

# VFR · Screw-Terminal · 6000 h/85 °C

High Ripple Current · Bottom cooling design · Low ESR

Optional design for permanent and deep charge-discharge application with high voltage hub and pulsed operation mode upon request.

Spezielles Design für häufige und tiefe Lade-, Entladeanwendungen mit hohem Spannungshub und Impulsbetrieb auf Anfrage erhältlich.

## > Specifications · Spezifikationen

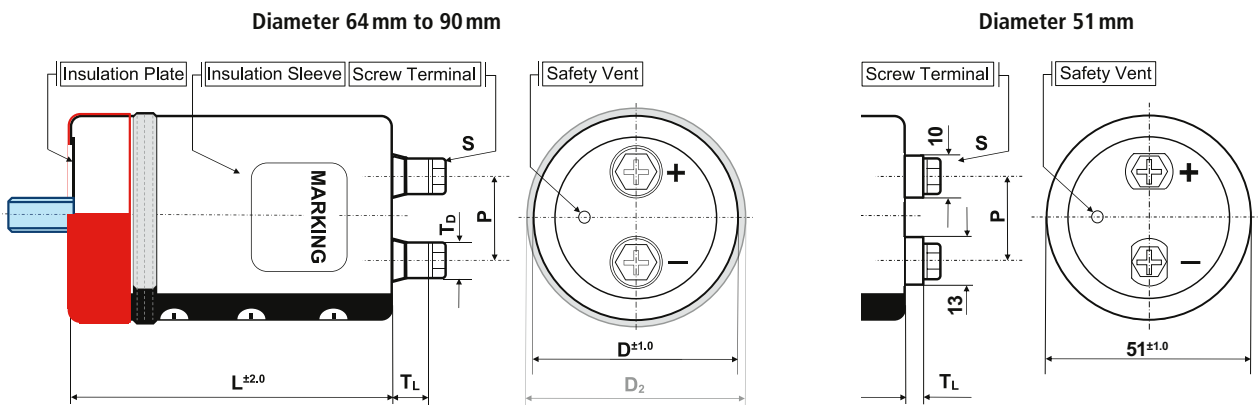
Items	Characteristics
Temperature range	-40°C ~ + 85°C
Capacitance tolerance (at 20°C)	Standard +/- 20%, -10/+30% on request
Surge voltage / Ripple voltage	Repetitive max. 30 sec per 6 Minutes / ≤ 70V
Leakage current max. $I_L$ (20°C, 5 min)	0.01 • C • V <sub>r</sub> [μA] or 5 mA, which is smaller.
Useful life	6000 hours at 85°C
Field failure rate	0.5 FIT = 0.5 • 10 <sup>-9</sup> Failures/hour
Reference standards	IEC 60384-4, JIS C 5101-4
Vibration	0.75mm, 10...55Hz, 10g, 3x2h
Outer materials	UL94-V0/UL224-VW1 certified (cap/sleeve)
Sleeve withstanding voltage	4000 Vac/ 1min between terminals bundled and plate*
Product Compliance	RoHS, REACH, Conflict Minerals a.o. – refer to p. 12–13

\* Typical value



## > Shape designation · Formbezeichnung

- additional information on p. 10–11 · Zusatzinformationen auf S. 10–11
- mounting accessories from p. 189 · Montagezubehör ab S. 189



Shape code Features	B Bolt	I/Y double sleeve for 2/3 points metal Bracket	N + suffix WC blank bottom + seating ring	N standard
outer insulation sleeve	•	•	•	•
insulation plate	•	•		•
stud bolt	•			
bottom double sleeve		•		
integrated seating ring			•	

diameter code	ØD	available shape	P	S	T <sub>L</sub>	T <sub>D</sub>	Cap material
C	51	B, N, I, Y	22.0	M5x10	4.5	13/10	PH
D	64	B, N, I, Y	28.6	M5x10	8.0	11	PH
E	77	B, N, I, Y, WC	31.5	M6x12	9.0	12	PH
F	90	B, N, I, Y, WC	31.5	M6x12	8.0	12	PH

