)	(V / µs)	L (nH)	Rs (mΩ)	Rthn (°C/W)	(kHz)	(Nm)	(kg)	(pcs)
LNK-P7X-1200-70	1200	700	200	1400	180	10	30	0.22	2.02	20	12	2.9	8
LNK-P7X-750-90	750	900	250	1800	155	10	30	0.28	2.02	20	12	2.9	8
LNK-P7X-600-100	600	1000	300	2000	150	13	30	0.32	2.02	20	12	2.9	8
LNK-P7X-500-110	500	1100	350	2200	145	14	30	0.35	2.02	20	12	2.9	8
LNK-P7X-400-125	400	1250	400	2500	140	17	30	0.38	2.02	20	12	2.9	8
LNK-P7X-300-145	300	1450	400	2900	130	19	30	0.44	2.02	20	12	2.9	8
LNK-P7X-200-180	200	1800	450	3600	120	24	30	0.53	2.02	20	12	2.9	8

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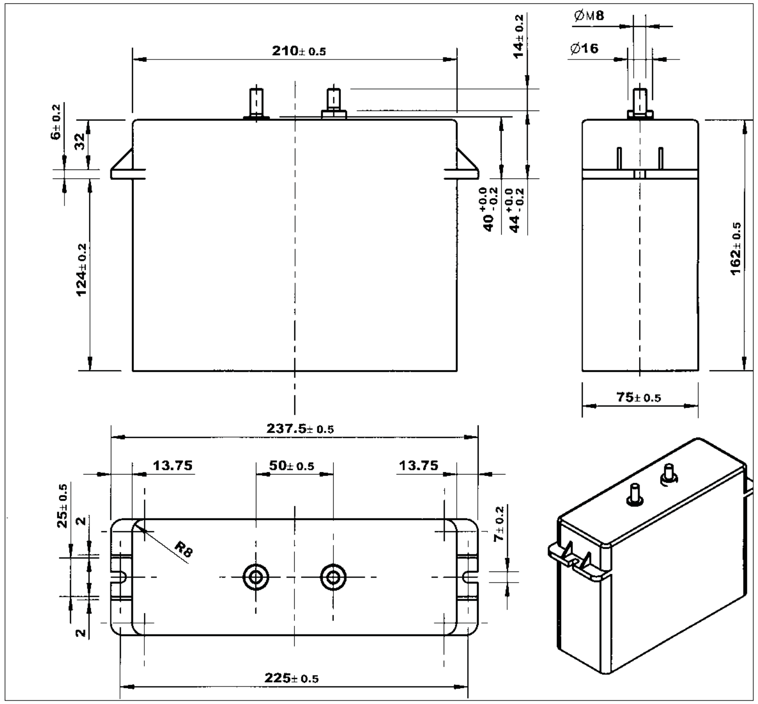
Via Isonzo 10, 20052 Monza (Mi) Italy

LNK – P8X - … Series

Sturdy construction for busbars connections



Model	Capacitance	Rated DC Voltage	Rated AC Voltage	Peak Voltage	Max rms Current	dv / dt	Self Inductance	Series Resistance	Thermal Resistance with Natural cooling	Full current Max Working Frequency**	Tightening Torque	Weight	Box qty
	C (µF)	Un (V)	Urms (V)	Us (V)	(A)	(V / µs)	L (nH)	Rs (mΩ)	Rthn (C/W)	(KHz)	(Nm)	(kg)	(pcs)
LNK-P8X-1500-70	1500	700	200	1400	180	10	30	0.22	1.8	20	12	3.6	6
LNK-P8X-850-90	850	900	250	1800	155	12	30	0.27	1.8	20	12	3.6	6
LNK-P8X-700-100	700	1000	300	2000	150	13	30	0.30	1.8	20	12	3.6	6
LNK-P8X-600-110	600	1100	350	2200	145	14	30	0.31	1.8	20	12	3.6	6
LNK-P8X-430-125	430	1250	400	2500	140	17	30	0.36	1.8	20	12	3.6	6
LNK-P8X-330-145	330	1450	400	2900	130	19	30	0.40	1.8	20	12	3.6	6
LNK-P8X-200-180	200	1800	450	3600	120	24	30	0.51	1.8	20	12	3.6	6

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WARNING

DO NOT MISAPPLY CAPACITORS FOR POWER ELECTRONICS

Icar spa is not responsible for any kind of possible damages to persons or things, derived from the improper installation and application of Power Electronics capacitors.

Most common misapplication forms:

- Ripple current beyond specification or not according with the maximum power that can be dissipated.
- Surge or working voltage beyond specified value.
- Hot spot or storage temperature beyond the specified limits or not according with the maximum power that can be dissipated.
- Incorrect mounting or wrong installation
- – installation nearby hot components or heat sources
- – not suitable connections (not adequate cable or busbars cross section)
- – nuts and washers material, shape or size not suitable for the application
- – tightening torque not according to the specification
- Unusual service conditions as :
- – mechanical shock and vibrations,
- – corrosive or abrasive conductive parts in cooling air,
- – oil or water vapour or corrosive substances,
- – explosive gas or dust,
- – radioactivity,
- – excessive and fast variations of ambient conditions,
- – service areas higher than 2000 m above sea level.

Periodic check of the connection conditions and tightening torque is strongly recommended.

In case of doubt in choice or in performances of the capacitors Icar technical service **MUST** be contacted.

Personal Safety :

Electrical or mechanical misapplication of Power Electronics Capacitors may become hazardous. Personal injury or property damage may result from disruption of the capacitor and consequent expulsion of melted material.
Before using the capacitors in any application, please read carefully the technical information contained in this catalogue.
The energy stored in a capacitor may become lethal, to prevent any chance of shock the capacitor should be discharged before handling.
Special attention must be taken to make sure the capacitors are correctly used for each application and that warnings and instructions are followed

Via Isonzo 10, 20052 Monza (Mi) Italy

ICAR PRODUCTS

ICAR provides a first class service in the following products:

- **Power Electronics Capacitors;**
- **Metallized polypropylene film capacitors for lighting and motor running;**
- **Power factor correction capacitors low and high voltage;**
- **Automatic power factor correction banks with harmonics filtering;**
- **Coupling capacitors and Capacitive Voltage Transformers (CVT);**
- **Energy storage and pulse capacitors ;**
- **RFI / EMI Filters.**

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Via Isonzo 10, 20052 Monza (Mi) , Italy
Ph. ++39-03983951 Fax ++39-039833227

Monza, 06 February 2014

DECLARATION

We confirm that LNK-P1X-45-70 and LNK-P2X-100-90 capacitors are suitable to be used at -40°C.

ICAR SpA
Low Voltage Technical Department

ICAR S.p.A.
INDUSTRIA CONDENSATORI APPLICAZIONI ELETTROELETTRONICHE
DIREZIONE QUALITA'

SEMITRANS®2

Fast IGBT4 Modules

SKM150GB12T4

Features

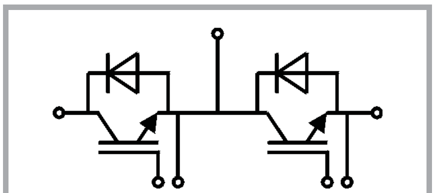
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to 6 x Icnom
- Fast & soft inverse CAL diodes
- Large clearance (10 mm) and creepage distances (20 mm)
- Isolated copper baseplate using DBC Technology (Direct Copper Bonding)

Typical Applications

- AC inverter drives
- UPS
- Electronic welders at fsw up to 20 kHz

Remarks

- Case temperature limited to T_c = 125°C max, recomm. T_{op} = -40 ... +150°C, product rel. results valid for T_j = 150°



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Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
IGBT				
V_{CES}			1200	V
I_C	T_j = 175 °C	T_c = 25 °C	232	A
		T_c = 80 °C	179	A
I_{Cnom}			150	A
I_{CRM}	I_{CRM} = 3xI_{Cnom}		450	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 800 V $V_{GE} \leq$ 15 V $V_{CES} \leq$ 1200 V	T_j = 150 °C	10	µs
T_j			-40 ... 175	°C
Inverse diode				
I_F	T_j = 175 °C	T_c = 25 °C	189	A
		T_c = 80 °C	141	A
I_{Fnom}			150	A
I_{FRM}	I_{FRM} = 3xI_{Fnom}		450	A
I_{FSM}	t_p = 10 ms, sin 180°, T_j = 25 °C		900	A
T_j			-40 ... 175	°C
Module				
$I_{t(RMS)}$			200	A
T_{stg}			-40 ... 125	°C
V_{isol}	AC sinus 50Hz, t = 1 min		4000	V

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
IGBT						
$V_{CE(sat)}$	I_C = 150 A V_{GE} = 15 V chiplevel	T_j = 25 °C		1.8	2.05	V
		T_j = 150 °C		2.2	2.4	V
V_{CE0}		T_j = 25 °C		0.8	0.9	V
		T_j = 150 °C		0.7	0.8	V
r_{CE}	V_{GE} = 15 V	T_j = 25 °C		6.7	7.7	mΩ
		T_j = 150 °C		10.0	10.7	mΩ
$V_{GE(th)}$	V_{GE}=V_{CE}, I_C = 6 mA		5	5.8	6.5	V
I_{CES}	V_{GE} = 0 V V_{CE} = 1200 V	T_j = 25 °C		0.1	0.3	mA
		T_j = 150 °C				mA
C_{ies}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		9.3		nF
C_{oes}		f = 1 MHz		0.58		nF
C_{res}		f = 1 MHz		0.51		nF
Q_G	V_{GE} = - 8 V...+ 15 V			850		nC
R_{Gint}	T_j = 25 °C			5.0		Ω
$t_{d(on)}$	V_{CC} = 600 V I_C = 150 A V_{GE} = ±15 V $R_{G\ on}$ = 1 Ω $R_{G\ off}$ = 1 Ω di/dt$_{on}$ = 3400 A/µs di/dt$_{off}$ = 1750 A/µs	T_j = 150 °C		180		ns
t_r		T_j = 150 °C		42		ns
E_{on}		T_j = 150 °C		19.2		mJ
$t_{d(off)}$		T_j = 150 °C		410		ns
t_f		T_j = 150 °C		72		ns
E_{off}		T_j = 150 °C		15.8		mJ
$R_{th(j-c)}$	per IGBT				0.19	K/W

SEMITRANS®2

Fast IGBT4 Modules

SKM150GB12T4

Features

- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to 6 x Icnom
- Fast & soft inverse CAL diodes
- Large clearance (10 mm) and creepage distances (20 mm)
- Isolated copper baseplate using DBC Technology (Direct Copper Bonding)

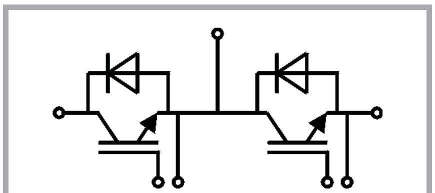
Typical Applications

- AC inverter drives
- UPS
- Electronic welders at fsw up to 20 kHz

Remarks

- Case temperature limited to T_c = 125°C max, recomm. T_{op} = -40 ... +150°C, product rel. results valid for T_j = 150°

Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Inverse diode						
$V_F = V_{EC}$	I_F = 150 A V_{GE} = 0 V chip	T_j = 25 °C		2.14	2.46	V
		T_j = 150 °C		2.07	2.38	V
V_{F0}		T_j = 25 °C		1.3	1.5	V
		T_j = 150 °C		0.9	1.1	V
r_F		T_j = 25 °C		5.6	6.4	mΩ
		T_j = 150 °C		7.8	8.5	mΩ
I_{RRM}	I_F = 150 A	T_j = 150 °C		120		A
Q_{rr}	di/dt_{off} = 3100 A/µs	T_j = 150 °C		31.3		µC
E_{rr}	V_{GE} = ±15 V V_{CC} = 600 V	T_j = 150 °C		13		mJ
$R_{th(j-c)}$	per diode				0.31	K/W
Module						
L_{CE}					30	nH
$R_{CC'+EE'}$	terminal-chip	T_C = 25 °C		0.65		mΩ
		T_C = 125 °C		1		mΩ
$R_{th(c-s)}$	per module			0.04	0.05	K/W
M_s	to heat sink M6		3		5	Nm
M_t		to terminals M5	2.5		5	Nm
						Nm
w					160	g



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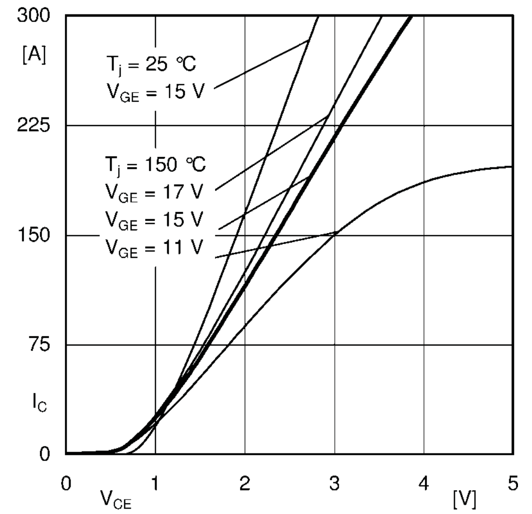


