

SMQ Series

- Endurance with ripple current : 2,000 hours at 85°C
- Non solvent resistant type
- RoHS2 Compliant



SPECIFICATIONS

| Items | Characteristics | | | |
|--|--|---------------------------------------|-------------|-----------------------|
| Category | -25 to +85°C | | | |
| Temperature Range | -25 to +85°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 250V | 315 to 400V | 420 & 450V |
| | tan δ (Max.) | 0.15 | 0.15 | 0.20 (at 20°C, 120Hz) |
| Low Temperature Characteristics (Max. Impedance Ratio) | Rated voltage (V _{dc}) | 160 to 250V | 315 to 400V | 420 & 450V |
| | Z(-25°C)/Z(+20°C) | 4 | 8 | 8 (at 120Hz) |
| 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 2,000 hours at 85°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 85°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)



The standard design has no plastic disc.

PART NUMBERING SYSTEM



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

◆STANDARD RATINGS

| WV (V _{dc}) | Cap (μF) | Case size φD×L(mm) | tan δ | Rated ripple current (Arms/85°C, 120Hz) | Part No. | WV (V _{dc}) | Cap (μF) | Case size φD×L(mm) | tan δ | Rated ripple current (Arms/85°C, 120Hz) | Part No. |
|-----------------------|----------|--------------------|-------|---|--------------------|-----------------------|----------|--------------------|--------------------|---|--------------------|
| 160 | 560 | 22 × 25 | 0.15 | 2.25 | ESMQ161VSN561MP25S | 250 | 270 | 22 × 25 | 0.15 | 1.31 | ESMQ251VSN271MP25S |
| | 680 | 22 × 30 | 0.15 | 2.50 | ESMQ161VSN681MP30S | | 330 | 22 × 30 | 0.15 | 1.75 | ESMQ251VSN331MP30S |
| | 820 | 22 × 35 | 0.15 | 2.75 | ESMQ161VSN821MP35S | | 390 | 22 × 30 | 0.15 | 1.91 | ESMQ251VSN391MP30S |
| | 1,000 | 22 × 40 | 0.15 | 3.00 | ESMQ161VSN102MP40S | | 390 | 25.4 × 25 | 0.15 | 1.91 | ESMQ251VSN391MQ25S |
| | 1,000 | 25.4 × 30 | 0.15 | 3.00 | ESMQ161VSN102MQ30S | | 470 | 22 × 35 | 0.15 | 2.11 | ESMQ251VSN471MP35S |
| | 1,200 | 22 × 45 | 0.15 | 3.25 | ESMQ161VSN122MP45S | | 470 | 25.4 × 30 | 0.15 | 2.11 | ESMQ251VSN471MQ30S |
| | 1,200 | 25.4 × 35 | 0.15 | 3.25 | ESMQ161VSN122MQ35S | | 560 | 22 × 40 | 0.15 | 2.25 | ESMQ251VSN561MP40S |
