

# Type MLS 125 °C Flatpack, Ultra Long Life, Aluminum Electrolytic

## Now Available with High Vibration and High Reliability Options



Encased in rugged stainless steel, the MLS is perfect for high reliability military systems and applications operating above 85 °C. For our highest performing 125 °C Flatpacks, choose type HVMLS available in a special stainless steel case for high vibration applications up to 50g. Specify type HRMLS for high reliability Flatpacks which are subjected to MIL level burn-in processes to ensure established reliability.

### Highlights

- Near-hermetic welded seal
- Stainless-steel case
- 100 years expected operating life
- Withstands more than 80,000 feet altitude
- Type HV up to 50g
- Type HR, High Reliability

### Specifications

|                                 |                                                                                                                                                                                                                                                 |       |        |        |       |       |             |        |        |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------|--------|-------|-------|-------------|--------|--------|
| Temperature Range               | -55 °C to +125 °C                                                                                                                                                                                                                               |       |        |        |       |       |             |        |        |
| Rated Voltage Range             | 5.0 Vdc to 250 Vdc                                                                                                                                                                                                                              |       |        |        |       |       |             |        |        |
| Capacitance Range               | 220 μF to 47,000 μF                                                                                                                                                                                                                             |       |        |        |       |       |             |        |        |
| Capacitance Tolerance           | ±20%                                                                                                                                                                                                                                            |       |        |        |       |       |             |        |        |
| Leakage Current                 | ≤ 0.002 CV μA, @ 25 °C and 5 mins.                                                                                                                                                                                                              |       |        |        |       |       |             |        |        |
| Ripple Current Multipliers      | Case Temperature                                                                                                                                                                                                                                |       |        |        |       |       |             |        |        |
|                                 | 45 °C                                                                                                                                                                                                                                           | 55 °C | 65 °C  | 75 °C  | 85 °C | 95 °C | 105 °C      | 115 °C | 125 °C |
|                                 | 1.41                                                                                                                                                                                                                                            | 1.32  | 1.22   | 1.12   | 1.00  | 0.87  | 0.71        | 0.50   | 0.00   |
|                                 | Ambient Temperature, No Heatsink                                                                                                                                                                                                                |       |        |        |       |       |             |        |        |
|                                 | 45 °C                                                                                                                                                                                                                                           | 55 °C | 65 °C  | 75 °C  | 85 °C | 95 °C | 105 °C      | 115 °C | 125 °C |
|                                 | 0.63                                                                                                                                                                                                                                            | 0.58  | 0.54   | 0.49   | 0.44  | 0.38  | 0.31        | 0.22   | 0.00   |
|                                 | Frequency                                                                                                                                                                                                                                       |       |        |        |       |       |             |        |        |
|                                 | 50 Hz                                                                                                                                                                                                                                           | 60 Hz | 120 Hz | 360 Hz | 1 kHz | 5 kHz | 10 kHz & up |        |        |
| 5 to 40 V                       | 0.95                                                                                                                                                                                                                                            | 0.96  | 1.00   | 1.03   | 1.04  | 1.04  | 1.04        |        |        |
| 60 to 250 V                     | 0.80                                                                                                                                                                                                                                            | 0.84  | 1.00   | 1.18   | 1.25  | 1.30  | 1.30        |        |        |
| Low Temperature Characteristics | Impedance ratio: Z <sub>-55 °C</sub> /Z <sub>+25 °C</sub><br>≤ 10 (5 - 20 Vdc)<br>≤ 2 (25 - 250 Vdc)                                                                                                                                            |       |        |        |       |       |             |        |        |
| Endurance Life Test             | 10,000 h @ full load at 85 °C<br>Δ Capacitance ±10%<br>ESR 200% of limit<br>DCL 100% of limit                                                                                                                                                   |       |        |        |       |       |             |        |        |
| DC Life Test                    | 2000 h at rated voltage & 125 °C<br>Δ Capacitance ±10%<br>ESR 200% of limit<br>DCL 100% of limit                                                                                                                                                |       |        |        |       |       |             |        |        |
| Shelf Life Test                 | 500 h at 125 °C<br>Capacitance 100% of limit<br>ESR 100% of limit<br>DCL 100% of limit                                                                                                                                                          |       |        |        |       |       |             |        |        |
| Vibration                       | Standard MLS Flatpack: 10g<br>10 Hz to 2 kHz Sine Swept, 0.06” pp max and 10g.<br>Type HVMLS Flatpack 1.5” and 2.0” case length, 50g<br>Type HVMLS Flatpack 2.5” and 3.0” case length, 30g<br>MIL-STD-202, Meth. 204, Sine Swept, IEC 60068-2-6 |       |        |        |       |       |             |        |        |

