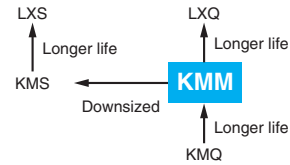


KMM Series

- Longer life from KMQ series
- Endurance with ripple current : 2,000 to 3,000 hours at 105°C
- Non solvent resistant type
- RoHS2 Compliant

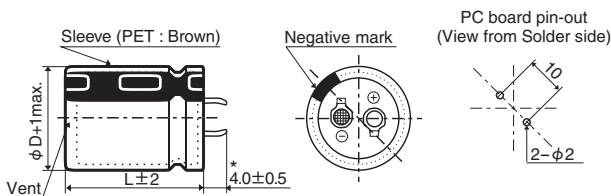


SPECIFICATIONS

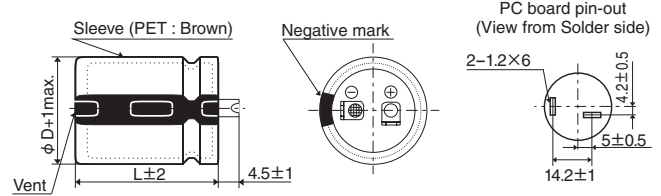
Items	Characteristics		
Category	-25 to +105°C		
Temperature Range	-25 to +105°C		
Rated Voltage Range	160 to 450V _{dc}		
Capacitance Tolerance	±20% (M) (at 20°C, 120Hz)		
Leakage Current	I ≤ 3/√CV Where, I : Max. leakage current (µA), C : Nominal capacitance (µF), V : Rated voltage (V) (at 20°C after 5 minutes)		
Dissipation Factor (tan δ)	Rated voltage (V _{dc})	160 to 400V	420 & 450V
	tan δ (Max.)	0.15	0.20
Low Temperature Characteristics (Max. Impedance Ratio)	Rated voltage (V _{dc})	160 to 400V	420 & 450V
	Z(-25°C)/Z(+20°C)	4	8
Endurance	The following specifications shall be satisfied when the capacitors are restored to 20°C after subjected to DC voltage with the rated ripple current is applied (the peak voltage shall not exceed the rated voltage) for 3,000 hours at 105°C.		
	Capacitance change	≤ ±20% of the initial value	
	D.F. (tan δ)	≤ 200% of the initial specified value	
	Leakage current	≤ The initial specified value	
Shelf Life	The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them for 1,000 hours at 105°C without voltage applied. Before the measurement, the capacitor shall be preconditioned by applying voltage according to Item 4.1 of JIS C 5101-4.		
	Capacitance change	≤ ±15% of the initial value	
	D.F. (tan δ)	≤ 150% of the initial specified value	
	Leakage current	≤ The initial specified value	

DIMENSIONS [mm]

- Terminal Code : VS (φ22 to φ35) : Standard



- Terminal Code : LI (φ35)



* φD=35mm : 3.5±0.5mm

The standard design has no plastic disc.

PART NUMBERING SYSTEM



Please refer to "Product code guide (snap-in type)"