| | 1,200 | 30 × 25 | 0.15 | 3.25 | ESMQ161VSN122MR25S | | 560 | 25.4 × 30 | 0.15 | 2.25 | ESMQ251VSN561MQ30S |
| | 1,500 | 22 × 50 | 0.15 | 3.73 | ESMQ161VSN152MP50S | | 560 | 30 × 25 | 0.15 | 2.25 | ESMQ251VSN561MR25S |
| | 1,500 | 25.4 × 40 | 0.15 | 3.73 | ESMQ161VSN152MQ40S | | 680 | 22 × 45 | 0.15 | 2.50 | ESMQ251VSN681MP45S |
| | 1,500 | 30 × 30 | 0.15 | 3.73 | ESMQ161VSN152MR30S | | 680 | 25.4 × 35 | 0.15 | 2.50 | ESMQ251VSN681MQ35S |
| | 1,500 | 35 × 25 | 0.15 | 3.73 | ESMQ161VSN152MA25S | | 680 | 30 × 30 | 0.15 | 2.50 | ESMQ251VSN681MR30S |
| | 1,800 | 25.4 × 45 | 0.15 | 4.20 | ESMQ161VSN182MQ45S | | 820 | 22 × 50 | 0.15 | 2.77 | ESMQ251VSN821MP50S |
| | 1,800 | 30 × 35 | 0.15 | 4.20 | ESMQ161VSN182MR35S | | 820 | 25.4 × 40 | 0.15 | 2.77 | ESMQ251VSN821MQ40S |
| | 1,800 | 35 × 30 | 0.15 | 4.20 | ESMQ161VSN182MA30S | | 820 | 30 × 30 | 0.15 | 2.77 | ESMQ251VSN821MR30S |
| | 2,200 | 30 × 40 | 0.15 | 4.78 | ESMQ161VSN222MR40S | | 820 | 35 × 25 | 0.15 | 2.77 | ESMQ251VSN821MA25S |
| | 2,200 | 35 × 35 | 0.15 | 4.78 | ESMQ161VSN222MA35S | | 1,000 | 25.4 × 45 | 0.15 | 3.32 | ESMQ251VSN102MQ45S |
| | 2,700 | 35 × 40 | 0.15 | 5.45 | ESMQ161VSN272MA40S | | 1,000 | 30 × 35 | 0.15 | 3.32 | ESMQ251VSN102MR35S |
| | 3,300 | 35 × 45 | 0.15 | 5.75 | ESMQ161VSN332MA45S | | 1,000 | 35 × 30 | 0.15 | 3.32 | ESMQ251VSN102MA30S |
| | 3,900 | 35 × 50 | 0.15 | 6.00 | ESMQ161VSN392MA50S | | 1,200 | 30 × 40 | 0.15 | 3.53 | ESMQ251VSN122MR40S |
| 180 | 470 | 22 × 25 | 0.15 | 2.08 | ESMQ181VSN471MP25S | 1,200 | 35 × 35 | 0.15 | 3.53 | ESMQ251VSN122MA35S | |
| | 560 | 22 × 30 | 0.15 | 2.25 | ESMQ181VSN561MP30S | 1,500 | 30 × 50 | 0.15 | 4.04 | ESMQ251VSN152MR50S | |
| | 680 | 22 × 30 | 0.15 | 2.50 | ESMQ181VSN681MP30S | 1,500 | 35 × 40 | 0.15 | 4.04 | ESMQ251VSN152MA40S | |
| | 680 | 25.4 × 25 | 0.15 | 2.50 | ESMQ181VSN681MQ25S | 1,800 | 35 × 45 | 0.15 | 4.55 | ESMQ251VSN182MA45S | |
| | 820 | 22 × 35 | 0.15 | 2.75 | ESMQ181VSN821MP35S | 315 | 180 | 22 × 25 | 0.15 | 1.21 | ESMQ311VSN181MP25S |
| | 820 | 25.4 × 30 | 0.15 | 2.75 | ESMQ181VSN821MQ30S | | 220 | 22 × 30 | 0.15 | 1.41 | ESMQ311VSN221MP30S |
| | 1,000 | 22 × 45 | 0.15 | 3.00 | ESMQ181VSN102MP45S | | 270 | 22 × 30 | 0.15 | 1.60 | ESMQ311VSN271MP30S |