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| Vibration Test                | <p><b>Level</b><br/>The specimens, while deenergized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified for each case size.</p> <p><b>Amplitude</b><br/>The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or peak level specified above (XXg peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.</p> <p><b>Frequency Range</b><br/>The vibration frequency shall be varied logarithmically between the approximate limits of 10 to 2,000 Hz.</p> <p><b>Sweep Time and Duration</b><br/>The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met.</p> |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|--|------------------------|-------------|------|------|------|------------|------|------|------|-----|------|-----|-----|-----|-----------|-----|-----|-----|------|------|-----|-----|-----|-----------|-----|-----|-----|
| High Reliability Test/Burn-in | Established Reliability capacitors shall be subjected to a minimum of 100 percent of the dc rated voltage at 85 °C for 48 hours minimum but not to exceed 96 hours. During this test, capacitors shall be adequately protected against temporary voltage surges of 10 percent or more of the test voltage. After burn-in, the capacitors shall be returned to room ambient conditions and the dc leakage, capacitance, and ESR shall be measured with respect to specified limits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| Thermal Resistance            | <table><tr><th rowspan="2">Large Sides Heatsinked</th><th>Case Length</th><th>1.5"</th><th>2.0"</th><th>3.0"</th></tr><tr><th>Insulation</th><th>°C/W</th><th>°C/W</th><th>°C/W</th></tr><tr><td rowspan="2">one</td><td>None</td><td>3.3</td><td>1.8</td><td>1.3</td></tr><tr><td>Polyester</td><td>4.5</td><td>2.6</td><td>1.6</td></tr><tr><td rowspan="2">both</td><td>None</td><td>2.8</td><td>2.2</td><td>1.1</td></tr><tr><td>Polyester</td><td>4.0</td><td>3.2</td><td>1.6</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |      |      |  | Large Sides Heatsinked | Case Length | 1.5" | 2.0" | 3.0" | Insulation | °C/W | °C/W | °C/W | one | None | 3.3 | 1.8 | 1.3 | Polyester | 4.5 | 2.6 | 1.6 | both | None | 2.8 | 2.2 | 1.1 | Polyester | 4.0 | 3.2 | 1.6 |
| Large Sides Heatsinked        | Case Length                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1.5" | 2.0" | 3.0" |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
|                               | Insulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | °C/W | °C/W | °C/W |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| one                           | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3.3  | 1.8  | 1.3  |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
|                               | Polyester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 4.5  | 2.6  | 1.6  |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| both                          | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2.8  | 2.2  | 1.1  |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
|                               | Polyester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 4.0  | 3.2  | 1.6  |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| ESL                           | ≤30 nH measured 1/4" from case at 1 MHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| Weight                        | Case EK 43 g typical<br>Case EA 76 g typical<br>Case EB 92 g typical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| Terminals                     | 18 AWG copper wire with 60/40 tin-lead electroplate, 20 amps max                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| Ripple Current Capability     | The ripple current capability is set by the maximum permissible internal core temperature, 125 °C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| Air Cooled                    | The ripple currents in the ratings tables are for 85 °C case temperatures. For air temperatures without a heatsink use the multipliers Ambient Temperature, No Heatsink.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| Heatsink Cooled               | Temperature rise from the internal hottest spot, the core, to ambient air is<br>$\Delta T = I^2(ESR)(\theta_{cc} + \theta_{ca})$ where $\theta_{cc}$ is the thermal resistance from core to case and $\theta_{ca}$ from case to ambient. To calculate maximum ripple capability with the MLS attached to a heatsink use the maximum core temperature and the values for $\theta_{cc}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |
| Example                       | As an illustration, suppose you operate an insulated MLS332M060EB1C in 65 °C air and attach it to a commercial heatsink with a free-air thermal resistance of 2.7 °C/W. Use a good thermal grease between the MLS and the heatsink, and the total thermal resistance is 2.7 + 1.8 or 4.5 °C/W. The power which would heat the core to 125 °C is (125 - 65)/4.5 or 13.3 W. For an ESR of 31 mΩ, 13.3 W equates to a ripple current of 20.7 A, however, the wire leads are rated for only 20 A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |      |      |  |                        |             |      |      |      |            |      |      |      |     |      |     |     |     |           |     |     |     |      |      |     |     |     |           |     |     |     |