Size in mm

## > Product Code · Bestellbezeichnung

**Example:** Series VFR · 12000 µF +/- 20 % · 400 V · D=90 mm · L= 167 mm with Y-Bracket

<b>VFR</b>	<b>2G</b>	<b>123</b>	<b>Y</b>	<b>F</b>	<b>167</b>
Series name	Capacitance code		Shape code	Diameter code	Specific features
Rated voltage code					
Code	Voltage	Code	Voltage	Capacitance tolerance	
2V	350	2W	450	Ø : ± 20 %	
2G	400	2H	500	Q : -10 % ~ +30 %	
Case length code – length in mm (3 digits)					

Rated Voltage Code (Surge Voltage) $V_r$ [V DC]	Capacitance $C_r$ [µF]	Ripple Current at 85°C/120Hz $I_r$ [A RMS]	Ripple Current at 40°C/120Hz [A RMS]	ESR (typ) at 20°C/100Hz [mΩ]	Zmax at 20°C/10kHz [mΩ]	ESL (typ) [nH]	Dissipation Factor at 20°C/120Hz Tan δ	DxL [mm]	Product Code # = variable value, see fixing code in the product code
<b>350 VDC</b> Code: 2V  Surge Voltage 400 VDC	2 200	10.2	21.5	24	26	17	0.20	51x96	VFR2V222#C096
	2 700	11.4	24.0	20	22	17	0.20	51x109	VFR2V272#C109
	3 300	12.7	26.7	16	18	17	0.20	51x125	VFR2V332#C125
	3 900	17.0	35.7	14	16	18	0.20	64x107	VFR2V392#D107
	4 700	19.2	40.3	11	13	18	0.20	64x123	VFR2V472#D123
			43.3	10	11	18	0.20	64x147	VFR2V562#D147
	5 600	20.6	49.4	10	11	20	0.20	77x108	VFR2V562#E108
			23.3	8	10	18	0.20	64x164	VFR2V682#D164
	6 800	26.5	55.7	8	10	20	0.20	77x124	VFR2V682#E124
			25.8	7	8	18	0.20	64x187	VFR2V822#D187
	8 200	28.5	59.9	7	8	20	0.20	77x148	VFR2V822#E148
			32.6	7	8	20	0.20	90x110	VFR2V822#F110
	10 000	32.1	67.4	5	7	20	0.20	77x165	VFR2V103#E165
			35.9	5	7	20	0.20	90x126	VFR2V103#F126
	12 000	35.3	74.1	5	5	20	0.20	77x188	VFR2V123#E188
			39.1	5	5	20	0.20	90x150	VFR2V123#F150
15 000	40.8	85.7	4	5	20	0.20	77x228	VFR2V153#E228	
		43.3	4	5	20	0.20	90x167	VFR2V153#F167	
18 000	47.1	98.9	3	4	20	0.20	90x190	VFR2V183#F190	
22 000	51.2	107.5*	3	4	20	0.20	90x230	VFR2V223#F230	
27 000	56.0	117.6*	2	3	20	0.20	90x268	VFR2V273#F268	
<b>400 VDC</b> Code: 2G  Surge Voltage 450 VDC	1 800	9.5	20.0	30	32	17	0.20	51x96	VFR2G182#C096
	2 200	10.6	22.3	25	27	17	0.20	51x109	VFR2G222#C109
	2 700	11.9	25.0	20	22	17	0.20	51x125	VFR2G272#C125
	3 300	15.7	33.0	16	18	18	0.20	64x107	VFR2G332#D107
	3 900	17.1	35.9	14	16	18	0.20	64x95	VFR2G392#D095
			36.8	14	16	18	0.20	64x123	VFR2G392#D123
	4 700	18.9	39.7	11	13	18	0.20	64x147	VFR2G472#D147
			45.2	11	13	20	0.20	77x108	VFR2G472#E108
	5 600	21.5	44.5	10	11	18	0.20	64x164	VFR2G562#D164
			24.0	10	11	20	0.20	77x124	VFR2G562#E124