| | 1,000 | 25.4 × 35 | 0.15 | 3.00 | ESMQ181VSN102MQ35S | | 330 | 22 × 40 | 0.15 | 1.82 | ESMQ311VSN331MP40S |
| | 1,000 | 30 × 25 | 0.15 | 3.00 | ESMQ181VSN102MR25S | | 330 | 25.4 × 30 | 0.15 | 1.82 | ESMQ311VSN331MQ30S |
| | 1,200 | 22 × 50 | 0.15 | 3.31 | ESMQ181VSN122MP50S | | 330 | 30 × 25 | 0.15 | 1.82 | ESMQ311VSN331MR25S |
| | 1,200 | 25.4 × 40 | 0.15 | 3.31 | ESMQ181VSN122MQ40S | | 390 | 22 × 45 | 0.15 | 2.01 | ESMQ311VSN391MP45S |
| | 1,200 | 30 × 30 | 0.15 | 3.31 | ESMQ181VSN122MR30S | | 390 | 25.4 × 35 | 0.15 | 2.01 | ESMQ311VSN391MQ35S |
| | 1,200 | 35 × 25 | 0.15 | 3.31 | ESMQ181VSN122MA25S | | 390 | 30 × 30 | 0.15 | 2.01 | ESMQ311VSN391MR30S |
| | 1,500 | 25.4 × 45 | 0.15 | 3.83 | ESMQ181VSN152MQ45S | | 470 | 22 × 50 | 0.15 | 2.27 | ESMQ311VSN471MP50S |
| | 1,500 | 30 × 35 | 0.15 | 3.83 | ESMQ181VSN152MR35S | | 470 | 25.4 × 40 | 0.15 | 2.27 | ESMQ311VSN471MQ40S |
| | 1,500 | 35 × 30 | 0.15 | 3.83 | ESMQ181VSN152MA30S | | 470 | 30 × 30 | 0.15 | 2.27 | ESMQ311VSN471MR30S |
| | 1,800 | 25.4 × 50 | 0.15 | 4.32 | ESMQ181VSN182MQ50S | | 470 | 35 × 25 | 0.15 | 2.27 | ESMQ311VSN471MA25S |
| | 1,800 | 30 × 40 | 0.15 | 4.32 | ESMQ181VSN182MR40S | | 560 | 25.4 × 45 | 0.15 | 2.56 | ESMQ311VSN561MQ45S |
| | 1,800 | 35 × 30 | 0.15 | 4.32 | ESMQ181VSN182MA30S | | 560 | 30 × 35 | 0.15 | 2.56 | ESMQ311VSN561MP35S |
| | 2,200 | 30 × 45 | 0.15 | 4.92 | ESMQ181VSN222MR45S | | 560 | 35 × 30 | 0.15 | 2.56 | ESMQ311VSN561MA30S |
| 2,200 | 35 × 40 | 0.15 | 4.92 | ESMQ181VSN222MA40S | 680 | | 30 × 40 | 0.15 | 2.87 | ESMQ311VSN681MR40S | |
| 2,700 | 35 × 45 | 0.15 | 5.52 | ESMQ181VSN272MA45S | 680 | | 35 × 35 | 0.15 | 2.87 | ESMQ311VSN681MA35S | |
| 3,300 | 35 × 50 | 0.15 | 5.75 | ESMQ181VSN332MA50S | 820 | | 30 × 45 | 0.15 | 3.25 | ESMQ311VSN821MP45S | |
| 200 | 390 | 22 × 25 | 0.15 | 1.68 | ESMQ201VSN391MP25S | | 820 | 35 × 40 | 0.15 | 3.25 | ESMQ311VSN821MA40S |
| | 470 | 22 × 30 | 0.15 | 1.85 | ESMQ201VSN471MP30S | 1,000 | 30 × 50 | 0.15 | 3.63 | ESMQ311VSN102MR50S | |
| | 560 | 22 × 30 | 0.15 | 2.43 | ESMQ201VSN561MP30S | 1,000 | 35 × 45 | 0.15 | 3.63 | ESMQ311VSN102MA45S | |
| | 560 | 25.4 × 25 | 0.15 | 2.43 | ESMQ201VSN561MQ25S | 350 | 150 | 22 × 25 | 0.15 | 1.12 | ESMQ351VSN151MP25S |