Fig. 1: Typ. output characteristic, inclusive $R_{CC'+ EE'}$

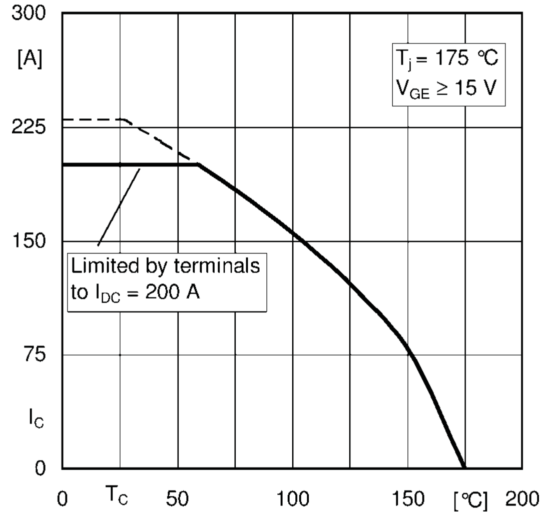


Fig. 2: Rated current vs. temperature $I_C = f\ (T_C)$

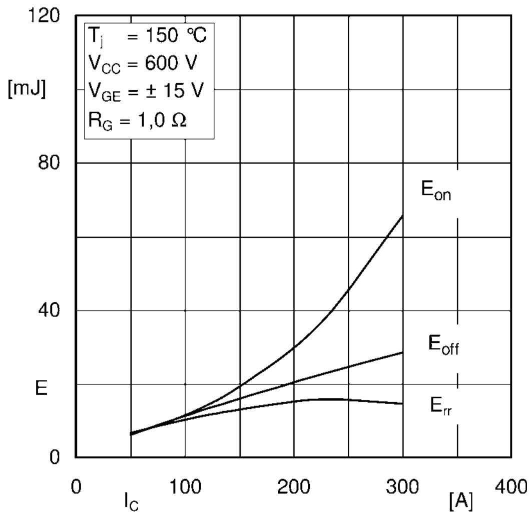


Fig. 3: Typ. turn-on /-off energy = f (I_C)

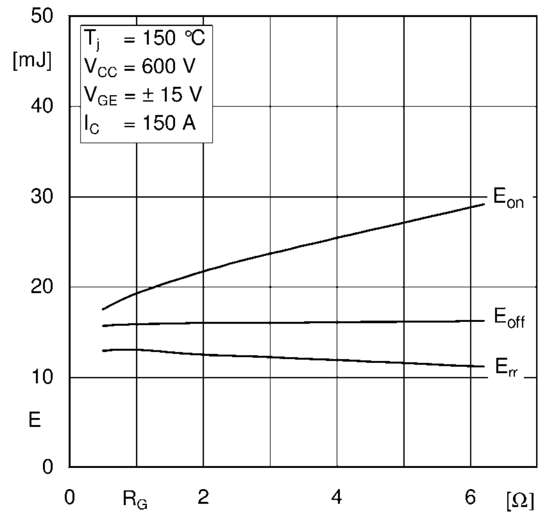


Fig. 4: Typ. turn-on /-off energy = f (R_G)

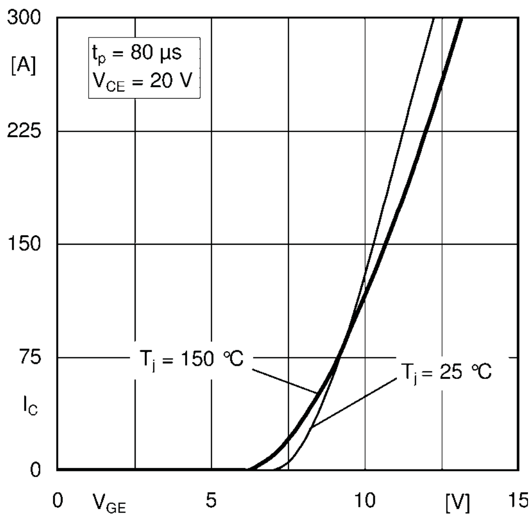


Fig. 5: Typ. transfer characteristic

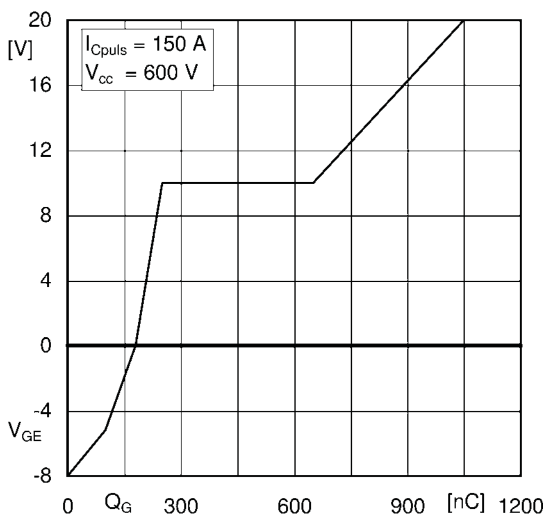


Fig. 6: Typ. gate charge characteristic

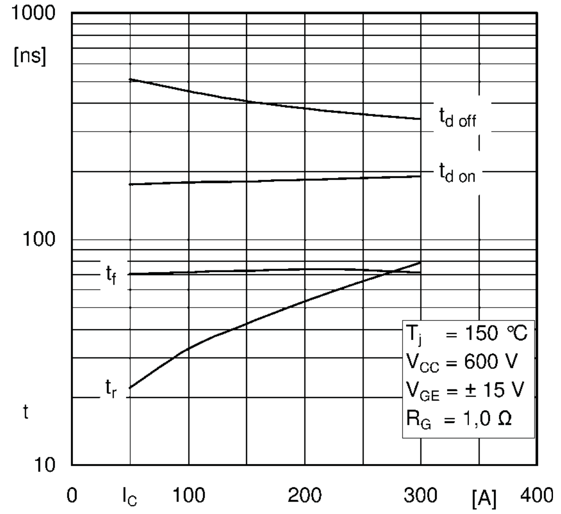


Fig. 7: Typ. switching times vs. I_C

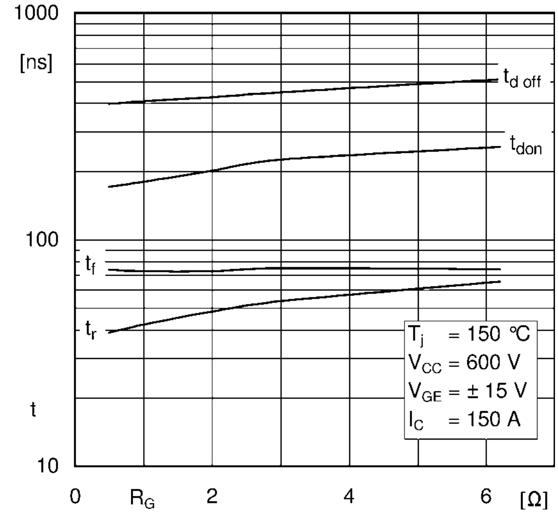


Fig. 8: Typ. switching times vs. gate resistor R_G

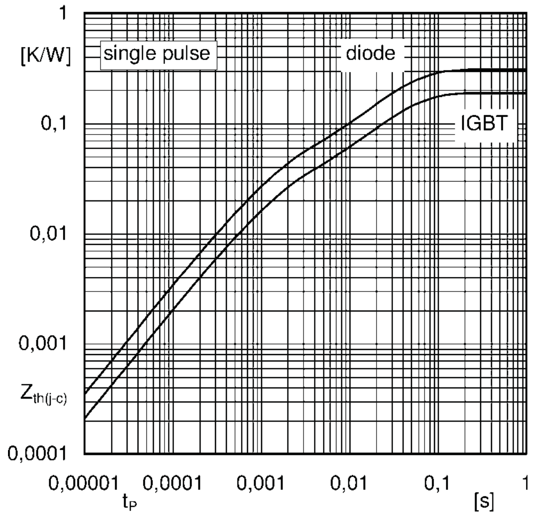


Fig. 9: Transient thermal impedance

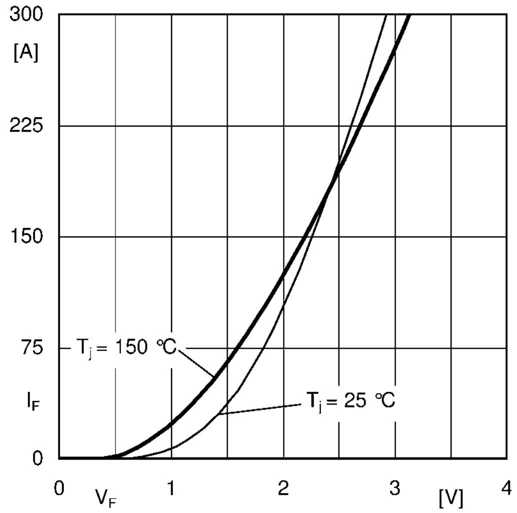


Fig. 10: CAL diode forward characteristic

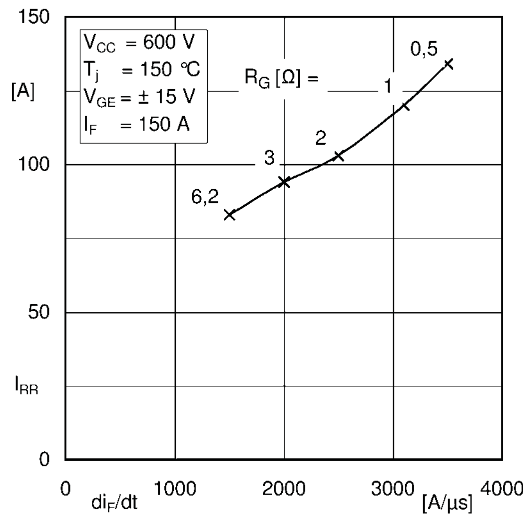


Fig. 11: CAL diode peak reverse recovery current

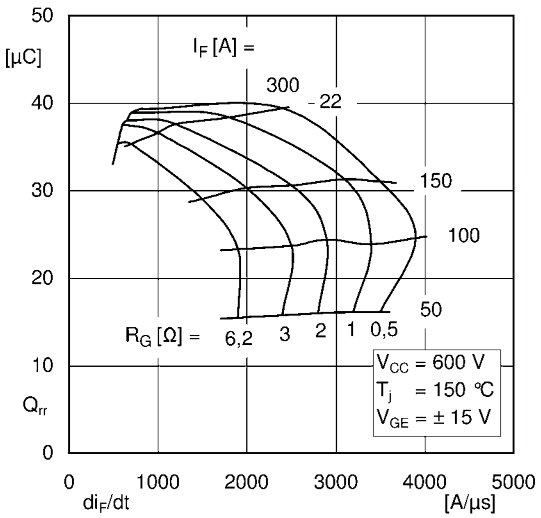
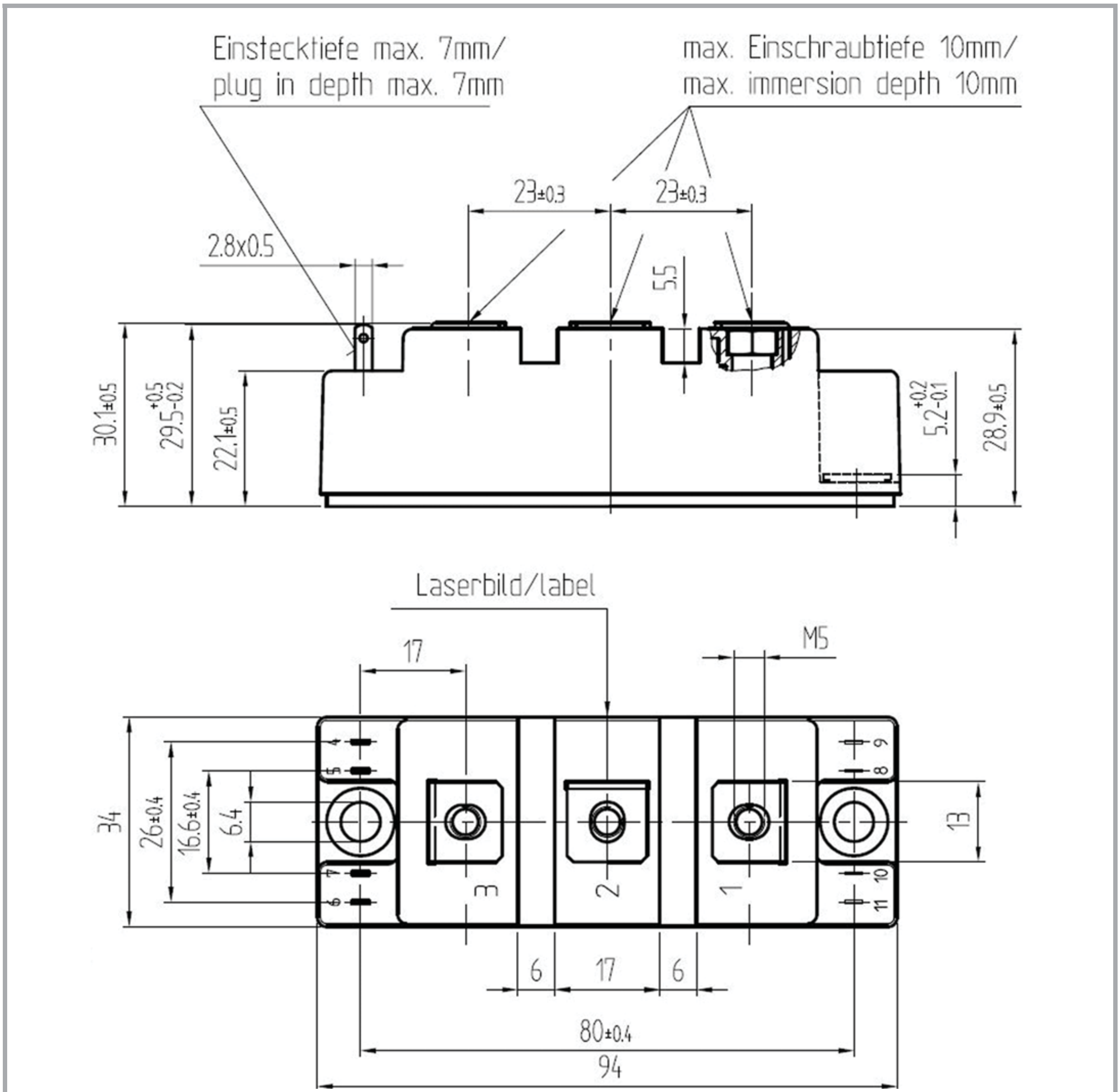
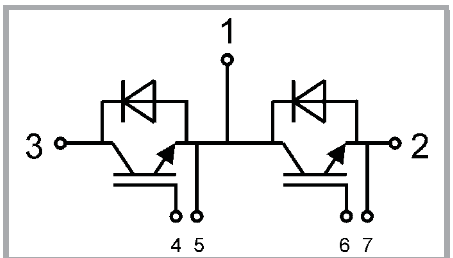


Fig. 12: Typ. CAL diode peak reverse recovery charge



Semitrans 2



GB

This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, Chapter IX.