◆STANDARD RATINGS

	160						180						200						220										
	WV (V _{dc})	Cap (μF)	Case size φD×L(mm)	tan δ	Rated ripple current (Arms/105°C, 120Hz)	Part No.	WV (V _{dc})	Cap (μF)	Case size φD×L(mm)	tan δ	Rated ripple current (Arms/105°C, 120Hz)	Part No.	WV (V _{dc})	Cap (μF)	Case size φD×L(mm)	tan δ	Rated ripple current (Arms/105°C, 120Hz)	Part No.	WV (V _{dc})	Cap (μF)	Case size φD×L(mm)	tan δ	Rated ripple current (Arms/105°C, 120Hz)	Part No.					
	220	22 × 20	0.15	0.81	EKMM161VSN221MP20S		1,200	25.4 × 50	0.15	2.55	EKMM181VSN122MQ50S		150	22 × 20	0.15	0.73	EKMM201VSN151MP20S		150	22 × 20	0.15	0.80	EKMM201VSN181MP20S		180	22 × 20	0.15	0.85	EKMM201VSN221MQ20S
	270	25.4 × 20	0.15	0.98	EKMM161VSN271MQ20S		1,200	30 × 40	0.15	2.55	EKMM181VSN122MR40S		180	22 × 20	0.15	0.80	EKMM201VSN181MP20S		220	25.4 × 20	0.15	1.10	EKMM201VSN271MP25S		270	22 × 25	0.15	1.10	EKMM201VSN271MP25S
	330	22 × 25	0.15	1.20	EKMM161VSN331MP25S		1,200	35 × 30	0.15	2.55	EKMM181VSN122MA30S		220	25.4 × 20	0.15	0.85	EKMM201VSN221MQ20S		270	22 × 25	0.15	1.10	EKMM201VSN271MP25S		270	22 × 25	0.15	1.10	EKMM201VSN271MP25S
	330	25.4 × 20	0.15	1.02	EKMM161VSN331MQ20S		1,500	30 × 45	0.15	2.90	EKMM181VSN152MR45S		270	30 × 20	0.15	1.05	EKMM201VSN271MR20S		330	22 × 30	0.15	1.25	EKMM201VSN331MP30S		330	25.4 × 25	0.15	1.25	EKMM201VSN331MQ25S
	390	22 × 25	0.15	1.30	EKMM161VSN391MP25S		1,500	35 × 35	0.15	2.90	EKMM181VSN152MA35S		330	25.4 × 25	0.15	1.25	EKMM201VSN331MQ25S		330	25.4 × 25	0.15	1.25	EKMM201VSN331MQ25S		390	22 × 30	0.15	1.35	EKMM201VSN391MP30S
	390	25.4 × 25	0.15	1.26	EKMM161VSN391MQ25S		1,800	30 × 60	0.15	3.49	EKMM181VSN182MR60S		390	22 × 30	0.15	1.35	EKMM201VSN391MP30S		390	22 × 30	0.15	1.35	EKMM201VSN391MP30S		390	25.4 × 25	0.15	1.35	EKMM201VSN391MP25S
	390	30 × 20	0.15	1.25	EKMM161VSN391MR20S		1,800	35 × 40	0.15	3.30	EKMM181VSN182MA40S		390	25.4 × 25	0.15	1.35	EKMM201VSN391MP25S		390	25.4 × 25	0.15	1.35	EKMM201VSN391MP25S		470	22 × 35	0.15	1.50	EKMM201VSN471MP35S
	470	22 × 30	0.15	1.55	EKMM161VSN471MP30S		2,200	35 × 50	0.15	3.65	EKMM181VSN222MA50S		470	22 × 35	0.15	1.50	EKMM201VSN471MP35S		470	22 × 35	0.15	1.50	EKMM201VSN471MP35S		470	22 × 35	0.15	1.50	EKMM201VSN471MP35S
	470	25.4 × 25	0.15	1.55	EKMM161VSN471MQ25S		2,700	35 × 60	0.15	4.19	EKMM181VSN272MA60S		470	25.4 × 30	0.15	1.50	EKMM201VSN471MQ30S		470	25.4 × 30	0.15	1.50	EKMM201VSN471MQ30S		470	30 × 25	0.15	1.50	EKMM201VSN471MR25S
	470	30 × 20	0.15	1.30	EKMM161VSN471MR20S		150	22 × 20	0.15	0.73	EKMM201VSN151MP20S		470	30 × 20	0.15	1.41	EKMM201VSN471MA20S		470	30 × 20	0.15	1.41	EKMM201VSN471MA20S		470	30 × 20	0.15	1.41	EKMM201VSN471MA20S