Additional designs on request · Weitere Designs auf Anfrage

Rated VoltageCode (Surge Voltage) $V_r$ [V DC]	Capacitance $C_r$ [ $\mu$ F]	Ripple Current at 85°C/120Hz $I_r$ [A RMS]	Ripple Current at 40°C/120Hz [A RMS]	ESR (typ) at 20°C/100Hz [m $\Omega$ ]	Zmax at 20°C/10kHz [m $\Omega$ ]	ESL (typ) [nH]	Dissipation Factor at 20°C/120Hz Tan $\delta$	DxL [mm]	Product Code  # = variable value, see fixing code in the product code
<b>400 VDC</b> Code: 2G  Surge Voltage 450 VDC	<b>6 800</b>	23.5	49.4	8	10	18	0.20	64x187	VFR2G682#D187
		26.4	55.4	8	10	20	0.20	77x124	VFR2G682#E124
		29.7	62.4	8	10	20	0.20	90x110	VFR2G682#F110
	<b>8 200</b>	28.4	59.6	7	8	20	0.20	77x148	VFR2G822#E148
		29.1	61.1	7	8	20	0.20	77x165	VFR2G822#E165
		32.5	68.3	7	8	20	0.20	90x126	VFR2G822#F126
	<b>10 000</b>	32.2	67.6	5	7	20	0.20	77x188	VFR2G103#E188
		35.7	75.0	5	7	20	0.20	90x150	VFR2G103#F150
	<b>12 000</b>	36.5	76.7	5	5	20	0.20	77x228	VFR2G123#E228
		38.7	81.3	5	5	20	0.20	90x167	VFR2G123#F167
	<b>15 000</b>	43.0	90.3	4	5	20	0.20	90x190	VFR2G153#F190
	<b>18 000</b>	46.3	97.2	3	4	20	0.20	90x230	VFR2G183#F230
<b>22 000</b>	50.5	106.1*	3	4	20	0.20	90x268	VFR2G223#F268	
<b>450 VDC</b> Code: 2W  Surge Voltage 500 VDC	<b>1 500</b>	9.0	18.9	35	38	17	0.20	51x96	VFR2W152#C096
	<b>1 800</b>	10.1	21.3	30	32	17	0.20	51x109	VFR2W182#C109
	<b>2 200</b>	11.3	23.8	24	26	17	0.20	51x125	VFR2W222#C125
	<b>2 700</b>	14.5	30.5	20	22	18	0.20	64x107	VFR2W272#D107
	<b>3 300</b>	16.5	34.7	16	18	18	0.20	64x123	VFR2W332#D123
		17.6	37.0	14	16	18	0.20	64x147	VFR2W392#D147
	<b>3 900</b>	20.1	42.2	14	16	20	0.20	77x108	VFR2W392#E108
		19.9	41.8	11	13	18	0.20	64x164	VFR2W472#D164
	<b>4 700</b>	22.6	47.5	11	13	20	0.20	77x124	VFR2W472#E124
		21.9	46.0	10	11	18	0.20	64x187	VFR2W562#D187
	<b>5 600</b>	24.1	50.6	10	11	20	0.20	77x148	VFR2W562#E148
		27.6	58.0	10	11	20	0.20	90x110	VFR2W562#F110
	<b>6 800</b>	27.1	56.9	8	10	20	0.20	77x165	VFR2W682#E165
		30.3	63.6	8	10	20	0.20	90x126	VFR2W682#F126
	<b>8 200</b>	29.9	62.8	7	8	20	0.20	77x188	VFR2W822#E188
		33.1	69.5	7	8	20	0.20	90x150	VFR2W822#F150
	<b>10 000</b>	34.1	71.6	5	7	20	0.20	77x228	VFR2W103#E228
		36.2	76.0	5	7	20	0.20	90x167	VFR2W103#F167
	<b>12 000</b>	39.4	82.7	5	5	20	0.20	90x190	VFR2W123#F190
	<b>14 000</b>	42.5	89.3	4	5	20	0.20	90x190	VFR2W143#F190
<b>15 000</b>	43.3	90.9	4	5	20	0.20	90x230	VFR2W153#F230	
<b>17 000</b>	44.5	93.4	4	5	20	0.20	90x230	VFR2W173#F230	
<b>18 000</b>	46.9	98.5	3	4	20	0.20	90x268	VFR2W183#F268	
<b>500 VDC</b> Code: 2H  Surge Voltage 550 VDC	<b>820</b>	6.1	12.9	71	74	17	0.20	51x96	VFR2H821#C096
	<b>1 000</b>	7.0	14.7	58	61	17	0.20	51x109	VFR2H102#C109
	<b>1 200</b>	7.9	16.6	48	51	17	0.20	51x125	VFR2H122#C125
	<b>1 800</b>	11.3	23.7	32	35	18	0.20	64x107	VFR2H182#D107
	<b>2 200</b>	12.8	26.9	26	28	18	0.20	64x123	VFR2H222#D123
	<b>2 700</b>	13.9	29.2	22	24	18	0.20	64x147	VFR2H272#D147
		15.9	33.4	22	24	20	0.20	77x108	VFR2H272#E108