This technical information specifies semiconductor devices but promises no characteristics. No warranty or guarantee expressed or implied is made regarding delivery, performance or suitability.

Schottky Rectifier, 400 A

ADD-A-PAK

FEATURES

- 175 °C T_J operation
- Low forward voltage drop
- High frequency operation
- Guard ring for enhanced ruggedness and long term reliability
- UL pending
- Totally lead (Pb)-free, RoHS compliant
- Designed and qualified for industrial level

Pb-free RoHS COMPLIANT

PRODUCT SUMMARY	
$I_{F(AV)}$	400 A

MECHANICAL DESCRIPTION

The Generation 5 of ADD-A-PAK module combine the excellent thermal performance obtained by the usage of direct bonded copper substrate with superior mechanical ruggedness, thanks to the insertion of a solid copper baseplate at the bottom side of the device.
The Cu baseplate allow an easier mounting on the majority of heatsink with increased tolerance of surface roughness and improved thermal spread.
The Generation 5 of ADD-A-PAK module is manufactured without hard mold, eliminating in this way any possible direct stress on the leads.
The electrical terminals are secured against axial pull-out: they are fixed to the module housing via a click-stop feature already tested and proved as reliable on other Vishay HPP modules.

DESCRIPTION

The VSKCS409.. Schottky rectifier common cathode has been optimized for low reverse leakage at high temperature. The proprietary barrier technology allows for reliable operation up to 175 °C junction temperature.
Typical applications are in high current switching power supplies, plating power supplies, UPS systems, converters, freewheeling diodes, welding, and reverse battery protection.

MAJOR RATINGS AND CHARACTERISTICS

SYMBOL	CHARACTERISTICS	VALUES	UNITS
$I_{F(AV)}$	Rectangular waveform	400	A
V_{RRM}		150	V
I_{FSM}	t_p = 5 µs sine	20 000	A
V_F	200 Apk, T_J = 125 °C	0.79	V
T_J	Range	- 55 to 175	°C

VOLTAGE RATINGS

PARAMETER	SYMBOL	VSKCS409/150P	UNITS
Maximum DC reverse voltage	V_R	150	V
Maximum working peak reverse voltage	V_{RWM}		

ABSOLUTE MAXIMUM RATINGS						
PARAMETER		**SYMBOL**	**TEST CONDITIONS**		**VALUES**	**UNITS**
Maximum average forward current	per module	$I_{F(AV)}$	50 % duty cycle at T_C = 94 °C, rectangular waveform		400	A
	per leg				200	
Maximum peak one cycle non-repetitive surge current		I_{FSM}	5 µs sine or 3 µs rect. pulse	Following any rated load condition and with rated V_{RRM} applied	20 000	
			10 ms sine or 6 ms rect. pulse		2300	
Non-repetitive avalanche energy		E_{AS}	T_J = 25 °C, I_{AS} = 1.8 Amps, L = 1 mH		15	mJ
Repetitive avalanche current		I_{AR}	Current decaying linearly to zero in 1 µs Frequency limited by T_J maximum V_A = 1.5 x V_R typical		1	A

ELECTRICAL SPECIFICATIONS					
PARAMETER	**SYMBOL**	**TEST CONDITIONS**		**VALUES**	**UNITS**
Maximum forward voltage drop	V_{FM} (1)	200 A	T_J = 25 °C	0.98	V
		400 A		1.23	
		200 A	T_J = 125 °C	0.79	
		400 A		1.03	
Maximum reverse leakage current	I_{RM} (1)	T_J = 25 °C	V_R = Rated V_R	6	mA
		T_J = 125 °C		85	
Maximum junction capacitance	C_T	V_R = 5 V_{DC} (test signal range 100 kHz to 1 MHz) 25 °C		6000	pF
Typical series inductance	L_S	From top of terminal hole to mounting plane		5.0	nH
Maximum voltage rate of change	dV/dt	Rated V_R		10 000	V/µs
RMS insulation voltage	V_{INS}	50 Hz, circuit to base, all terminals shorted (1 s)		3500	V

Note
(1) Pulse width < 300 µs, Duty cycle < 2 %

THERMAL - MECHANICAL SPECIFICATIONS					
PARAMETER		**SYMBOL**	**TEST CONDITIONS**	**VALUES**	**UNITS**
Maximum junction and storage temperature range		T_J, T_{Stg}		- 55 to 175	°C
Maximum thermal resistance, junction to case per leg		R_{thJC}	DC operation	0.36	°C/W
Maximum thermal resistance, case to heatsink		R_{thCS}	Mounting surface, smooth and greased	0.1	
Approximate weight				110	g
				4	oz.
Mounting torque ± 10 %	to heatsink			5	Nm
	busbar			4	
Case style			JEDEC	TO-240AA	

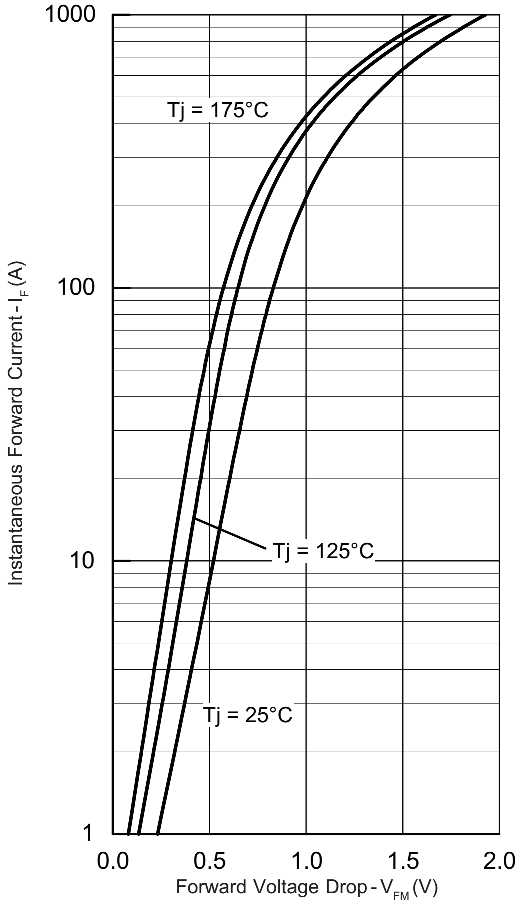


Fig. 1 - Maximum Forward Voltage Drop Characteristics

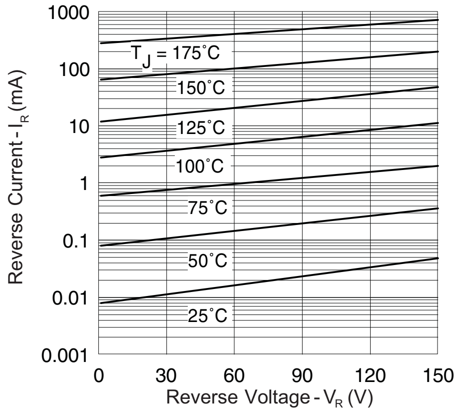


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

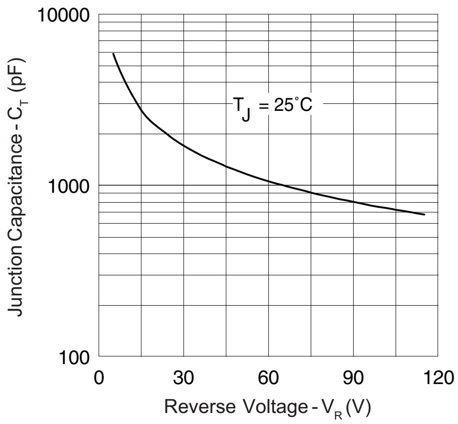


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

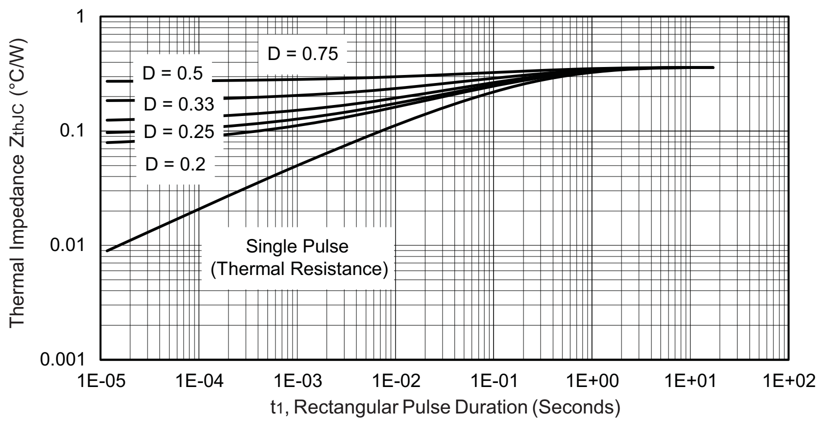


Fig. 4 - Maximum Thermal Impedance Z_{thJC} Characteristics

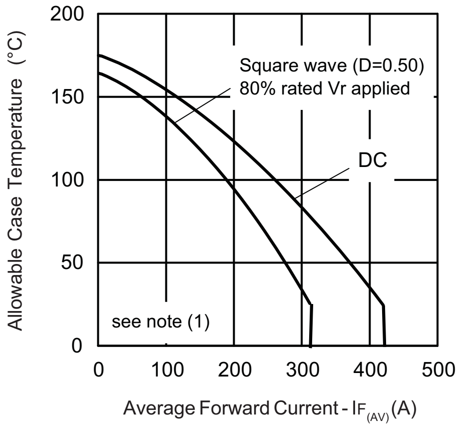


Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

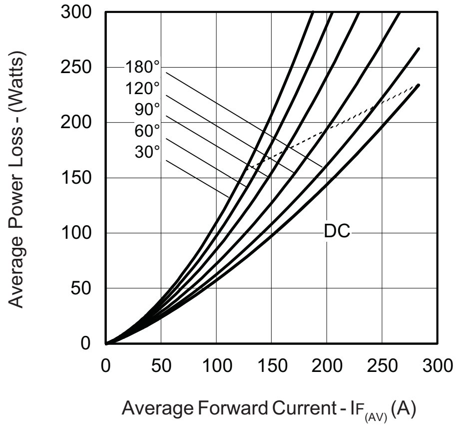


Fig. 6 - Forward Power Loss Characteristics

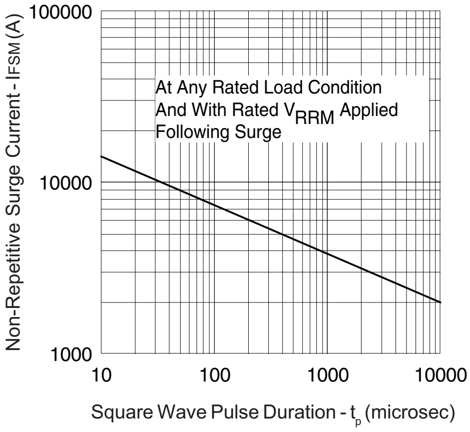


Fig. 7 - Maximum Non-Repetitive Surge Current

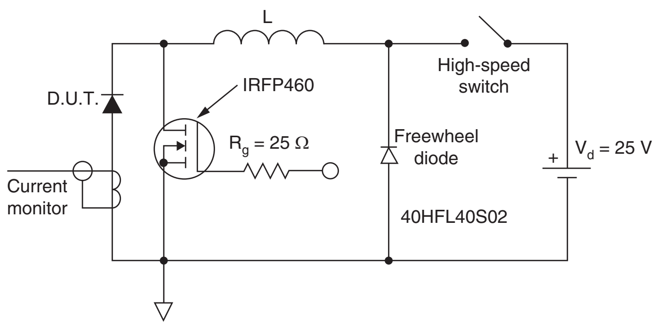


Fig. 8 - Unclamped Inductive Test Circuit

Note

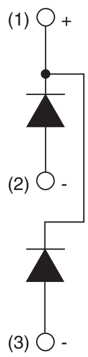
(1) Formula used: $T_C = T_J - (Pd + Pd_{REV}) \times R_{thJC}$;
Pd = Forward power loss = $I_{F(AV)} \times V_{FM}$ at $(I_{F(AV)}/D)$ (see fig. 6);
Pd_{REV} = Inverse power loss = $V_{R1} \times I_R (1 - D)$; I_R at V_{R1} = 80 % rated V_R

ORDERING INFORMATION TABLE

Device code	VS	KC	S	40	9	/	150	P
	1	2	3	4	5		6	7

- **1** - Vishay HPP
- **2** - Circuit configuration:
  KC = ADD-A-PAK - 2 diodes/common cathode
- **3** - S = Schottky diode
- **4** - Average rating (x 10)
- **5** - Product silicon identification
- **6** - Voltage rating (150 = 150 V)
- **7** - Lead (Pb)-free