| | 680 | 22 × 35 | 0.15 | 2.68 | ESMQ201VSN681MP35S | | 180 | 22 × 30 | 0.15 | 1.22 | ESMQ351VSN181MP30S |
| | 680 | 25.4 × 30 | 0.15 | 2.68 | ESMQ201VSN681MQ30S | | 220 | 22 × 35 | 0.15 | 1.44 | ESMQ351VSN221MP35S |
| | 820 | 22 × 40 | 0.15 | 2.93 | ESMQ201VSN821MP40S | | 270 | 22 × 40 | 0.15 | 1.66 | ESMQ351VSN271MP40S |
| | 820 | 25.4 × 30 | 0.15 | 2.93 | ESMQ201VSN821MQ30S | | 270 | 25.4 × 30 | 0.15 | 1.66 | ESMQ351VSN271MQ30S |
| | 820 | 30 × 25 | 0.15 | 2.93 | ESMQ201VSN821MR25S | | 330 | 22 × 45 | 0.15 | 1.88 | ESMQ351VSN331MP45S |
| | 1,000 | 22 × 45 | 0.15 | 3.25 | ESMQ201VSN102MP45S | | 330 | 25.4 × 35 | 0.15 | 1.88 | ESMQ351VSN331MQ35S |
| | 1,000 | 25.4 × 35 | 0.15 | 3.25 | ESMQ201VSN102MQ35S | | 390 | 22 × 50 | 0.15 | 2.06 | ESMQ351VSN391MP50S |
| | 1,000 | 30 × 30 | 0.15 | 3.25 | ESMQ201VSN102MR30S | | 390 | 25.4 × 40 | 0.15 | 2.06 | ESMQ351VSN391MQ40S |
| | 1,000 | 35 × 25 | 0.15 | 3.25 | ESMQ201VSN102MA25S | | 390 | 30 × 30 | 0.15 | 2.06 | ESMQ351VSN391MR30S |
| | 1,200 | 25.4 × 40 | 0.15 | 3.50 | ESMQ201VSN122MQ40S | | 390 | 35 × 25 | 0.15 | 2.06 | ESMQ351VSN391MA25S |
| | 1,200 | 30 × 30 | 0.15 | 3.50 | ESMQ201VSN122MR30S | | 470 | 25.4 × 45 | 0.15 | 2.40 | ESMQ351VSN471MQ45S |
| | 1,200 | 35 × 30 | 0.15 | 3.50 | ESMQ201VSN122MA30S | | 470 | 30 × 35 | 0.15 | 2.40 | ESMQ351VSN471MR35S |
| | 1,500 | 25.4 × 50 | 0.15 | 3.87 | ESMQ201VSN152MQ50S | | 470 | 35 × 30 | 0.15 | 2.40 | ESMQ351VSN471MA30S |
| | 1,500 | 30 × 35 | 0.15 | 3.87 | ESMQ201VSN152MR35S | | 560 | 25.4 × 50 | 0.15 | 2.60 | ESMQ351VSN561MQ50S |
| | 1,500 | 35 × 30 | 0.15 | 3.87 | ESMQ201VSN152MA30S | | 560 | 30 × 40 | 0.15 | 2.60 | ESMQ351VSN561MR40S |
| | 1,800 | 30 × 45 | 0.15 | 4.32 | ESMQ201VSN182MR45S | | 560 | 35 × 30 | 0.15 | 2.60 | ESMQ351VSN561MA30S |
| 1,800 | 35 × 35 | 0.15 | 4.32 | ESMQ201VSN182MA35S | 680 | | 30 × 45 | 0.15 | 2.96 | ESMQ351VSN681MR45S | |
| 2,200 | 30 × 50 | 0.15 | 4.92 | ESMQ201VSN222MR50S | 680 | | 35 × 35 | 0.15 | 2.96 | ESMQ351VSN681MA35S | |
| 2,200 | 35 × 40 | 0.15 | 4.92 | ESMQ201VSN222MA40S | 820 | | 30 × 50 | 0.15 | 3.25 | ESMQ351VSN821MR50S | |
| 2,700 | 35 × 50 | 0.15 | 5.45 | ESMQ201VSN272MA50S | 820 | 35 × 45 | 0.15 | 3.25 | ESMQ351VSN821MA45S | | |