Additional designs on request · Weitere Designs auf Anfrage

# VFR · Screw-Terminal · 6000 h/85 °C

Rated VoltageCode (Surge Voltage) $V_r$ [V DC]	Capacitance $C_r$ [μF]	Ripple Current at 85°C/120Hz $I_r$ [A RMS]	Ripple Current at 40°C/120Hz [A RMS]	ESR (typ) at 20°C/100Hz [mΩ]	Zmax at 20°C/10kHz [mΩ]	ESL (typ) [nH]	Dissipation Factor at 20°C/120Hz Tan δ	DxL [mm]	Product Code # = variable value, see fixing code in the product code
<b>500 VDC</b> Code: 2H  Surge Voltage 550 VDC	<b>3 300</b>	15.8	33.2	18	20	18	0.20	64x164	VFR2H332#D164
		18.0	37.8	18	20	20	0.20	77x124	VFR2H332#E124
	<b>3 900</b>	17.3	36.3	15	17	18	0.20	64x187	VFR2H392#D187
		19.1	40.1	15	17	20	0.20	77x148	VFR2H392#E148
		21.9	46.0	15	17	20	0.20	90x110	VFR2H392#F110
	<b>4 700</b>	21.4	44.9	13	15	20	0.20	77x165	VFR2H472#E165
		24.0	50.4	13	15	20	0.20	90x126	VFR2H472#F126
	<b>5 600</b>	23.5	49.4	11	13	20	0.20	77x188	VFR2H562#E188
		26.0	54.6	11	13	20	0.20	90x150	VFR2H562#F150
	<b>6 800</b>	26.7	56.1	9	10	20	0.20	77x228	VFR2H682#E228
		28.6	60.1	9	10	20	0.20	90x150	VFR2H682#F150
		28.4	59.6	9	10	20	0.20	90x167	VFR2H682#F167
	<b>8 200</b>	31.0	65.1	8	8	20	0.20	90x190	VFR2H822#F190
	<b>10 000</b>	34.2	71.8	6	7	20	0.20	90x190	VFR2H103#F190
		33.6	70.6	6	7	20	0.20	90x230	VFR2H103#F230
	<b>12 000</b>	36.3	76.2	5	6	20	0.20	90x268	VFR2H123#F268

\* Please contact us if load condition exceeds terminals related  $I_{rmax}$  referred on page 11

Additional designs on request · Weitere Designs auf Anfrage

## > Ripple Current Multiplier · Wechselstrommultiplikator

Frequency [Hz]	50/60	120	300	1k	≥ 10k
Multiplier	0.80	1.00	1.18	1.34	1.45

Ta (°C)	40	45	50	55	60	65	70	75	80	85
Multiplier	2.1	2.1	2.0	1.9	1.8	1.6	1.5	1.3	1.1	1.0

Forced cooling – Wind speed [m/sec]	v < 0.25	v ≥ 0.25	v ≥ 0.5	v ≥ 1.0	v ≥ 2.0	v ≥ 3.0
Multiplier	1.00	1.07	1.15	1.25	1.30	1.35

Water cooled heatsink – size ratio [L/D]	1.10	1.25	1.40	1.55	1.70	2.00	2.50	3.00
Multiplier	2.0	1.9	1.7	1.6	1.5	1.4	1.2	1.1