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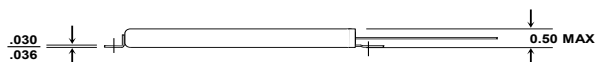
## Part Numbering System

| HV                                | HR                  | MLS                | 821                                   | M            | 200           | EB                                                                            | 0                             | A                                                                                                              |
|-----------------------------------|---------------------|--------------------|---------------------------------------|--------------|---------------|-------------------------------------------------------------------------------|-------------------------------|----------------------------------------------------------------------------------------------------------------|
| Optional                          | Optional            | Type               | Capacitance                           | Tolerance    | Rated Voltage | Case Code                                                                     | Insulation                    | Mounting Style                                                                                                 |
| High<br>Vibration                 | High<br>Reliability | MLS                | 821=820 $\mu$ F<br>102 = 1000 $\mu$ F | M= $\pm$ 20% | Vdc           | EK, L=1.5 in.<br>EA, L=2.0 in.<br>EB, L=3.0 in.<br>* other sizes<br>available | 0 = bare can<br>1 = polyester | A = mounting tabs<br>C = two leads/no tabs<br>D = hook leads/tabs<br>* other mounting tab<br>options available |
| <b>Examples:</b>                  |                     |                    |                                       |              |               |                                                                               |                               |                                                                                                                |
| Standard MLS:                     |                     | MLS821M200EB0C     |                                       |              |               |                                                                               |                               |                                                                                                                |
| High Reliability:                 |                     | HRMLS821M200EB0C   |                                       |              |               |                                                                               |                               |                                                                                                                |
| High Vibration:                   |                     | HVMLS821M200EB0C   |                                       |              |               |                                                                               |                               |                                                                                                                |
| High Reliability, High Vibration: |                     | HVHRMLS821M200EB0C |                                       |              |               |                                                                               |                               |                                                                                                                |

## Outline Drawings

Note: The polyester tape wrap may add up to 0.020 inches to the thickness and width of the capacitor.