◆STANDARD RATINGS

| WV (V _{dc}) | Cap (μF) | Case size φD×L(mm) | tan δ | Rated ripple current (Arms/85°C, 120Hz) | Part No. | WV (V _{dc}) | Cap (μF) | Case size φD×L(mm) | tan δ | Rated ripple current (Arms/85°C, 120Hz) | Part No. | |
|-----------------------|-----------|--------------------|-------|---|--------------------|-----------------------|----------|--------------------|---------|---|--------------------|--------------------|
| 350 | 1,000 | 35 × 50 | 0.15 | 3.54 | ESMQ351VSN102MA50S | 420 | 270 | 30 × 30 | 0.20 | 1.94 | ESMQ421VSN271MR30S | |
| | 120 | 22 × 25 | 0.15 | 1.02 | ESMQ401VSN121MP25S | | 330 | 25.4 × 45 | 0.20 | 2.17 | ESMQ421VSN331MQ45S | |
| | 150 | 22 × 30 | 0.15 | 1.16 | ESMQ401VSN151MP30S | | 330 | 30 × 35 | 0.20 | 2.17 | ESMQ421VSN331MR35S | |
| | 180 | 22 × 35 | 0.15 | 1.44 | ESMQ401VSN181MP35S | | 330 | 35 × 30 | 0.20 | 2.17 | ESMQ421VSN331MA30S | |
| | 220 | 22 × 40 | 0.15 | 1.49 | ESMQ401VSN221MP40S | | 390 | 25.4 × 50 | 0.20 | 2.27 | ESMQ421VSN391MQ50S | |
| | 220 | 25.4 × 30 | 0.15 | 1.49 | ESMQ401VSN221MQ30S | | 390 | 30 × 35 | 0.20 | 2.27 | ESMQ421VSN391MR35S | |
| | 270 | 22 × 45 | 0.15 | 1.67 | ESMQ401VSN271MP45S | | 390 | 35 × 30 | 0.20 | 2.27 | ESMQ421VSN391MA30S | |
| | 270 | 25.4 × 35 | 0.15 | 1.67 | ESMQ401VSN271MQ35S | | 470 | 30 × 40 | 0.20 | 2.61 | ESMQ421VSN471MR40S | |
| | 270 | 30 × 25 | 0.15 | 1.67 | ESMQ401VSN271MR25S | | 470 | 35 × 35 | 0.20 | 2.61 | ESMQ421VSN471MA35S | |
| | 330 | 22 × 50 | 0.15 | 1.90 | ESMQ401VSN331MP50S | | 560 | 30 × 50 | 0.20 | 2.82 | ESMQ421VSN561MR50S | |
| | 330 | 25.4 × 40 | 0.15 | 1.90 | ESMQ401VSN331MP40S | | 560 | 35 × 40 | 0.20 | 2.82 | ESMQ421VSN561MA40S | |
| | 330 | 30 × 30 | 0.15 | 1.90 | ESMQ401VSN331MR30S | | 680 | 35 × 45 | 0.20 | 3.11 | ESMQ421VSN681MA45S | |
| | 330 | 35 × 25 | 0.15 | 1.90 | ESMQ401VSN331MA25S | | 450 | 82 | 22 × 25 | 0.20 | 0.83 | ESMQ451VSN820MP25S |
| | 390 | 25.4 × 45 | 0.15 | 2.13 | ESMQ401VSN391MQ45S | | | 100 | 22 × 25 | 0.20 | 0.93 | ESMQ451VSN101MP25S |
| | 390 | 30 × 35 | 0.15 | 2.13 | ESMQ401VSN391MP35S | | | 120 | 22 × 30 | 0.20 | 1.04 | ESMQ451VSN121MP30S |
| | 390 | 35 × 30 | 0.15 | 2.13 | ESMQ401VSN391MA30S | | | 150 | 22 × 35 | 0.20 | 1.19 | ESMQ451VSN151MP35S |