CIRCUIT CONFIGURATION



LINKS TO RELATED DOCUMENTS	
Dimensions	http://www.vishay.com/doc?95174

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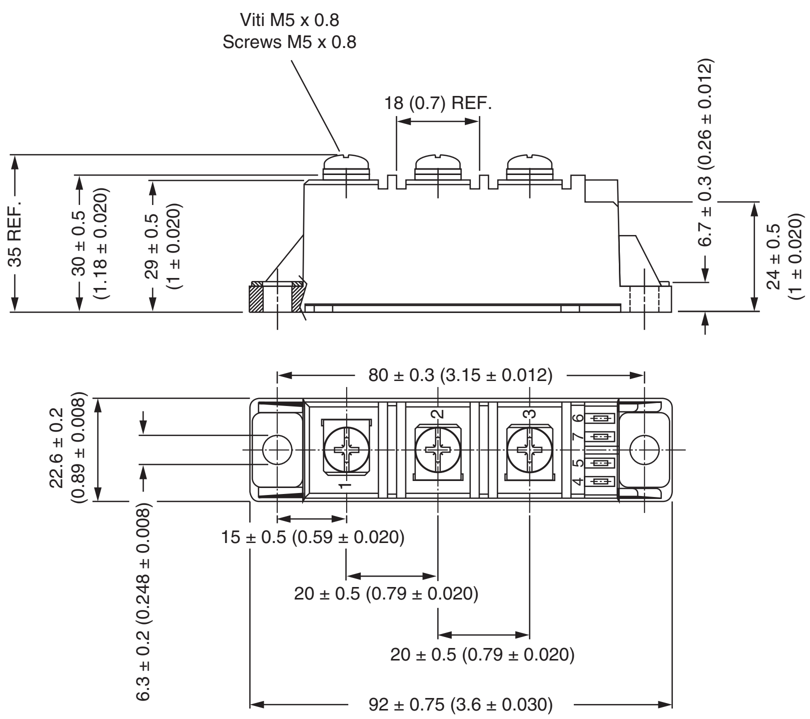
ADD-A-PAK Generation VII - Diode

DIMENSIONS in millimeters (inches)



ADD-A-PAK Generation VII Power Modules Schottky Rectifier, 400 A

ADD-A-PAK

PRODUCT SUMMARY	
$I_{F(AV)}$	400 A
V_R	150 V
Package	ADD-A-PAK
Circuit	Two diodes common cathodes

MECHANICAL DESCRIPTION

The ADD-A-PAK generation VII, new generation of ADD-A-PAK module, combines the excellent thermal performances obtained by the usage of exposed direct bonded copper substrate, with advanced compact simple package solution and simplified internal structure with minimized number of interfaces.

FEATURES

- 175 °C T_J operation
- Low forward voltage drop
- High frequency operation
- Low thermal resistance
- UL approved file E78996
- Designed and qualified for industrial level
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

RoHS
COMPLIANT

BENEFITS

- Excellent thermal performances obtained by the usage of exposed direct bonded copper substrate
- High surge capability
- Easy mounting on heatsink

ELECTRICAL DESCRIPTION

The VS-VSKCS409/150 Schottky rectifier common cathode has been optimized for low reverse leakage at high temperature. The proprietary barrier technology allows for reliable operation up to 175 °C junction temperature.
Typical applications are in high current switching power supplies, plating power supplies, UPS systems, converters, freewheeling diodes, welding, and reverse battery protection.

MAJOR RATINGS AND CHARACTERISTICS			
SYMBOL	CHARACTERISTICS	VALUES	UNITS
$I_{F(AV)}$	Rectangular waveform	400	A
V_{RRM}		150	V
I_{FSM}	t_p = 5 μs sine	20 000	A
V_F	200 A_{pk}, T_J = 125 °C	0.85	V
T_J	Range	-55 to 175	°C

VOLTAGE RATINGS			
PARAMETER	SYMBOL	VS-VSKCS409/150	UNITS
Maximum DC reverse voltage	V_R	150	V
Maximum working peak reverse voltage	V_{RWM}		

ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum average forward current	per module	$I_{F(AV)}$	50 % duty cycle at T_C = 105 °C, rectangular waveform		400	A
	per leg				200	
Maximum peak one cycle non-repetitive surge current		I_{FSM}	5 µs sine or 3 µs rect. pulse	Following any rated load condition and with rated V_{RRM} applied	20 000	
			10 ms sine or 6 ms rect. pulse		2300	
Non-repetitive avalanche energy		E_{AS}	T_J = 25 °C, I_{AS} = 1.8 A, L = 10 mH		15	mJ
Repetitive avalanche current		I_{AR}	Current decaying linearly to zero in 1 µs Frequency limited by T_J maximum V_A = 1.5 x V_R typical		1	A

ELECTRICAL SPECIFICATIONS

PARAMETER	SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum forward voltage drop	V_{FM}	200 A	T_J = 25 °C	1.03	V
		400 A		1.33	
		200 A	T_J = 125 °C	0.85	
		400 A		1.13	
Maximum reverse leakage current	I_{RM}	T_J = 25 °C	V_R = Rated V_R	6	mA
		T_J = 125 °C		85	
Maximum junction capacitance	C_T	V_R = 5 V_{DC} (test signal range 100 kHz to 1 MHz), 25 °C		6000	pF
Typical series inductance	L_S	Measured lead to lead 5 mm from package body		5.0	nH
Maximum voltage rate of change	dV/dt	Rated V_R		10 000	V/µs
Maximum RMS insulation voltage	V_{INS}	50 Hz		3000 (1 min) 3600 (1 s)	V

THERMAL - MECHANICAL SPECIFICATIONS

PARAMETER		SYMBOL	TEST CONDITIONS	VALUES	UNITS
Maximum junction and storage temperature range		T_J, T_{Stg}		- 55 to 175	°C
Maximum thermal resistance, junction to case per leg		R_{thJC}	DC operation	0.32	°C/W
Typical thermal resistance, case to heatsink per module		R_{thCS}		0.1	
Approximate weight				75	g
				2.7	oz.
Mounting torque ± 10 %	to heatsink		A mounting compound is recommended and the torque should be rechecked after a period of 3 h to allow for the spread of the compound.	4	Nm
	busbar			3	
Case style			JEDEC®	TO-240AA compatible	

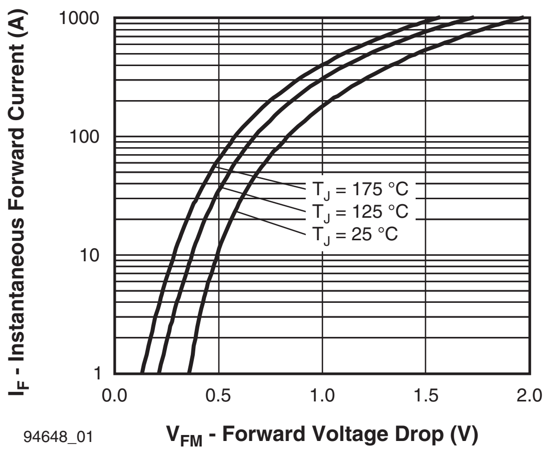


Fig. 1 - Maximum Forward Voltage Drop Characteristics (Per Leg)

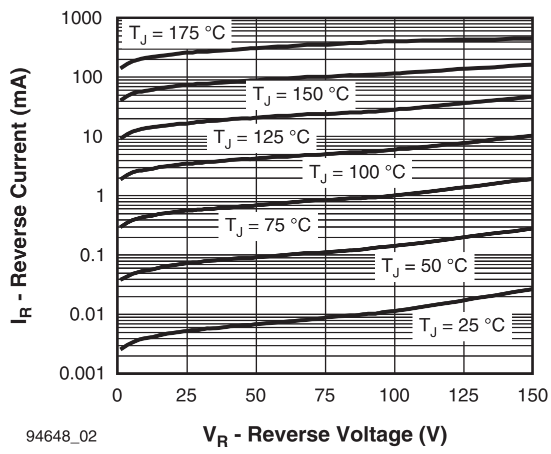


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

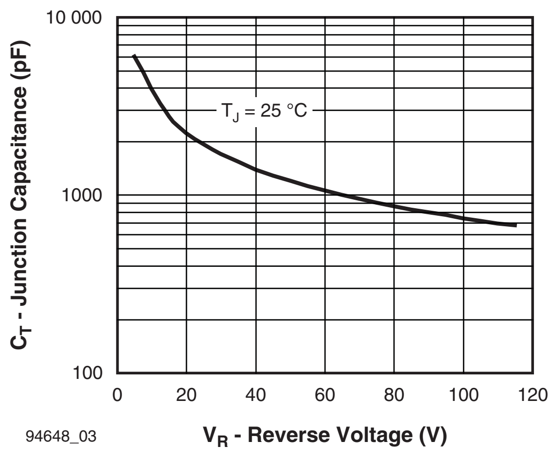


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

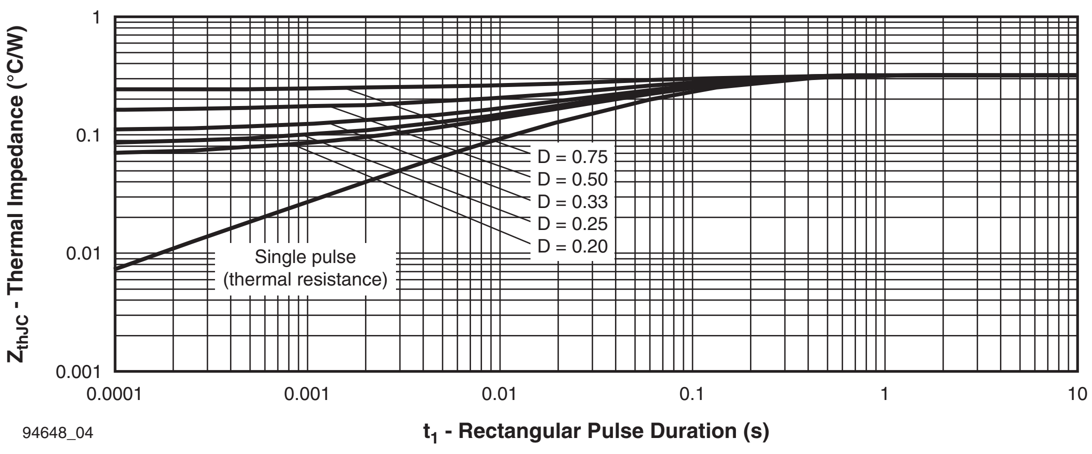


Fig. 4 - Maximum Thermal Impedance Z_{thJC} Characteristics (Per Diode)

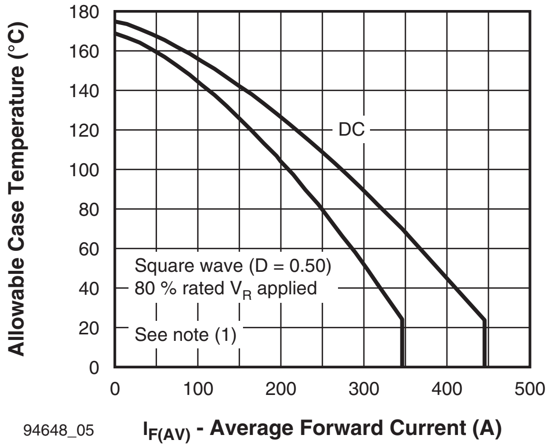


Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current (Per Leg)

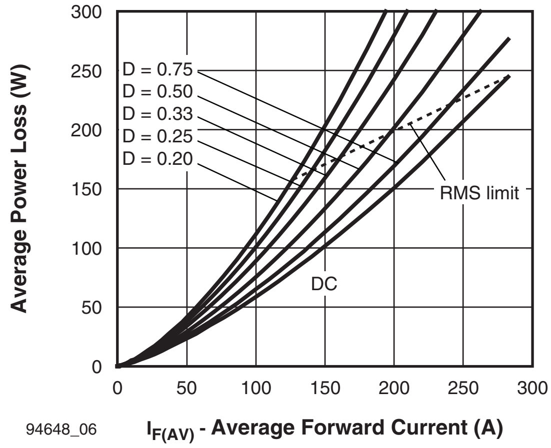


Fig. 6 - Forward Power Loss Characteristics (Per Leg)

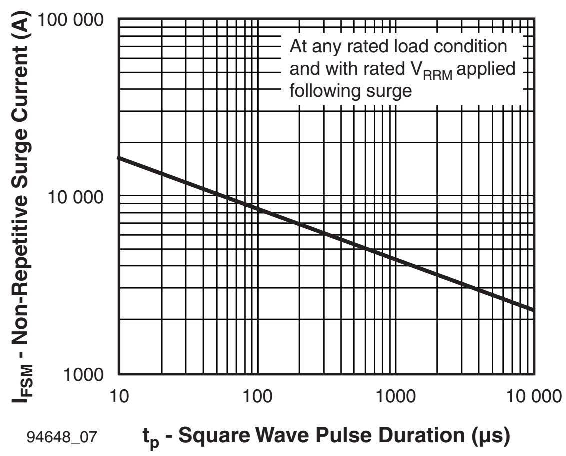


Fig. 7 - Maximum Non-Repetitive Surge Current

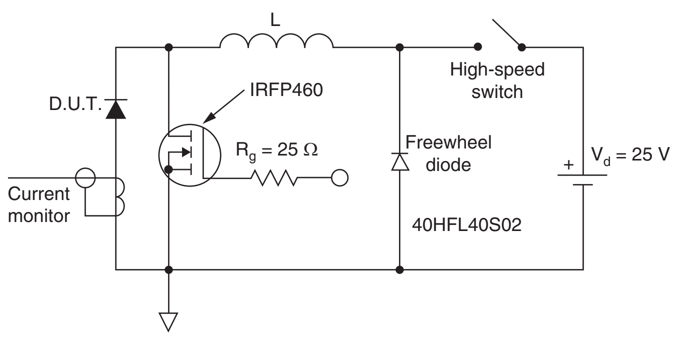


Fig. 8 - Unclamped Inductive Test Circuit

Note

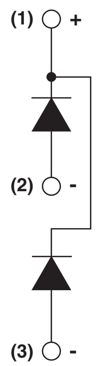
(1) Formula used: $T_C = T_J - (Pd + Pd_{REV}) \times R_{thJC}$;
Pd = Forward power loss = $I_{F(AV)} \times V_{FM}$ at $(I_{F(AV)}/D)$ (see fig. 6);
Pd_{REV} = Inverse power loss = $V_{R1} \times I_R (1 - D)$; I_R at V_{R1} = 80 % rated V_R