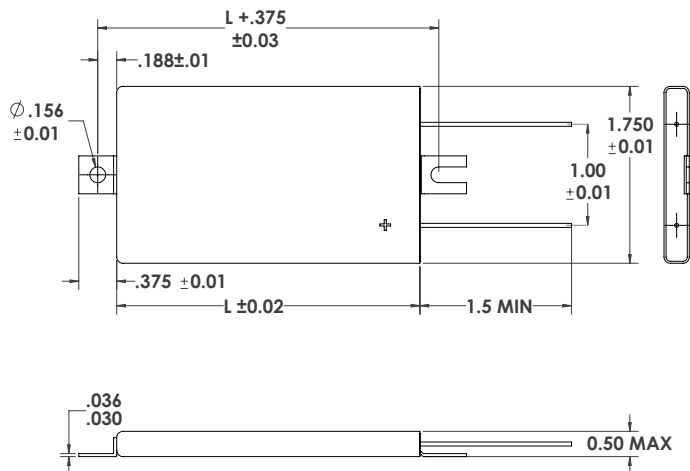
Standard Type MLS



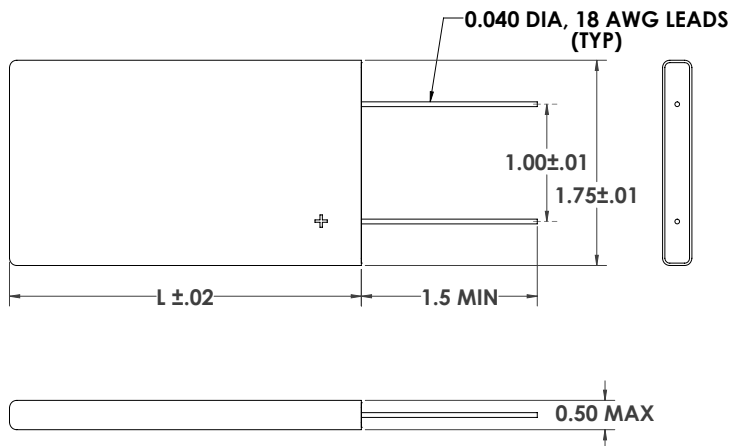
Type HV, Rilled Construction



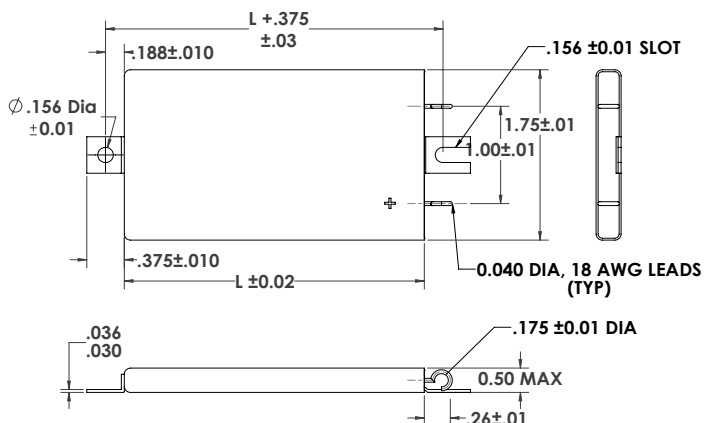
Style A: Mounting Tabs



Style C: No Tabs



Style D: Hook Leads



| Case Code | Length L (in) | Weight (g) |
|-----------|---------------|------------|
| EK        | 1.5           | 43         |
| EA        | 2.0           | 76         |
| EB        | 3.0           | 92         |

Mounting tabs are welded to the case.

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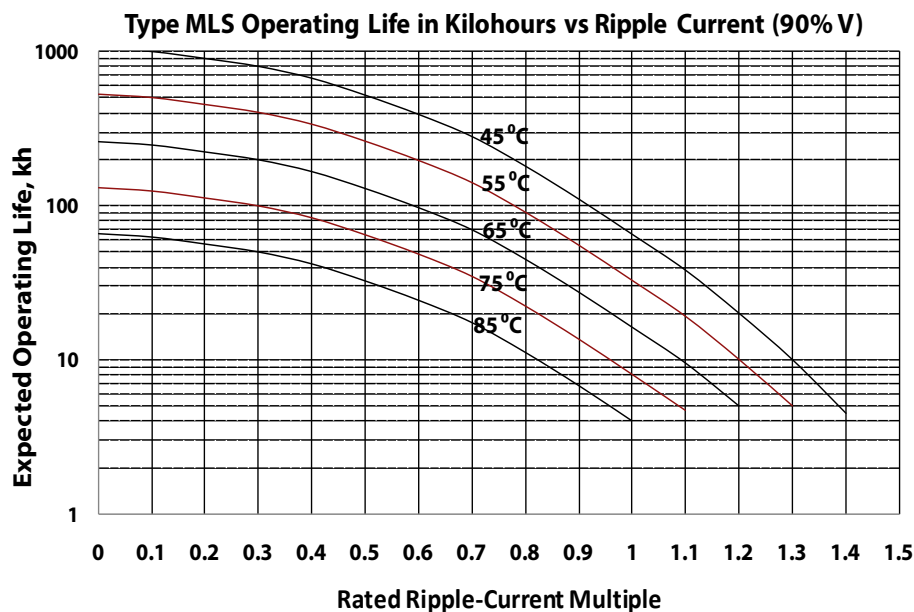
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## Ratings