| 470 | 25.4 × 50 | 0.15 | 2.39 | ESMQ401VSN471MQ50S | 150 | 25.4 × 25 | | 0.20 | 1.19 | ESMQ451VSN151MQ25S | | |
| 470 | 30 × 40 | 0.15 | 2.39 | ESMQ401VSN471MR40S | 180 | 22 × 40 | | 0.20 | 1.35 | ESMQ451VSN181MP40S | | |
| 470 | 35 × 30 | 0.15 | 2.39 | ESMQ401VSN471MA30S | 180 | 25.4 × 30 | | 0.20 | 1.35 | ESMQ451VSN181MQ30S | | |
| 560 | 30 × 45 | 0.15 | 2.69 | ESMQ401VSN561MR45S | 220 | 22 × 45 | | 0.20 | 1.55 | ESMQ451VSN221MP45S | | |
| 560 | 35 × 35 | 0.15 | 2.69 | ESMQ401VSN561MA35S | 220 | 25.4 × 40 | | 0.20 | 1.55 | ESMQ451VSN221MQ40S | | |
| 680 | 30 × 50 | 0.15 | 2.96 | ESMQ401VSN681MR50S | 220 | 30 × 30 | | 0.20 | 1.55 | ESMQ451VSN221MR30S | | |
| 680 | 35 × 40 | 0.15 | 2.96 | ESMQ401VSN681MA40S | 220 | 35 × 25 | | 0.20 | 1.55 | ESMQ451VSN221MA25S | | |
| 820 | 35 × 45 | 0.15 | 3.25 | ESMQ401VSN821MA45S | 270 | 22 × 50 | | 0.20 | 1.78 | ESMQ451VSN271MP50S | | |
| 400 | 100 | 22 × 25 | 0.20 | 0.97 | ESMQ421VSN101MP25S | 270 | | 25.4 × 40 | 0.20 | 1.78 | ESMQ451VSN271MQ40S | |
| | 120 | 22 × 25 | 0.20 | 1.08 | ESMQ421VSN121MP25S | 270 | | 30 × 30 | 0.20 | 1.78 | ESMQ451VSN271MR30S | |
| | 150 | 22 × 30 | 0.20 | 1.30 | ESMQ421VSN151MP30S | 330 | | 25.4 × 50 | 0.20 | 2.01 | ESMQ451VSN331MQ50S | |
| | 150 | 25.4 × 25 | 0.20 | 1.30 | ESMQ421VSN151MQ25S | 330 | | 30 × 40 | 0.20 | 2.01 | ESMQ451VSN331MR40S | |
| | 180 | 22 × 35 | 0.20 | 1.48 | ESMQ421VSN181MP35S | 330 | 35 × 30 | 0.20 | 2.01 | ESMQ451VSN331MA30S | | |
| | 180 | 25.4 × 30 | 0.20 | 1.48 | ESMQ421VSN181MQ30S | 390 | 30 × 40 | 0.20 | 2.24 | ESMQ451VSN391MR40S | | |
| | 220 | 22 × 40 | 0.20 | 1.65 | ESMQ421VSN221MP40S | 390 | 35 × 35 | 0.20 | 2.24 | ESMQ451VSN391MA35S | | |
| | 220 | 25.4 × 35 | 0.20 | 1.65 | ESMQ421VSN221MQ35S | 470 | 30 × 45 | 0.20 | 2.53 | ESMQ451VSN471MR45S | | |
| | 220 | 30 × 25 | 0.20 | 1.65 | ESMQ421VSN221MR25S | 470 | 35 × 40 | 0.20 | 2.53 | ESMQ451VSN471MA40S | | |
| | 270 | 22 × 50 | 0.20 | 1.94 | ESMQ421VSN271MP50S | 560 | 30 × 50 | 0.20 | 2.82 | ESMQ451VSN561MR50S | | |
| | 270 | 25.4 × 35 | 0.20 | 1.94 | ESMQ421VSN271MQ35S | 560 | 35 × 45 | 0.20 | 2.82 | ESMQ451VSN561MA45S | | |

◆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.