ORDERING INFORMATION TABLE

Device code	VS-VS	KC	S	40	9	/	150
	1	2	3	4	5		6

1 - VS-VS = Vishay Semiconductors product
2 - Circuit configuration:
KC = ADD-A-PAK - 2 diodes/common cathode
3 - S = Schottky diode
4 - Average current rating (40 = 400 A)
5 - Product silicon identification
6 - Voltage rating (150 = 150 V)

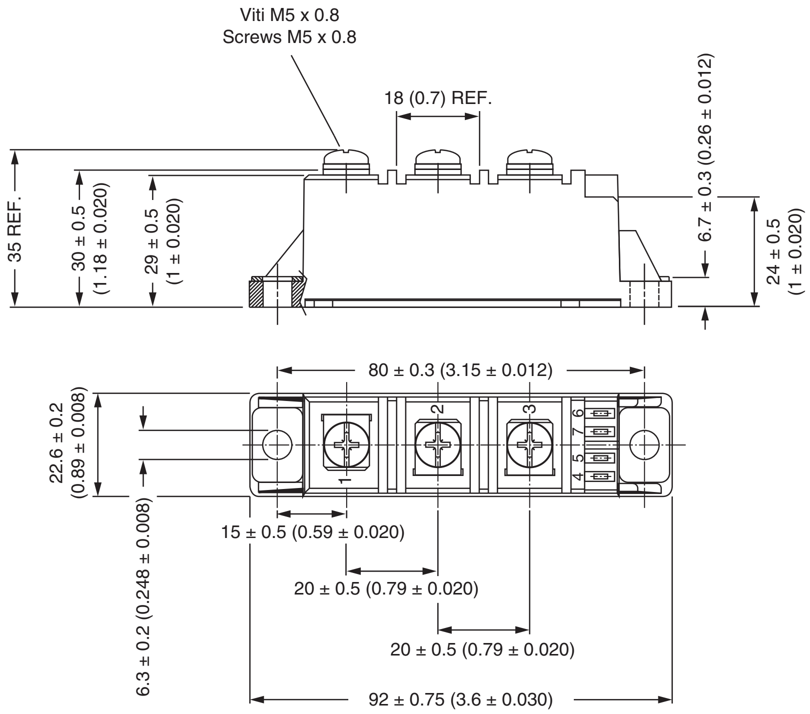
CIRCUIT CONFIGURATION



LINKS TO RELATED DOCUMENTS	
Dimensions	www.vishay.com/doc?95369

ADD-A-PAK Generation VII - Diode

DIMENSIONS in millimeters (inches)



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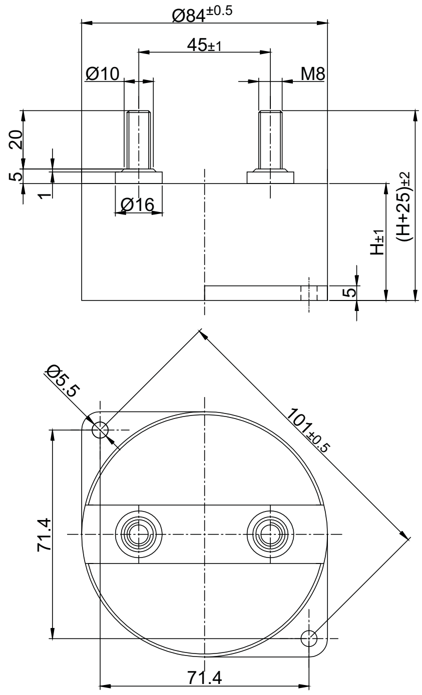
Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.

GENERAL TECHNICAL DATA

Reference Standards: IEC 61071 - EN 61071
Dielectric: Metallized polypropylene film
Winding: Non-inductive type
Case: Self extinguishing plastic case UL94 V0
Terminals: M6 or M8 threaded bolt; also available with threaded female connections
Construction: dry construction, filled by solid resin
IEC climatic category: 40/85/21 according to IEC 68-1
Temperature range (Case): -40 to +85 °C
Temperature storage: -40 to +105°C



TEST METHODS AND PERFORMANCES

Test voltage terminal to terminal (U_{TT})	1.5*Un for 10 s at 25°C
Test voltage terminal to case (U_{TC})	3 KV 50Hz for 2 sec.
Capacitance deviation in temperature range (-25..+85°C)	± 1,5% max on capacitance value at 20°C
Installation	Whatever position

ELECTRICAL CHARACTERISTICS

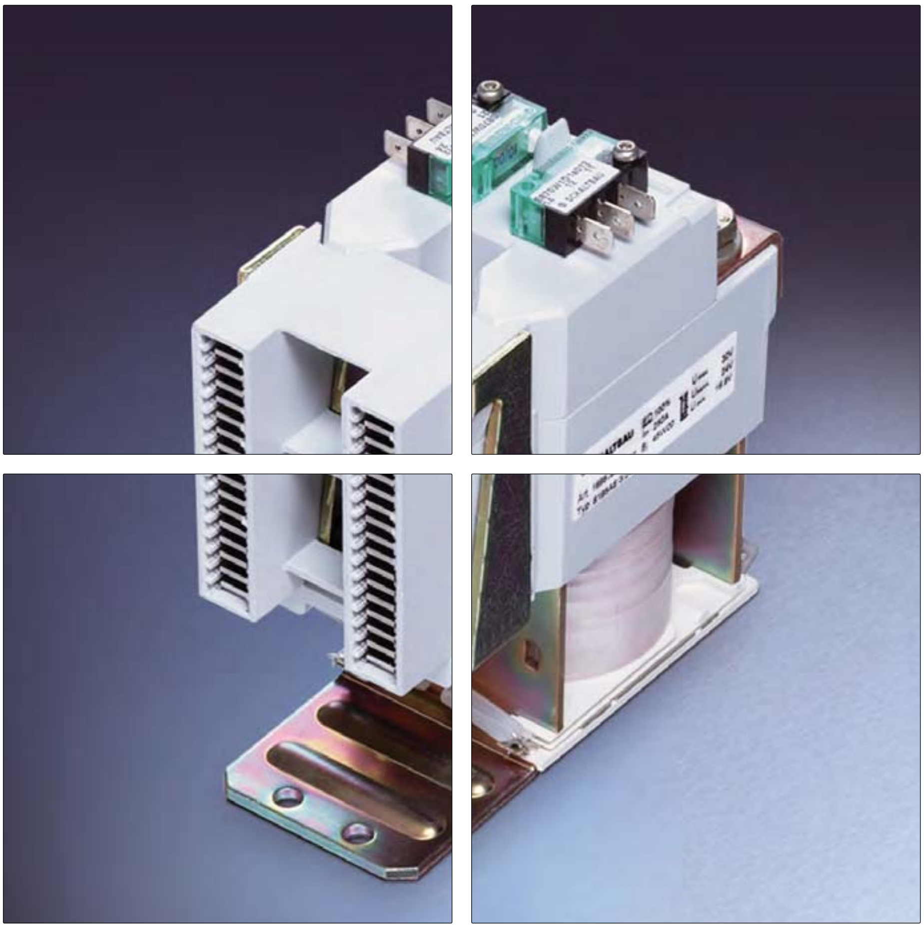
Capacitance	47 to 380 µF
Tolerance	± 10 %
Rated Voltage	400 to 1000 Vdc
dv/dt	15 to 37 V/µs
Repetitive Peak Current	1739 to 5700 Ap
ESR	0.5 to 1.3 mΩ (at repetition frequency 10KHz)
ESL	25 to 40 nH
Derated Voltage and Lifetime expectancy:	1.2 x Vr @ 85°C ► 1.000 hours 1 x Vr @ 85°C ► 10.000 hours 0.9 x Vr @ 85°C ► 100.000 hours
Derated Temperature and Lifetime expectancy	For working temperature between +85°C and +70°C an increasing factor of 0.67 on the rated Lifetime has to be applied.
Diameter / Packing Unit	84mm / 12pcs

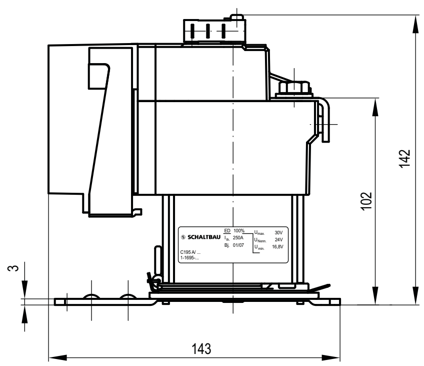
Code	Vdc V	C µF	H mm	ESL nH	ESR @ 10 kHz mΩ	DV/dt V/us	I_{PKR} A	Irms @ 10 kHz Ambient Temperature 25°C	45°C	65°C	85°C	Weight gr
C4DEFPQ6175A8TK	400	175	40	25	0.50	25	4375	100	100	80	46	283
C4DEFPQ6260A8TK	400	260	51	32	0.62	20	5200	100	100	77	45	349
C4DEFPQ6380A8TK	400	380	64	40	0.81	15	5700	100	94	73	42	419
C4DEHPQ6100A8TK	600	100	40	25	0.60	30	3000	100	93	72	42	286
C4DEHPQ6150A8TK	600	150	51	32	0.75	25	3750	100	90	70	40	353
C4DEHPQ6220A8TK	600	220	64	40	1.00	20	4400	100	85	65	38	424
C4DEIPQ5680A8TK	800	68	40	25	0.70	35	2380	100	87	68	40	284
C4DEIPQ6100A8TK	800	100	51	32	0.90	30	3000	100	84	65	37	350
C4DEIPQ6140A8TK	800	140	64	40	1.20	25	3500	91	77	60	35	425
C4DENPQ5470A8TK	1000	47	40	25	0.80	37	1739	96	81	63	36	282
C4DENPQ5680A8TK	1000	68	51	32	1.10	32	2176	92	77	60	35	352
C4DENPQ6100A8TK	1000	100	64	40	1.30	27	2700	86	72	56	32	422

SCHALTBAU

Connect · Contact · Control

Single pole NO contactor C195 Series





B 195.en

Single pole NO contactor C195 Series

Compact single pole high-voltage contactor
Being of compact size and featuring double-break contacts that are covered for the most part, the C195 Series contactors provide high-performance current breaking. Their high contact force improves electrical performance and reliability even under harsh ambient conditions.

C195 versions with permanent-magnetic blowout are available for DC operation and without blowout magnets for AC operation respectively.

There is also the option of a SPDT version of the C195 which has an added galvanically isolated NC contact.

Note: The added NC contact has a reduced current rating (I_{th}) as compared to the contactor‘s NO contact.

The coils of the contactors come fitted as standard with varistors or TransZorb diodes for limiting overvoltages.

Features

- Compact design
- Double-break contacts
- Magnetic blowout for DC operation

Applications

C195 series

Typical applications are to be found in traffic engineering equipment, particularly in heating circuits, air conditioning equipment and conversion engineering of complex power supplies.

Standards

Meet requirements for industrial applications to:

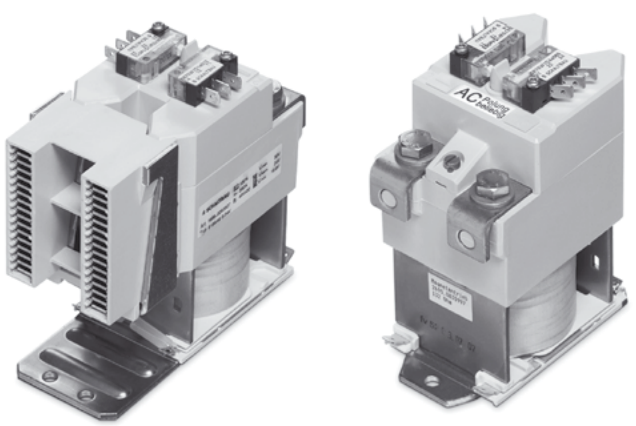
IEC 60947-1 Low-voltage switchgear and controlgear - Part 1: General rules

IEC 60947-4-1 Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor starters - Electromechanical contactors and motor starters.

Meet requirements for railway applications to:

IEC 60077-1, Railway applications - Electric equipment for rolling stock - Part 1: General service conditions and general rules.