|                                                     |                     | ESR max    |        | Ripple (A)  |        |          |
|-----------------------------------------------------|---------------------|------------|--------|-------------|--------|----------|
| Cap                                                 |                     | 25 °C (mΩ) |        | Case @ 85°C |        | Length   |
| (μF)                                                | Catalog Part Number | 120 Hz     | 20 kHz | 120 Hz      | 20 kHz | (inches) |
| 125 °C: 5 Vdc, 105 °C: 7.5 Vdc, 25 °C Surge: 10 Vdc |                     |            |        |             |        |          |
| 19,000                                              | MLS193M5R0EK0C      | 76         | 66     | 12.6        | 13.6   | 1.5      |
| 28,000                                              | MLS283M5R0EA0c      | 50         | 44     | 19.9        | 21.4   | 2.0      |
| 47,000                                              | MLS473M5R0EB0C      | 30         | 26     | 32.0        | 34.4   | 3.0      |
| 125 °C: 7.5 Vdc, 105 °C: 10 V, 25 °C Surge: 13 Vdc  |                     |            |        |             |        |          |
| 17,000                                              | MLS173M7R5EK0C      | 77         | 67     | 12.5        | 13.5   | 1.5      |
| 26,000                                              | MLS263M7R5EA0c      | 51         | 45     | 19.8        | 21.1   | 2.0      |
| 43,000                                              | MLS433M7R5EB0C      | 31         | 27     | 31.5        | 33.8   | 3.0      |
| 125 °C: 10 Vdc, 105 °C: 16 V, 25 °C Surge: 20 Vdc   |                     |            |        |             |        |          |
| 13,000                                              | MLS133M010EK0C      | 81         | 69     | 12.2        | 13.3   | 1.5      |
| 23,000                                              | MLS233M010EA0C      | 51         | 45     | 19.8        | 21.1   | 2.0      |
| 38,000                                              | MLS383M010EB0C      | 31         | 27     | 31.5        | 33.8   | 3.0      |
| 125 °C: 20 Vdc, 105 °C: 30 V, 25 °C Surge: 40 Vdc]  |                     |            |        |             |        |          |
| 6,800                                               | MLS682M020EK0C      | 84         | 69     | 11.0        | 12.2   | 1.5      |
| 10,000                                              | MLS103M020EA0C      | 56         | 46     | 13.6        | 15.0   | 2.0      |
| 17,000                                              | MLS173M020EB0C      | 33         | 27     | 17.6        | 19.5   | 3.0      |
| 125 °C: 40 Vdc, 105 °C: 50 V, 25 °C Surge: 63 Vdc   |                     |            |        |             |        |          |
| 4,400                                               | MLS442M040EK0C      | 97         | 70     | 10.3        | 12.1   | 1.5      |
| 6,600                                               | MLS662M040EA0C      | 62         | 46     | 12.9        | 15.0   | 2.0      |
| 11,000                                              | MLS113M040EB0C      | 36         | 27     | 16.9        | 19.5   | 3.0      |
| 125 °C: 60 Vdc, 105 °C: 80 V, 25 °C Surge: 100 Vdc  |                     |            |        |             |        |          |
| 1,500                                               | MLS152M060EK0C      | 106        | 77     | 9.8         | 11.5   | 1.5      |