## > Life Time Table · Brauchbarkeitsdauer – Tabelle

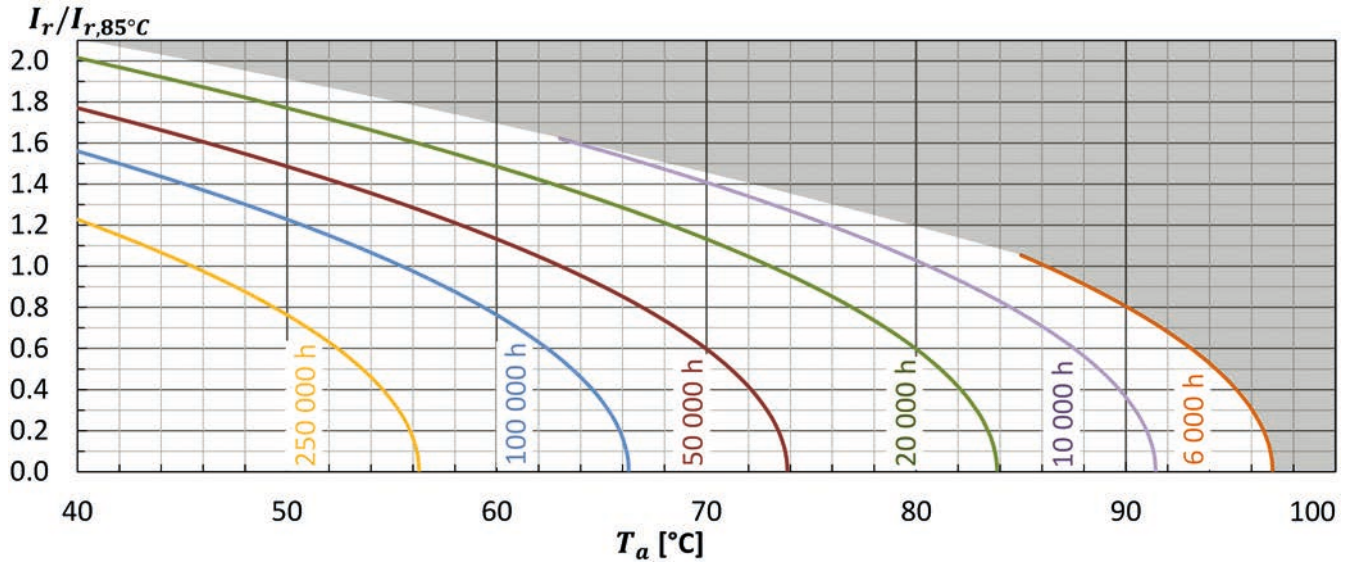
VFR	Useful life as function of ambient temperature and ripple current												
	$I_r$ at 85°C	x 1.0	x 1.1	x 1.2	x 1.3	x 1.4	x 1.5	x 1.6	x 1.7	x 1.8	x 1.9	x 2.0	x 2.1
T <sub>a</sub> = 40°C	250	250	250	208	159	120	88	63	45	31	21	14	
T <sub>a</sub> = 45°C	250	212	169	132	101	75	55	40	28	19	13	8	
T <sub>a</sub> = 50°C	165	134	107	83	63	48	35	25	18	12	8		
T <sub>a</sub> = 55°C	104	85	67	52	40	30	22	16	11	7			
T <sub>a</sub> = 60°C	66	53	42	33	25	19	14	10	7				
T <sub>a</sub> = 65°C	41	34	27	21	16	12	8						
T <sub>a</sub> = 70°C	26	21	17	13	10	7							
T <sub>a</sub> = 75°C	16	13	10	8									
T <sub>a</sub> = 80°C	10	8											
T <sub>a</sub> = 85°C	6												

khrs      Max. value limited to 250 000 hours.

> Life Time Graph · Brauchbarkeitsdauer – Diagramm

Useful life depending on ambient temperature  $T_a$  and ripple current operating conditions  $I_r$ , versus rated ripple current at the upper category temperature  $I_{r, 85^\circ\text{C}, 120\text{Hz}}$

Brauchbarkeitsdauer in Abhängigkeit von Umgebungstemperatur  $T_a$  und Wechselstrombelastung  $I_r$ , im Verhältnis zur max. Wechselstrombelastung bei oberer Kategorie-temperatur  $I_{r, 85^\circ\text{C}, 120\text{Hz}}$



> Life Time Tests and Requirements · Anforderungen Brauchbarkeitsdauer

Life time test	Test procedure	Life time criteria
Endurance test	$T_a = 85^\circ\text{C}$ ; $V_r$ , $I_r$ applied 4000 hours	$\Delta C/C \leq 10\%$ (of initial value) $\text{Tan}\delta \leq 175\%$ (of specified value) $I_L \leq$ specified value
Useful life	$T_a = 85^\circ\text{C}$ ; $V_r$ , $I_r$ applied 6000 hours	$\Delta C/C \leq 15\%$ (of initial value) $\text{Tan}\delta < 200\%$ (of specified value) $I_L \leq$ specified value

Reference Specification: JIS C 5101-4, JIS C 5102, IEC 60384-4