	560	22 × 35	0.15	1.67	EKMM161VSN561MP35S		180	22 × 20	0.15	0.80	EKMM201VSN181MP20S		560	22 × 40	0.15	1.67	EKMM201VSN561MP40S		560	22 × 40	0.15	1.67	EKMM201VSN561MP40S		560	22 × 40	0.15	1.67	EKMM201VSN561MP40S
	560	25.4 × 30	0.15	1.67	EKMM161VSN561MQ30S		220	25.4 × 20	0.15	0.85	EKMM201VSN221MQ20S		560	25.4 × 30	0.15	1.67	EKMM201VSN561MQ30S		560	25.4 × 30	0.15	1.67	EKMM201VSN561MQ30S		560	25.4 × 30	0.15	1.67	EKMM201VSN561MQ30S
	560	30 × 25	0.15	1.67	EKMM161VSN561MR25S		270	22 × 25	0.15	1.10	EKMM201VSN271MP25S		680	22 × 45	0.15	1.78	EKMM201VSN681MP45S		680	22 × 45	0.15	1.78	EKMM201VSN681MP45S		680	22 × 45	0.15	1.78	EKMM201VSN681MP45S
	560	35 × 20	0.15	1.46	EKMM161VSN561MA20S		330	25.4 × 25	0.15	1.25	EKMM201VSN331MQ25S		680	25.4 × 35	0.15	1.78	EKMM201VSN681MQ35S		680	25.4 × 35	0.15	1.78	EKMM201VSN681MQ35S		680	25.4 × 35	0.15	1.78	EKMM201VSN681MQ35S
	680	22 × 40	0.15	1.82	EKMM161VSN681MP40S		330	30 × 20	0.15	1.10	EKMM201VSN331MR20S		680	30 × 30	0.15	1.78	EKMM201VSN681MR30S		680	30 × 30	0.15	1.78	EKMM201VSN681MR30S		680	30 × 30	0.15	1.78	EKMM201VSN681MR30S
	680	25.4 × 30	0.15	1.82	EKMM161VSN681MQ30S		330	30 × 20	0.15	1.10	EKMM201VSN331MR20S		680	35 × 25	0.15	1.78	EKMM201VSN681MA25S		680	35 × 25	0.15	1.78	EKMM201VSN681MA25S		680	35 × 25	0.15	1.78	EKMM201VSN681MA25S
	680	30 × 25	0.15	1.82	EKMM161VSN681MR25S		390	22 × 30	0.15	1.35	EKMM201VSN391MP30S		820	25.4 × 45	0.15	2.04	EKMM201VSN821MQ45S		820	25.4 × 45	0.15	2.04	EKMM201VSN821MQ45S		820	25.4 × 45	0.15	2.04	EKMM201VSN821MQ45S
	680	35 × 20	0.15	1.51	EKMM161VSN681MA20S		390	22 × 30	0.15	1.35	EKMM201VSN391MP30S		820	30 × 30	0.15	2.04	EKMM201VSN821MR30S		820	30 × 30	0.15	2.04	EKMM201VSN821MR30S		820	30 × 30	0.15	2.04	EKMM201VSN821MR30S
	820	22 × 45	0.15	2.04	EKMM161VSN821MP45S		390	25.4 × 25	0.15	1.35	EKMM201VSN391MP25S		820	22 × 50	0.15	2.04	EKMM201VSN821MP50S		820	22 × 50	0.15	2.04	EKMM201VSN821MP50S		820	25.4 × 40	0.15	2.04	EKMM201VSN821MQ40S
	820	25.4 × 35	0.15	2.04	EKMM161VSN821MQ35S		390	35 × 20	0.15	1.30	EKMM201VSN391MA20S		820	25.4 × 35	0.15	2.04	EKMM201VSN821MQ35S		820	25.4 × 40	0.15	2.04	EKMM201VSN821MQ40S		820	25.4 × 40	0.15	2.04	EKMM201VSN821MQ40S
	820	30 × 30	0.15	2.04	EKMM161VSN821MR30S		470	22 × 35	0.15	1.50	EKMM201VSN471MP35S		820	30 × 30	0.15	2.04	EKMM201VSN821MR30S		820	30 × 30	0.15	2.04	EKMM201VSN821MR30S		820	30 × 30	0.15	2.04	EKMM201VSN821MR30S
	820	35 × 25	0.15	2.04	EKMM161VSN821MA25S		470	25.4 × 30	0.15	1.50	EKMM201VSN471MQ30S		820	35 × 25	0.15	2.04	EKMM201VSN821MA25S		820	35 × 25	0.15	2.04	EKMM201VSN821MA25S		1,000	25.4 × 45	0.15	2.30	EKMM201VSN102MQ45S