IEC 60077-2, Railway applications - Electric equipment for rolling stock - Part 2: Electrotechnical components; General rules



Single pole C195 Series NO contactors
Left: C195 A/ with arc chute and blowout for DC operation
Right: C195 T/ no blowout magnets for AC operation

Ordering code

C195 series

Example: **C195 A/ 24EV-U1**

Series

Version

A/	U_n 1.200 V DC, NO contactor with arc chute and blowout
B/	U_n 1.200 V AC, NO contactor with arc chute
S/	U_n 200 V DC, NO contactor
T/	U_n 200 V AC, NO contactor
W/	U_n 200 V DC, SPDT contactor

Coil voltage

24 / 36 / 48 / 60 / 72 / 80 / 96 / 110 V DC

Coil tolerance

E	-30 % ... +25 % U_s
J	-40 % ... 0 % U_s at 50° C max. ambient temperature
B	latching version: -30 % ... +25 % U_s

Coil suppression

V	Varistor
X	none

Aux. contacts*

U2	2x changeover switch S870 W1D1 a 012, standard
I2	2x changeover switch S870 W1D4 a 012, gold plated contacts

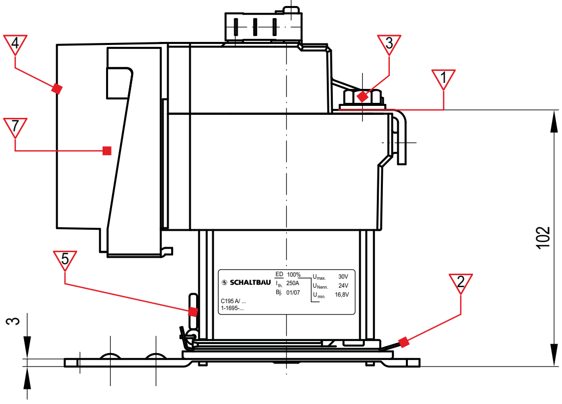
* only with versions A/, B/, S/, T/

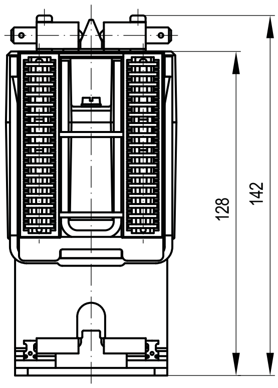
Note:
Presented in this catalogue are only stock items that can be supplied in short delivery time.

Special variant
If you need a special variant feel free to contact us. Maybe the type of contactor you are looking for is among our many **special designs**. If not, we can also supply customized designs. In this case, however, minumum order quantities apply.

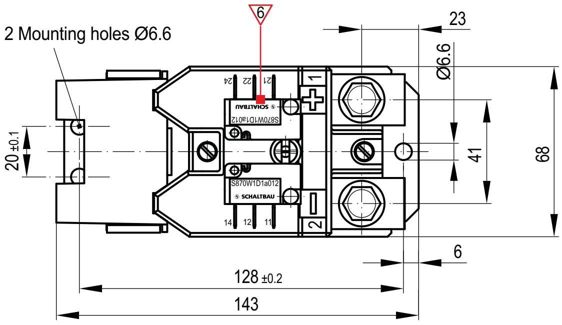
C195 A/ ..., C195 B/ ... NO contactor DC/AC with arc chute and/no blowout — C195 series

Dimension diagram:

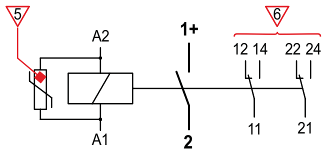




- 1 Main terminals
- 2 Coil terminals
  Quick connect 6.3x0.8 mm DIN 46244
- 3 Hex screw M8
  tightening torque = 12 Nm max.
- 4 Opening for plasma exit
- 5 Coil suppression (varistor)
- 6 2 aux. switches, optional: S870 W1D1a 012
- 7 Arc chute



Circuit diagram:

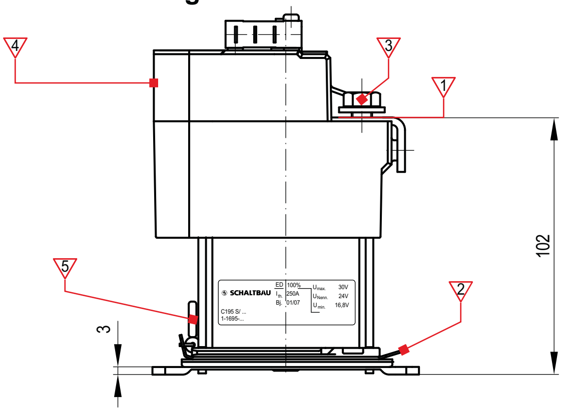


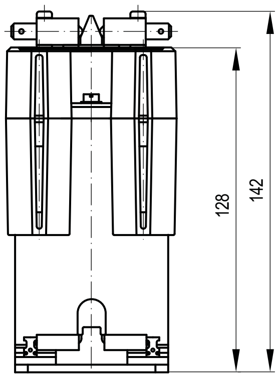
Note:

Take care to observe the correct polarity with DC versions.

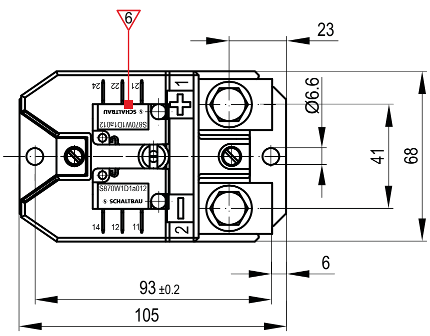
C195 S/ ..., C195 T/ ... NO contactor DC/AC — C195 series

Dimension diagram:

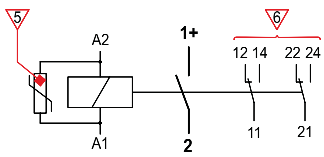




- 1 Main terminals
- 2 Coil terminals
  Quick connect 6.3x0.8 mm DIN 46244
- 3 Hex screw M8
  tightening torque = 12 Nm max.
- 4 Opening for plasma exit
- 5 Coil suppression (Varistor)
- 6 2 aux. switches, optional: S870 W1D1a 012



Circuit diagram:



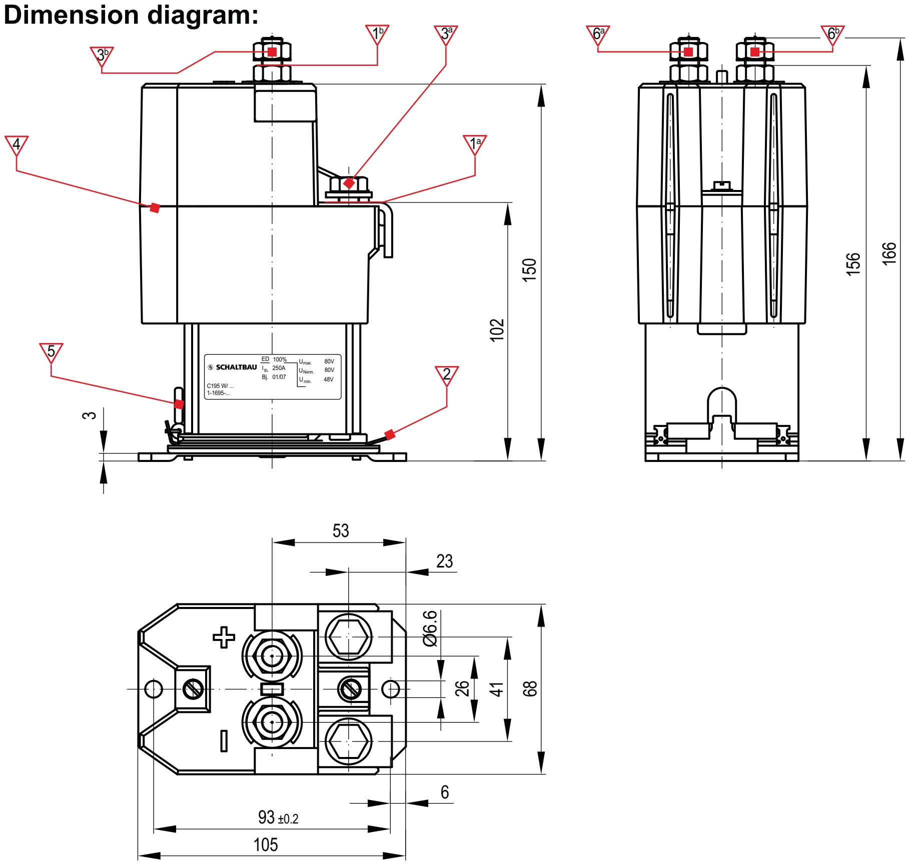
Note:

Take care to observe the correct polarity with DC versions.

Reduced scale diagrams / dimensions in mm

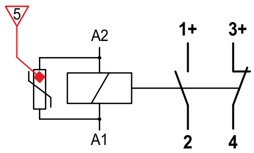
C195 W/ ... SPDT DC contactor — C195 series

Dimension diagram:



1a	Main terminal NO contact
1b	Main terminal NC contact
2	Coil terminal Quick connect 6.3x0.8 mm DIN 46244
3a	Hex screw M8 tightening torque = 12 Nm max.
3b	Hex nut M8 tightening torque = 6 Nm max.
4	Opening for plasma exit
5	Coil suppression (varistor)
6a	+ layer
6b	– layer

Circuit diagram:



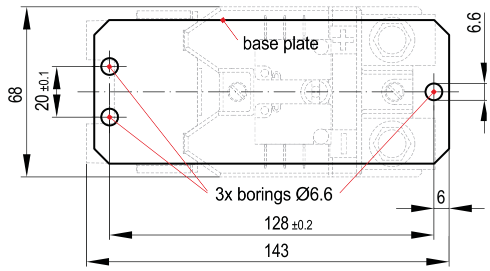
Note:

Terminals are not marked with the corresponding polarity. So take care to observe the correct polarity with DC versions of the contactor.

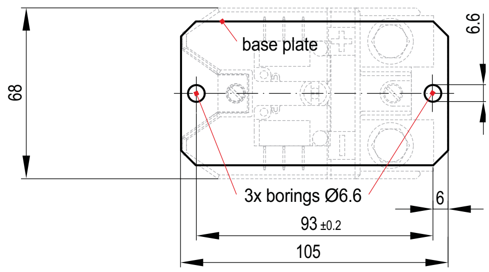
NC contacts (3), (4) are the ones on top of the contactor.

Mounting, Safety instructions — C195 series

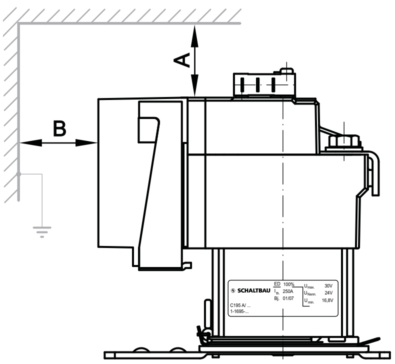
Mounting holes C195 A/ ..., C195 B/ ...



Mounting holes C195 S/ ..., C195 T/ ..., C195 W/ ...



Clearances between live parts:



Note:

Exemplified by the C195 A/ ... Series

Clearances A and B towards live parts are to be observed with all versions of the C195 Series, see table below.

Clearance towards live or earthed parts	> 10 mm
Clearance between contactors	> 5 mm

Clearance towards plasma exit (see diagram):	A	B
P < rated power	20 mm	30 mm
P ≥ rated power	20 mm	60 mm

Safety instructions:

The user has to make sure that there are no exposed electrical parts of the contactor when live or under load.

The way you mount the contactor has an impact on the rise of temperature and the insulation of the switching device. So please observe the clearances between live or earthed parts and comply with the safety regulations of the applicable standards.

No liability will be accepted by Schaltbau in any circumstances for indirect damage resulting from clearances not being observed, devices not mounted properly, or products tampered with in any way.

Reduced scale diagrams / dimensions in mm

Specifications

C195 series

C195 Series, version		A	B	S	T	W
Type of voltage		DC	AC	DC	AC	DC
Main contacts, number, configuration		1x SPST-NO	1x SPST-NO	1x SPST-NO	1x SPST-NO	1x SPDT
Nominal voltage U_n		1,200 V	1,200 V	200 V	200 V	200 V
Rated insulation voltage U_i to IEC 60947-1		1,300 V	1,300 V	1,300 V	1,300 V	630 V
Pollution degree Overvoltage category		PD3 OV3	PD3 OV3	PD3 OV3	PD3 OV3	PD3 OV3
Conventional thermal current I_{th}						
at T_a = 50°C, wire gauge 70 mm²	NO contact NC contact	250 A ---	250 A ---	250 A ---	250 A ---	250 A 160 A
at T_a = 70°C, wire gauge 95 mm²	NO contact NC contact	250 A ---	250 A ---	250 A ---	250 A ---	250 A 160 A
Temporary duty 3 min, at T_a = 50°C, Wire gauge 70 mm²	NO contact NC contact	450 A ---	450 A ---	450 A ---	450 A ---	450 A 250 A
Making capacity						
(resistive, T = 0 ms), (inductive, T > 5 ms),	NO contact NO contact	1,800 A 2,300 A	1,800 A 2,300 A	1,800 A 2,300 A	1,800 A 2,300 A	1,500 A 2,000 A
(resistive, T = 0 ms), (inductive, T > 5 ms),	NC contact NC contact	--- ---	--- ---	--- ---	--- ---	250 A 300 A
Breaking capacity (at rated operating voltage)	NO contact	950 V DC, L/R 1 ms: 240 A L/R 15 ms: 60 A	1,300 V AC, 50 Hz cosφ 0.8: 210 A 1,600 V AC, 50 Hz cosφ 0.8: 150 A	220 V DC, L/R 0 ms: 2,000 A L/R 15 ms: 1,000 A	220 V AC, 50 Hz cosφ 1.0: 1,500 A	220 V DC, L/R 0 ms: 1,500 A L/R 15 ms: 700 A
	NC contact	---	---	---	---	220 V DC, L/R 0 ms: 250 A L/R 15 ms: 100 A
Short-circuit current	NO contact NC contact	2,300 A ---	2,300 A ---	2,300 A ---	2,300 A ---	2,300 A 1,000 A
Switch-off, no reversing		only in one direction	---	only in one direction	---	only in one direction
Arc chute for DC operation		•	---	---	---	---
Blowout, permanent-magnetic		•	---	•	---	•
Arc chamber for AC operation		---	•	---	---	---
Main contacts: Material Terminals		$AgSnO_2$ M8, tightening torque NO contact: 12 Nm max. / NC contact: 6 Nm max.				
Auxiliary contact: Number of, Configuration Utilization category (IEC 60947-5-1) Terminals		2x snap-action switch S870, SPDT, optional (see catalogue D70.en) AC-15: 1.5 A at 230 V AC; DC-13: 0.5 A at 60 V DC or 2.0 A at 24 V DC Qick-connect 6.3 x 0.8 mm				---
Magnetic drive: Rated control supply voltage U_s Operating range of U_s Coil dissipation (T_a = 20° C / U_s) Coil temperature Coil suppression Terminals		24 / 36 / 48 / 60 / 72 / 80 / 96 / 110 V DC -30 % ... +25 % at T_a = 70° C max. Cold coil approx. 27 W, warm coil approx. 13.5 W 155° C at T_a and $U_{s\,max}$ Varistor Quick-connect 6.3 x 0.8 mm				
Degree of protection		IP00				
Mechanical endurance		> 3x10^6 operating cycles				
Electrical endurance		1,000,000 cycles (U_n = 750 V DC, I_{th} = 30 A, L/R = 1 ms)				
Shock / Vibration (EN 61373)		Class B, Cat. 1: 5 ... 150 Hz / 5 g (30 msec., half sinus)				
Duty cycle		100 %				
Mounting position		Any, except: do not mount upside down, so that mounting plate points upwards				
Temperature Operating temperature Storage temperature		-25° C ... +50° C for industrial / -40° C ... +70° C for railway applications -40° C ... +80° C				
Weight		2.0 kg	1.9 kg	1.8 kg	1.8 kg	1.9 kg