| Cap<br>(μF)                                                   | Catalog Part Number | ESR max<br>25 °C (mΩ) |        | Ripple (A)<br>Case @ 85°C |        | Length<br>(inches) |
|---------------------------------------------------------------|---------------------|-----------------------|--------|---------------------------|--------|--------------------|
|                                                               |                     | 120 Hz                | 20 kHz | 120 Hz                    | 20 kHz |                    |
| 2,100                                                         | MLS212M060EA0C      | 72                    | 52     | 11.9                      | 14.1   | 2.0                |
| 3,300                                                         | MLS332M060EB0C      | 44                    | 31     | 15.3                      | 18.2   | 3.0                |
| <b>125 °C: 75 Vdc, 105 °C: 100 V, 25 °C Surge: 125 Vdc</b>    |                     |                       |        |                           |        |                    |
| 1,100                                                         | MLS112M075EK0C      | 112                   | 78     | 9.6                       | 11.5   | 1.5                |
| 1,600                                                         | MLS162M075EA0C      | 76                    | 54     | 11.6                      | 13.8   | 2.0                |
| 2,700                                                         | MLS272M075EB0C      | 46                    | 33     | 14.9                      | 17.6   | 3.0                |
| <b>125 °C: 100 Vdc, 105 °C: 150 V, 25 °C Surge: 180 Vdc</b>   |                     |                       |        |                           |        |                    |
| 500                                                           | MLS501M100EK0C      | 355                   | 248    | 5.4                       | 6.4    | 1.5                |
| 770                                                           | MLS771M100EA0C      | 238                   | 166    | 6.6                       | 7.8    | 2.0                |
| 1,300                                                         | MLS132M100EB0C      | 143                   | 100    | 8.5                       | 10.1   | 3.0                |
| <b>125 °C: 150 Vdc, 105 °C: 200 V, 25 °C Surge: 250 Vdc</b>   |                     |                       |        |                           |        |                    |
| 400                                                           | MLS401M150EK0C      | 388                   | 253    | 5.1                       | 6.4    | 1.5                |
| 600                                                           | MLS601M150EA0C      | 261                   | 168    | 6.3                       | 7.8    | 2.0                |
| 1,000                                                         | MLS102M150EB0C      | 158                   | 100    | 8.1                       | 10.1   | 3.0                |
| <b>125 °C: 200 Vdc, 105 °C: 250 Vdc, 25 °C Surge: 300 Vdc</b> |                     |                       |        |                           |        |                    |
| 330                                                           | MLS331M200EK0C      | 426                   | 258    | 4.9                       | 6.2    | 1.5                |
| 490                                                           | MLS491M200EA0C      | 285                   | 172    | 6.0                       | 7.7    | 2.0                |
| 820                                                           | MLS821M200EB0C      | 172                   | 103    | 7.7                       | 10.0   | 3.0                |
| <b>125 °C: 250 Vdc, 105 °C: 250 Vdc, 25 °C Surge: 300 Vdc</b> |                     |                       |        |                           |        |                    |
| 220                                                           | MLS221M250EK0C      | 597                   | 393    | 4.1                       | 5.1    | 1.5                |
| 330                                                           | MLS331M250EA0C      | 399                   | 262    | 5.0                       | 6.3    | 2.0                |
| 560                                                           | MLS561M250EB0C      | 240                   | 157    | 6.5                       | 8.1    | 3.0                |