	1,000	22 × 50	0.15	2.25	EKMM161VSN102MP50S		470	30 × 25	0.15	1.50	EKMM201VSN471MR25S		1,000	22 × 50	0.15	2.25	EKMM201VSN102MP50S		1,000	22 × 50	0.15	2.25	EKMM201VSN102MP50S		1,000	25.4 × 45	0.15	2.30	EKMM201VSN102MQ45S
	1,000	25.4 × 40	0.15	2.25	EKMM161VSN102MQ40S		470	35 × 20	0.15	1.41	EKMM201VSN471MA20S		1,000	25.4 × 40	0.15	2.25	EKMM201VSN102MQ40S		1,000	25.4 × 40	0.15	2.25	EKMM201VSN102MQ40S		1,000	30 × 35	0.15	2.30	EKMM201VSN102MR35S
	1,000	30 × 30	0.15	2.25	EKMM161VSN102MR30S		560	22 × 40	0.15	1.67	EKMM201VSN561MP40S		1,000	30 × 30	0.15	2.25	EKMM201VSN102MR30S		1,000	30 × 30	0.15	2.25	EKMM201VSN102MR30S		1,000	30 × 30	0.15	2.25	EKMM201VSN102MR30S
	1,000	35 × 25	0.15	2.25	EKMM161VSN102MA25S		560	25.4 × 30	0.15	1.67	EKMM201VSN561MQ30S		1,000	35 × 25	0.15	2.25	EKMM201VSN102MA25S		1,000	35 × 25	0.15	2.25	EKMM201VSN102MA25S		1,000	35 × 25	0.15	2.25	EKMM201VSN102MA25S
	1,200	25.4 × 45	0.15	2.49	EKMM161VSN122MQ45S		560	30 × 25	0.15	1.67	EKMM201VSN561MR25S		1,200	25.4 × 45	0.15	2.49	EKMM201VSN122MQ45S		1,200	25.4 × 45	0.15	2.49	EKMM201VSN122MQ45S		1,200	25.4 × 45	0.15	2.49	EKMM201VSN122MQ45S
	1,200	30 × 35	0.15	2.49	EKMM161VSN122MR35S		680	22 × 45	0.15	1.78	EKMM201VSN681MP45S		1,200	30 × 35	0.15	2.49	EKMM201VSN122MR35S		1,200	30 × 35	0.15	2.49	EKMM201VSN122MR35S		1,200	30 × 35	0.15	2.49	EKMM201VSN122MR35S
	1,200	35 × 30	0.15	2.49	EKMM161VSN122MA30S		680	25.4 × 35	0.15	1.78	EKMM201VSN681MQ35S		1,200	35 × 30	0.15	2.49	EKMM201VSN122MA30S		1,200	35 × 30	0.15	2.49	EKMM201VSN122MA30S		1,200	35 × 30	0.15	2.49	EKMM201VSN122MA30S
	1,500	25.4 × 60	0.15	2.97	EKMM161VSN152MQ60S		680	30 × 30	0.15	1.78	EKMM201VSN681MR30S		1,500	25.4 × 60	0.15	2.97	EKMM201VSN152MQ60S		1,500	25.4 × 60	0.15	2.97	EKMM201VSN152MQ60S		1,500	25.4 × 60	0.15	2.97	EKMM201VSN152MQ60S
	1,500	30 × 40	0.15	2.84	EKMM161VSN152MR40S		680	35 × 25	0.15	1.78	EKMM201VSN681MA25S		1,500	30 × 40	0.15	2.84	EKMM201VSN152MR40S		1,500	30 × 40	0.15	2.84	EKMM201VSN152MR40S		1,500	30 × 40	0.15	2.84	EKMM201VSN152MR40S
	1,500	35 × 30	0.15	2.84	EKMM161VSN152MA30S		820	25.4 × 45	0.15	2.04	EKMM201VSN821MQ45S		1,500	35 × 30	0.15	2.84	EKMM201VSN152MA30S		1,500	35 × 30	0.15	2.84	EKMM201VSN152MA30S		1,500	35 × 30	0.15	2.84	EKMM201VSN152MA30S
	1,800	30 × 45	0.15	3.32	EKMM161VSN182MR45S		820	30 × 30	0.15	2.04	EKMM201VSN821MR30S		1,800	30 × 45	0.15	3.32	EKMM201VSN182MR45S		1,800	30 × 45	0.15	3.32	EKMM201VSN182MR45S		1,800	30 × 45	0.15	3.32	EKMM201VSN182MR45S
	1,800	35 × 35	0.15	3.00	EKMM161VSN182MA35S		820	35 × 25	0.15	2.04	EKMM201VSN821MA25S		1,800	35 × 35	0.15	3.00	EKMM201VSN182MA35S		1,800	35 × 35	0.15	3.00	EKMM201VSN182MA35S		1,800	35 × 35	0.15	3.00	EKMM201VSN182MA35S
	2,200	30 × 60	0.15	3.86</																									