* direkt am Betätiger

RoHS 2002/95/EC

Schaltbau GmbH manufactures in compliance with RoHS.

The production facilities of Schaltbau GmbH have been IRIS certified since 2008.

Certified to DIN EN ISO 14001 since 2002. For the most recent certificate visit our website.

Certified to DIN EN ISO 9001 since 1994. For the most recent certificate visit our website.

Electrical Components and Systems for Railway Engineering and Industrial Applications

Connectors	• Connectors manufactured to industry standards • Connectors to suit the special requirements of communications engineering (MIL connectors) • Charging connectors for battery-powered machines and systems • Connectors for railway engineering, including UIC connectors • Special connectors to suit customer requirements
Snap-action switches	• Snap-action switches with positive opening operation • Snap-action switches with self-cleaning contacts • Enabling switches • Special switches to suit customer requirements
Contactors	• Single and multi-pole DC contactors • High-voltage AC/DC contactors • Contactors for battery powered vehicles and power supplies • Contactors for railway applications • Terminal bolts and fuse holders • DC emergency stop switches • Special contactors to suit customer requirements
Electrics for rolling stock	• Equipment for driver‘s cab • Equipment for passenger use • High-voltage switchgear • High-voltage heaters • High-voltage roof equipment • Equipment for electric brakes • Design and engineering of train electrics to customer requirements

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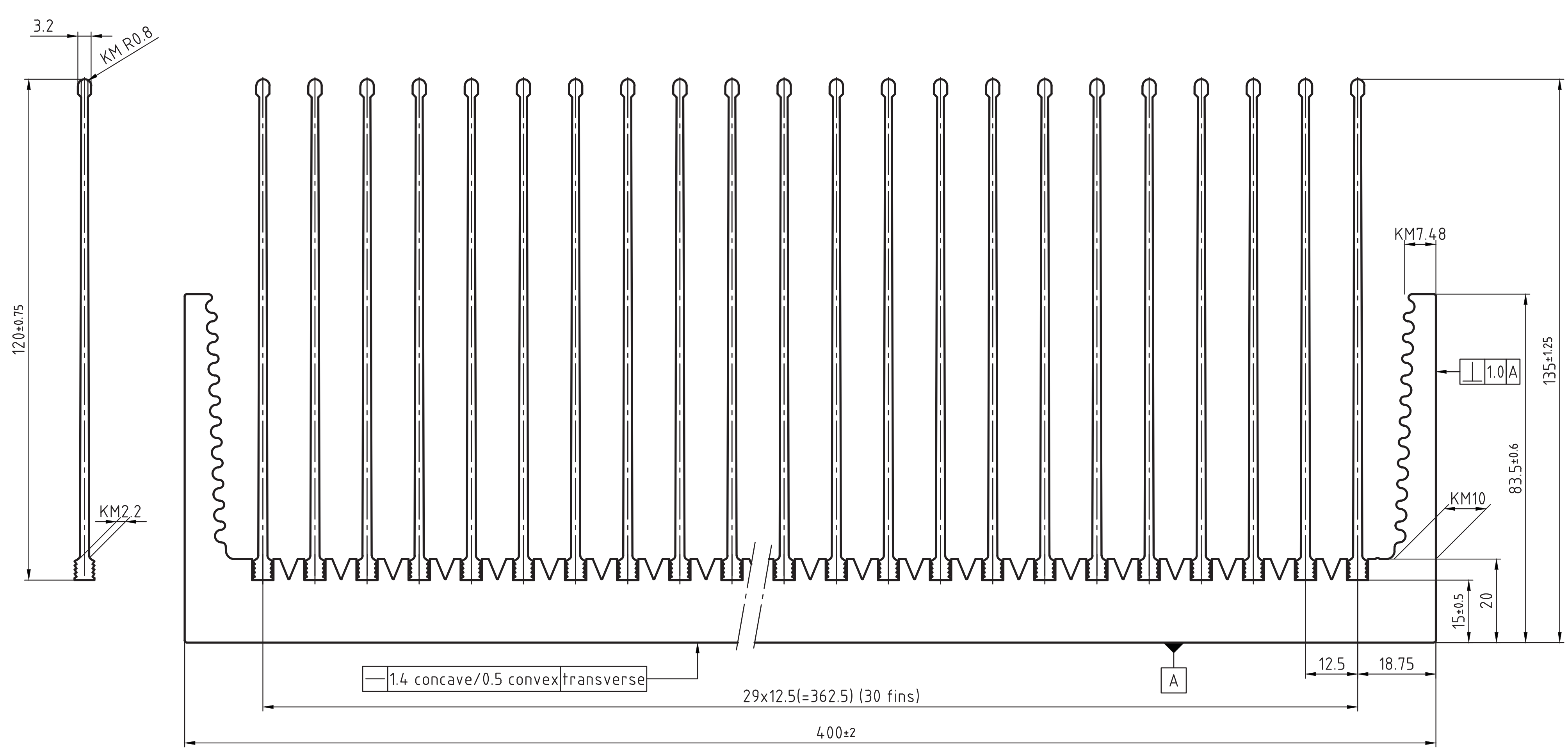


Thermal resistance in K/W for free convection, anodized black, heat sink temperature 85°C, ambient temperature 35°C.

Length in mm	200	300	400	500	600	please find more detailed values in appendix
R_{th}	0.122	0.094	0.076	0.064	0.06	

The thermal resistance values assigned to the different types of heat sink are only standard values for large-area heat distribution. They are no suited to replace measurements under field conditions (particulary referring to number and position of heat sources).

Alloy: EN AW-6101B

further tolerances on request

Constellium

Constellium Singen GmbH
D-78221 Singen/Htwl.
Tel. +49 (0)7731 80 2745

Standard-Delivery-Programme

Type	Order-No.	Width x Height mm	Nominal Weight kg/m
HK-S400 RH120	00769	400x135	41.108

Automotive Structures and Industry - Large Extrusions and Specialities

09.2013

A3

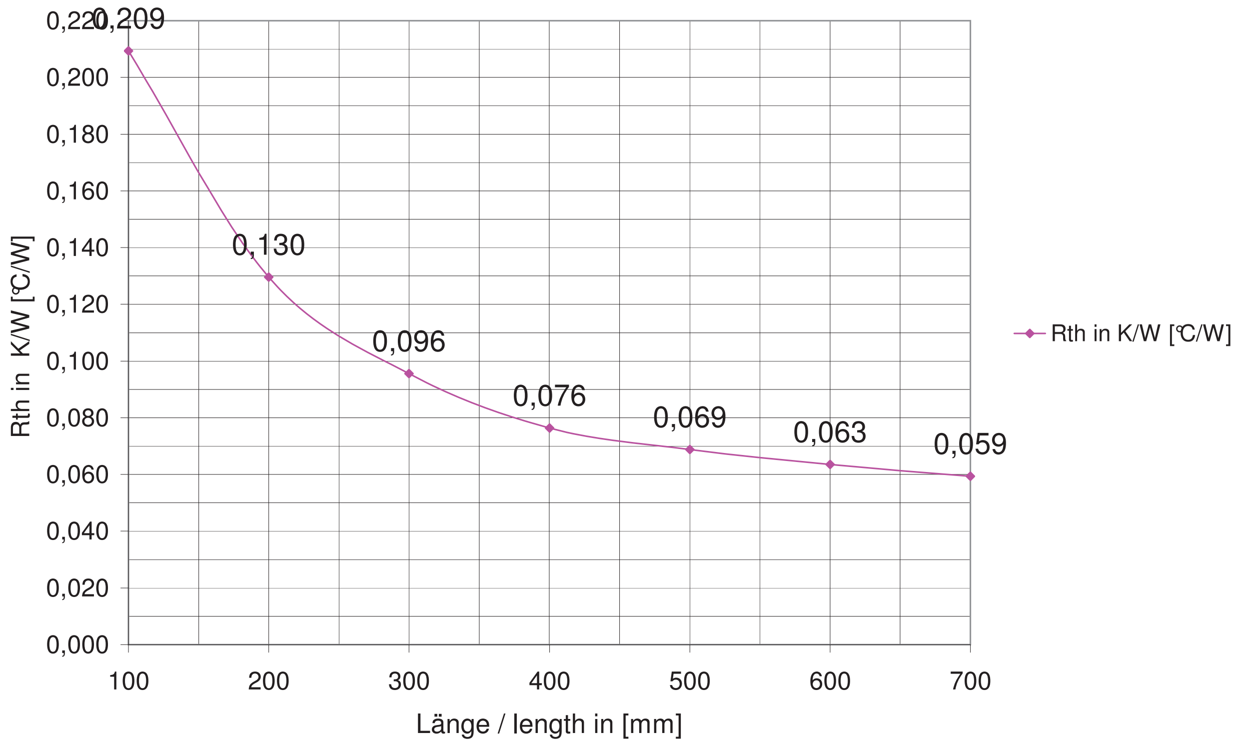
HOCHLEISTUNGSKÜHLKÖRPER/ HIGH DISSIPATION HEATSINK

TYPE: HK-S 400 RH120

BESTELLNR./ORDER-NO: 00769

Constellium Singen GmbH
Technical Customer Service

Werte bei natürlicher Konvektion/ Values for natural convection



Die Werte für den thermischen Widerstand basieren auf einer schwarzen Eloxalschicht, ausgehend von einer einer Umgebungstemperatur von 35°C
Die Wärmewiderstandswerte sind lediglich Richtwerte bei großflächiger Wärmeverteilung. Sie können Messungen unter praxisnahen Bedingungen, worunter besonders Anzahl und Anordnung der Wärmequellen zu verstehen sind, nicht ersetzen.
Thermal resistance values in °C/W for free (natural) convection are based on a black anodizing, values are basing on an ambient temperature of 35°C
The thermal resistance values assigned are only standard values for large-area heat distrubution. They are not suited to replace measurements under field conditions (particulary referring to number and position of heat sources).