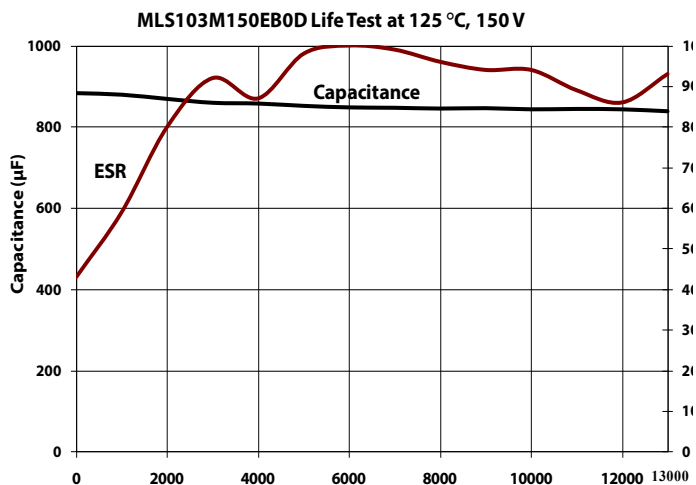
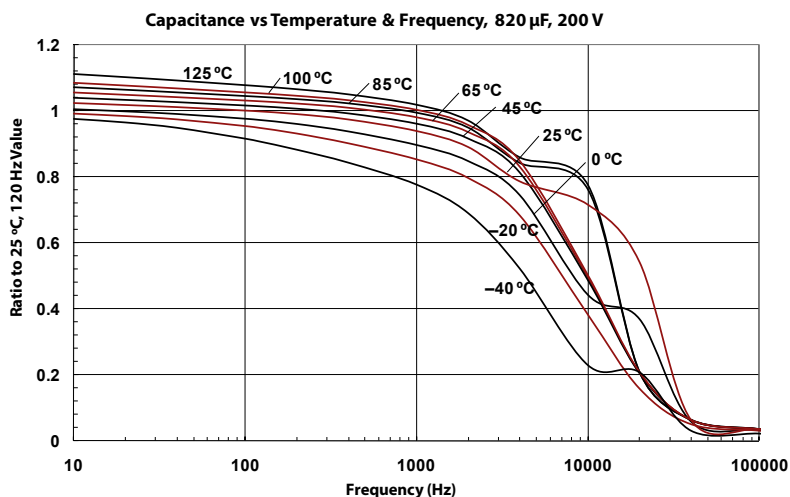
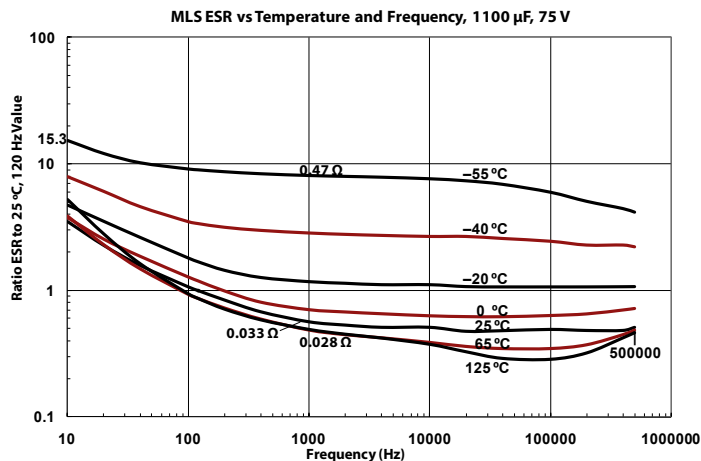
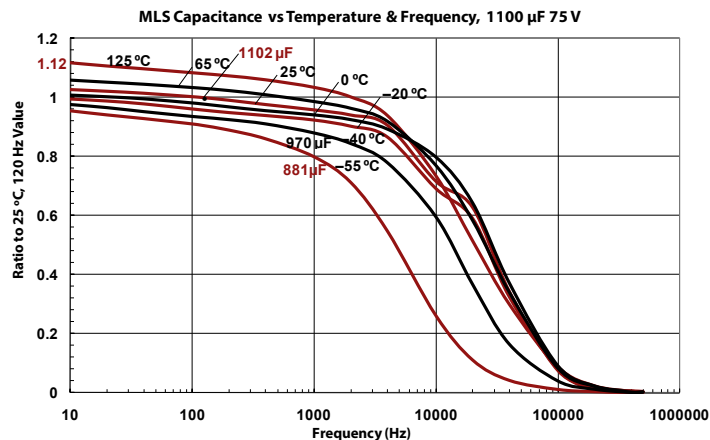
## Typical Performance Curves



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## Typical Performance Curves



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