KMM Series

STANDARD RATINGS

Table with columns: WV (Vdc), Cap (μF), Case size φD×L(mm), tan δ, Rated ripple current (Arms/105°C, 120Hz), Part No. It lists specifications for three series: 220, 250, and 315, each with sub-series 315 and 400. Each sub-series includes various capacitor values and their physical dimensions.

KMM Series

◆STANDARD RATINGS

WV (V _{dc})	Cap (μF)	Case size φD×L(mm)	tan δ	Rated ripple current (Arms/105°C, 120Hz)	Part No.	WV (V _{dc})	Cap (μF)	Case size φD×L(mm)	tan δ	Rated ripple current (Arms/105°C, 120Hz)	Part No.	
400	100	22 × 30	0.15	0.70	EKMM401VSN101MP30S	420	180	25.4 × 35	0.20	0.95	EKMM421VSN181MQ35S	
	100	25.4 × 25	0.15	0.70	EKMM401VSN101MQ25S		180	30 × 30	0.20	0.95	EKMM421VSN181MR30S	
	100	30 × 20	0.15	0.60	EKMM401VSN101MR20S		180	35 × 25	0.20	0.94	EKMM421VSN181MA25S	
	120	22 × 35	0.15	0.75	EKMM401VSN121MP35S		220	22 × 50	0.20	1.10	EKMM421VSN221MP50S	
	120	25.4 × 25	0.15	0.75	EKMM401VSN121MQ25S		220	25.4 × 45	0.20	1.10	EKMM421VSN221MQ45S	
	120	30 × 25	0.15	0.73	EKMM401VSN121MR25S		220	30 × 35	0.20	1.10	EKMM421VSN221MR35S	
	120	35 × 20	0.15	0.75	EKMM401VSN121MA20S		220	35 × 25	0.20	1.10	EKMM421VSN221MA25S	
	150	22 × 40	0.15	0.88	EKMM401VSN151MP40S		270	25.4 × 50	0.20	1.22	EKMM421VSN271MQ50S	
	150	25.4 × 30	0.15	0.88	EKMM401VSN151MQ30S		270	30 × 40	0.20	1.22	EKMM421VSN271MR40S	
	150	30 × 25	0.15	0.88	EKMM401VSN151MR25S		270	35 × 30	0.20	1.22	EKMM421VSN271MA30S	
	150	35 × 20	0.15	0.80	EKMM401VSN151MA20S		330	25.4 × 60	0.20	1.41	EKMM421VSN331MQ60S	
	180	22 × 45	0.15	0.98	EKMM401VSN181MP45S		330	30 × 45	0.20	1.45	EKMM421VSN331MR45S	
	180	25.4 × 35	0.15	0.98	EKMM401VSN181MQ35S		330	35 × 35	0.20	1.45	EKMM421VSN331MA35S	
	180	30 × 30	0.15	0.98	EKMM401VSN181MR30S		390	30 × 50	0.20	1.55	EKMM421VSN391MR50S	
	180	35 × 25	0.15	0.98	EKMM401VSN181MA25S		390	35 × 40	0.20	1.55	EKMM421VSN391MA40S	
	220	22 × 50	0.15	1.10	EKMM401VSN221MP50S		470	30 × 60	0.20	1.79	EKMM421VSN471MR60S	
	220	25.4 × 40	0.15	1.10	EKMM401VSN221MQ40S		470	35 × 45	0.20	1.90	EKMM421VSN471MA45S	
	220	30 × 30	0.15	1.10	EKMM401VSN221MR30S		560	35 × 50	0.20	2.15	EKMM421VSN561MA50S	
	220	35 × 25	0.15	1.10	EKMM401VSN221MA25S		680	35 × 60	0.20	2.27	EKMM421VSN681MA60S	
	270	25.4 × 45	0.15	1.22	EKMM401VSN271MQ45S		450	56	22 × 25	0.20	0.40	EKMM451VSN560MP25S
	270	30 × 35	0.15	1.22	EKMM401VSN271MR35S			68	22 × 30	0.20	0.53	EKMM451VSN680MP30S
	270	35 × 30	0.15	1.22	EKMM401VSN271MA30S			68	25.4 × 25	0.20	0.50	EKMM451VSN680MQ25S
	330	25.4 × 50	0.15	1.44	EKMM401VSN331MQ50S			82	22 × 30	0.20	0.64	EKMM451VSN820MP30S
	330	30 × 40	0.15	1.44	EKMM401VSN331MR40S			82	25.4 × 25	0.20	0.64	EKMM451VSN820MQ25S
	330	35 × 30	0.15	1.44	EKMM401VSN331MA30S			100	22 × 35	0.20	0.69	EKMM451VSN101MP35S