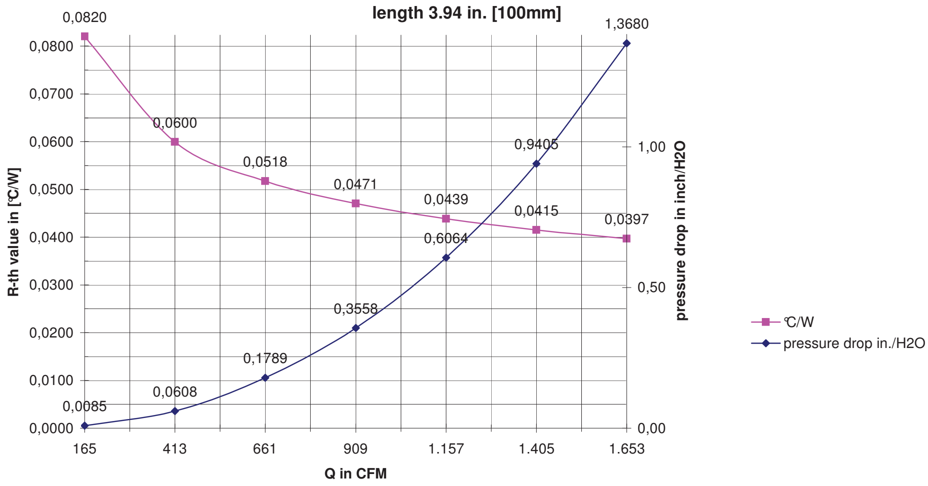
Constellium

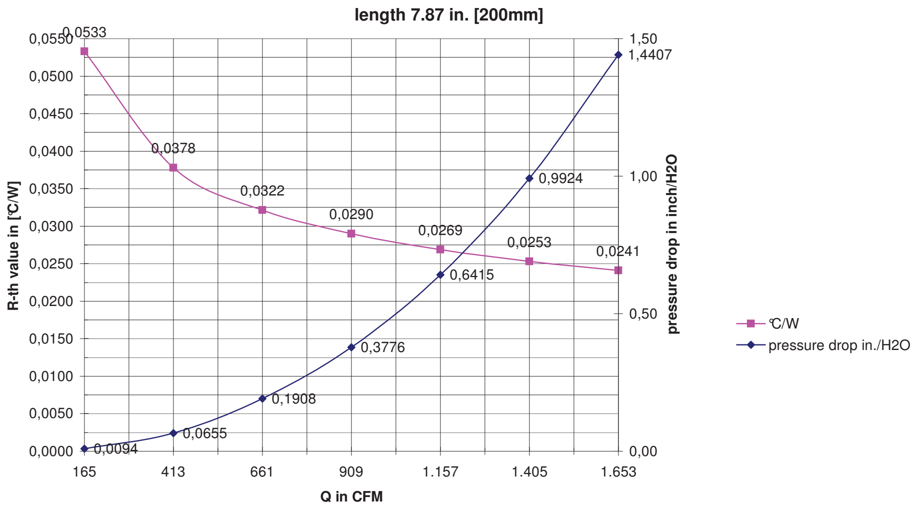
HIGH-DISSIPATION HEATSINKS

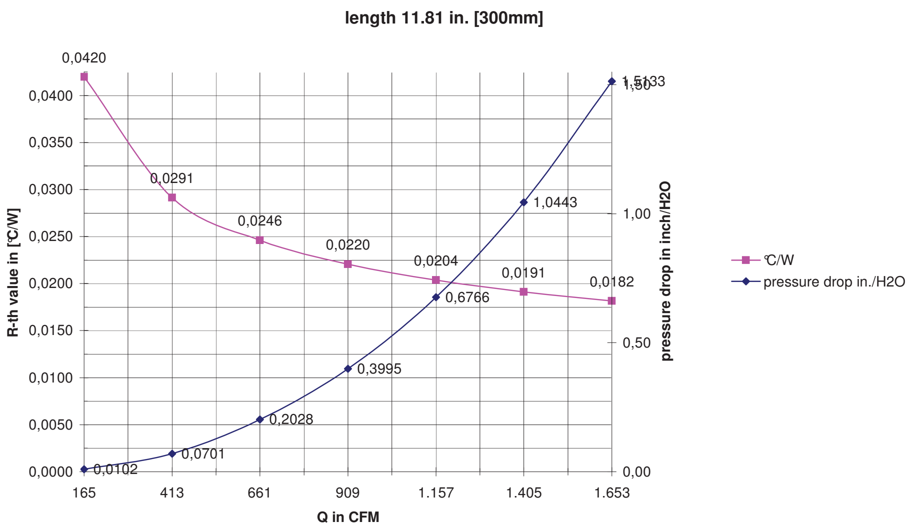
Constellium Singen GmbH
Technical Customer Service

TYPE: HK-S400 RH120

PART No.: 00769





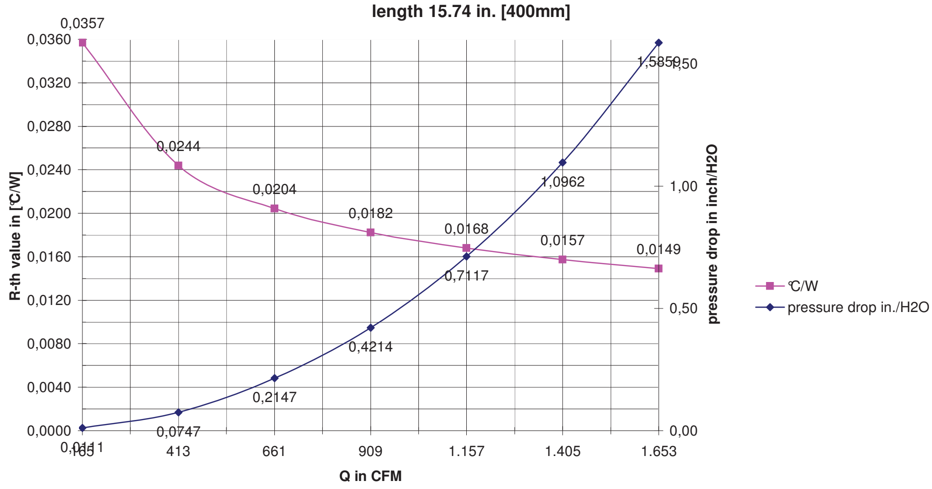


The thermal resistance values assigned to the different types of heat sinks are only standard values for large-area heat distrubution. They are not suited to replace measurements under field conditions (particulary referring to number and position of heat sources).

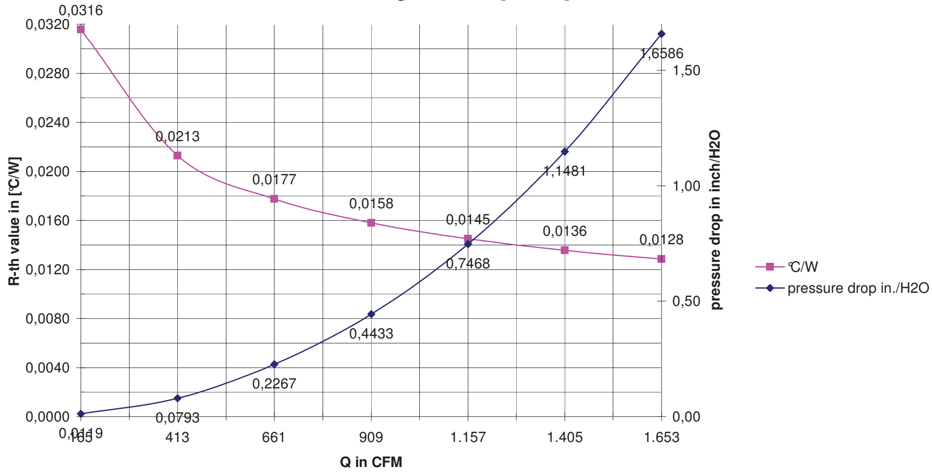
TYPE: HK-S400 RH120

PART No.: 00769

length 15.74 in. [400mm]



length 19.68 in. [500mm]



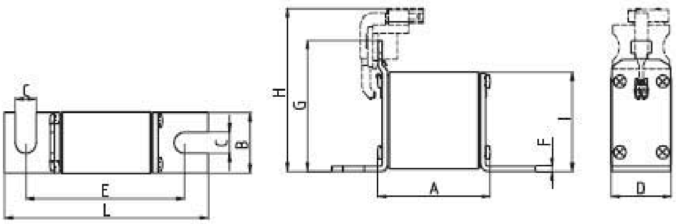
The thermal resistance values assigned to the different types of heat sinks are only standard values for large-area heat distrubution. They are not suited to replace measurements under field conditions (particulary referring to number and position of heat sources).

Fuses for Semiconductor Protection

European Standard — Sizes 000 and 00

Size	Rated Voltage	Standard
00	AC 690/700 V	DIN 43653

Rated Current [A]	Part No. Top Indicator and Fitting for Micro Switch	UL Rec.	Weight [kg/1]	Pack
32	20 412 20.32		0.21	3
35	20 412 20.35		0.21	3
40	20 412 20.40		0.21	3
50	20 412 20.50		0.21	3
63	20 412 20.63		0.21	3
80	20 412 20.80		0.21	3
100	20 412 20.100		0.21	3
125	20 412 20.125		0.21	3
160	20 412 20.160	✓	0.21	3
200	20 412 20.200	✓	0.21	3
250	20 412 20.250	✓	0.21	3
315	20 412 20.315	✓	0.21	3
350	20 412 20.350	✓	0.21	3
400	20 412 20.400		0.21	3



A	2.17" (55 mm)	F	0.10" (2.5 mm)
B	1.13" (28.8 mm)	G	2.48" (63 mm)
C	0.40" (10.3 mm)	H	3.15" (80 mm)
D	1.16" (29.5 mm)	I	1.85" (47 mm)
E	3.07" (78 mm)	$L_{(max)}$	4.13" (105 mm)

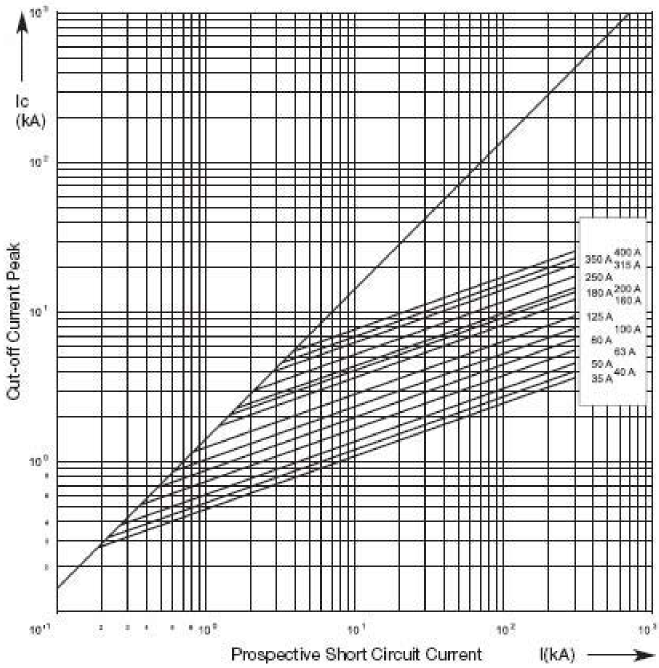
Electrical Characteristics

URB

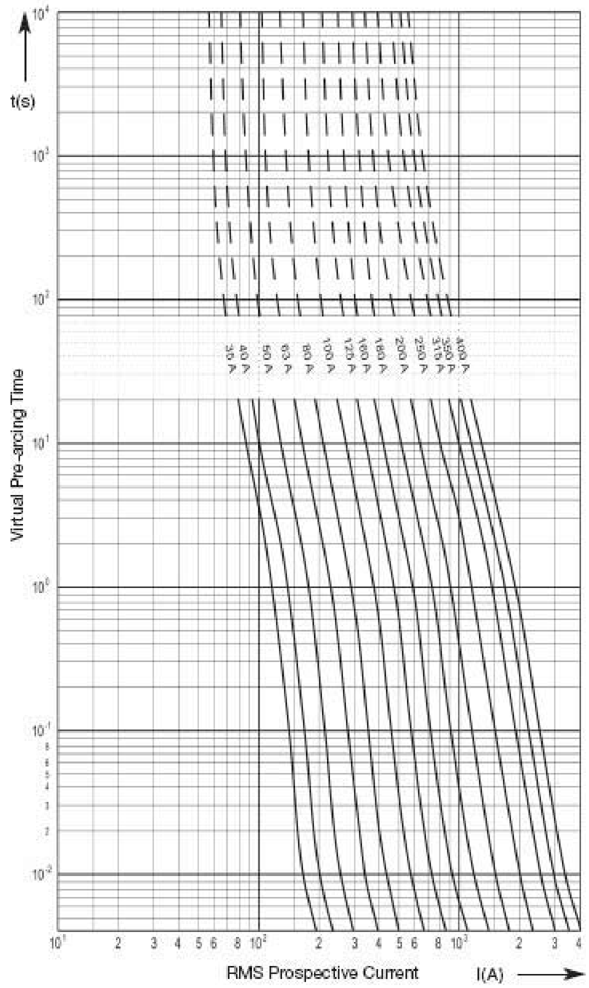
Size	Rated Voltage	Operating Class	Rated Breaking Capacity
00	AC 690/700 V	aR	600 V / 300 kA · 700 V / 200 kA

Rated Current [A]	Part No. with Top Indicator	Part No. without Top Indicator	Part No. Fitting for Micro Switch	Power Loss [W]	Pre-arcing I²t-value [A²s]	Total I²t-value @ 660 V [A²s]
35	20 189 20.35	20 189 21.35	20 412 20.35	8	66	360
40	20 189 20.40	20 189 21.40	20 412 20.40	10	90	500
50	20 189 20.50	20 189 21.50	20 412 20.50	12	140	770
63	20 189 20.63	20 189 21.63	20 412 20.63	14	250	1 400
80	20 189 20.80	20 189 21.80	20 412 20.80	17	470	2 600
100	20 189 20.100	20 189 21.100	20 412 20.100	21	730	4 000
125	20 189 20.125	20 189 21.125	20 412 20.125	25	1 300	7 200
160	20 189 20.160	20 189 21.160	20 412 20.160	31	2 800	15 400
180	20 189 20.180	20 189 21.180	20 412 20.180	34	4 200	23 100
200	20 189 20.200	20 189 21.200	20 412 20.200	37	5 000	27 500
250	20 189 20.250	20 189 21.250	20 412 20.250	44	8 500	46 800
315	20 189 20.315	20 189 21.315	20 412 20.315	53	15 600	86 000
350	20 189 20.350	20 189 21.350	20 412 20.350	57	20 000	110 000
400	20 189 20.400	20 189 21.400	20 412 20.400	68	28 400	156 000

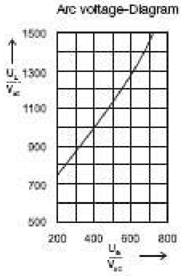
Cut-Off characteristics



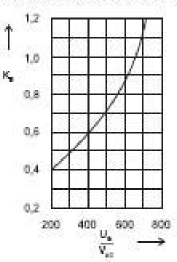
Time-Current Characteristics



Arc voltage-Diagram



Reduction factor for total I²t-value



Reduction factor for power loss