	390	25.4 × 60	0.15	1.51	EKMM401VSN391MQ60S			100	25.4 × 30	0.20	0.69	EKMM451VSN101MQ30S
	390	30 × 45	0.15	1.60	EKMM401VSN391MR45S			100	30 × 25	0.20	0.64	EKMM451VSN101MR25S
	390	35 × 35	0.15	1.60	EKMM401VSN391MA35S			120	22 × 40	0.20	0.80	EKMM451VSN121MP40S
470	30 × 50	0.15	1.90	EKMM401VSN471MR50S	120	25.4 × 30		0.20	0.80	EKMM451VSN121MQ30S		
470	35 × 40	0.15	1.90	EKMM401VSN471MA40S	120	30 × 25		0.20	0.80	EKMM451VSN121MR25S		
560	30 × 60	0.15	2.10	EKMM401VSN561MR60S	120	35 × 25		0.20	0.73	EKMM451VSN121MA25S		
560	35 × 45	0.15	2.12	EKMM401VSN561MA45S	150	22 × 45		0.20	0.88	EKMM451VSN151MP45S		
680	35 × 60	0.15	2.27	EKMM401VSN681MA60S	150	25.4 × 35		0.20	0.88	EKMM451VSN151MQ35S		
47	22 × 20	0.20	0.37	EKMM421VSN470MP20S	150	30 × 30		0.20	0.88	EKMM451VSN151MR30S		
56	25.4 × 20	0.20	0.42	EKMM421VSN560MQ20S	150	35 × 25		0.20	0.75	EKMM451VSN151MA25S		
68	22 × 25	0.20	0.50	EKMM421VSN680MP25S	180	22 × 50		0.20	1.00	EKMM451VSN181MP50S		
68	25.4 × 20	0.20	0.46	EKMM421VSN680MQ20S	180	25.4 × 40		0.20	1.00	EKMM451VSN181MQ40S		
82	22 × 25	0.20	0.64	EKMM421VSN820MP25S	180	30 × 30		0.20	1.00	EKMM451VSN181MR30S		
82	25.4 × 25	0.20	0.58	EKMM421VSN820MQ25S	220	25.4 × 45		0.20	1.12	EKMM451VSN221MQ45S		
82	30 × 20	0.20	0.53	EKMM421VSN820MR20S	220	30 × 35		0.20	1.12	EKMM451VSN221MR35S		
100	22 × 30	0.20	0.70	EKMM421VSN101MP30S	220	35 × 30		0.20	1.12	EKMM451VSN221MA30S		
100	25.4 × 25	0.20	0.70	EKMM421VSN101MQ25S	270	25.4 × 60		0.20	1.18	EKMM451VSN271MQ60S		
100	30 × 20	0.20	0.59	EKMM421VSN101MR20S	270	30 × 40		0.20	1.28	EKMM451VSN271MR40S		
120	22 × 35	0.20	0.75	EKMM421VSN121MP35S	270	35 × 35		0.20	1.28	EKMM451VSN271MA35S		
120	25.4 × 30	0.20	0.75	EKMM421VSN121MQ30S	330	30 × 50		0.20	1.45	EKMM451VSN331MR50S		
120	30 × 25	0.20	0.73	EKMM421VSN121MR25S	330	35 × 40		0.20	1.45	EKMM451VSN331MA40S		
120	35 × 20	0.20	0.67	EKMM421VSN121MA20S	390	30 × 60		0.20	1.51	EKMM451VSN391MR60S		
150	22 × 40	0.20	0.88	EKMM421VSN151MP40S	390	35 × 40	0.20	1.55	EKMM451VSN391MA40S			
150	25.4 × 35	0.20	0.88	EKMM421VSN151MQ35S	470	35 × 50	0.20	1.85	EKMM451VSN471MA50S			
150	30 × 25	0.20	0.88	EKMM421VSN151MR25S	560	35 × 60	0.20	1.91	EKMM451VSN561MA60S			
180	22 × 45	0.20	0.95	EKMM421VSN181MP45S								

◆RATED RIPPLE CURRENT MULTIPLIERS

●Frequency Multipliers

Frequency(Hz)	50	120	300	1k	10k	50k
160 to 250V _{dc}	0.81	1.00	1.17	1.32	1.45	1.50
315 to 450V _{dc}	0.77	1.00	1.16	1.30	1.41	1.43

The endurance of capacitors is reduced with internal heating produced by ripple current at the rate of halving the lifetime with every 5°C rise. When long life performance is required in actual use, the rms ripple current has to be reduced.