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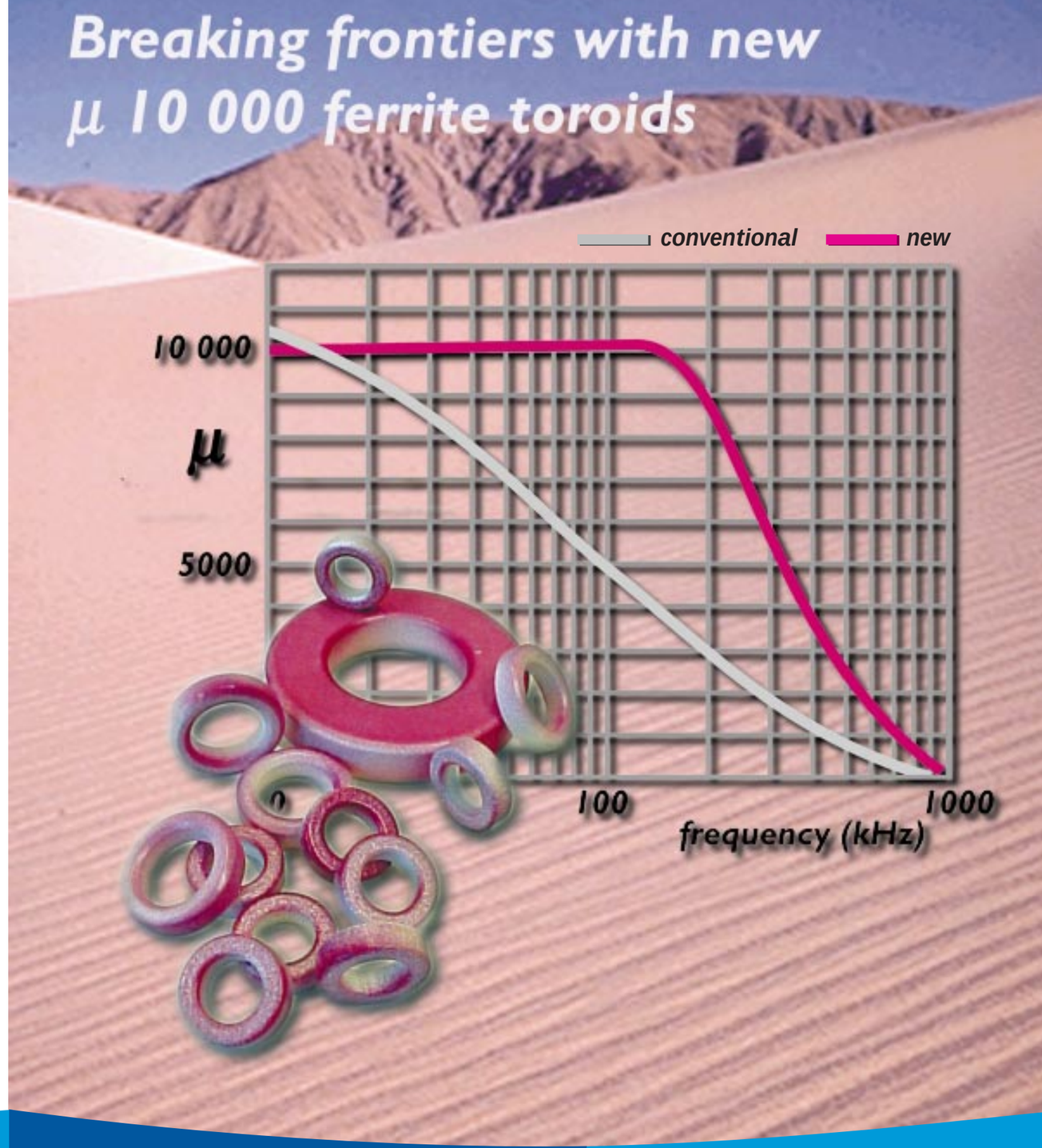
PHILIPS

*Let's make things better.*

# Breaking frontiers with new μ 10 000 ferrite toroids





PHILIPS

*Let's make things better.*

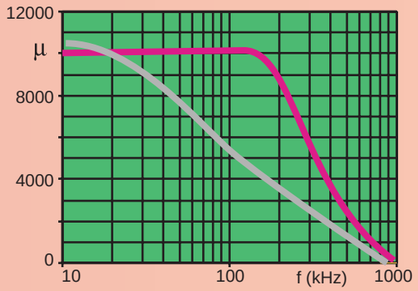
# 3E6 Toroids of a New Generation

Philips Components' very high permeability 3E6 ferrite toroids are mainly used in wideband transformers and common-mode chokes. In many of these applications a high inductance combined with a small occupied volume is of key importance.
Toroids, with their closed magnetic circuit in a high permeability ferrite material are ideal for realizing such design targets.
However, reaching a very high permeability in a ferrite often leads to a rather low material resistivity. This results in excessive eddy-currents at elevated frequencies, especially in larger toroids. When these eddy-currents occur, the applied magnetic field is partly cancelled out inside the ferrite core, resulting in a decreased effective permeability. This spoils the cores' permeability and impedance behaviour as a function of frequency.
Continuous research, the use of improved raw materials and well controlled process conditions have led to strong improvements in 3E6 toroids. This new generation of toroids features a permeability (μ) of 10 000 up to 100 kHz (Fig.1), lower eddy-current losses (Fig.2) and a much higher impedance level at frequencies around 1 MHz (Fig.3). In addition, the curve of permeability as a function of temperature shows moderate variations over a broad temperature range (Fig.4).
Results are a better response to high frequency pulses in wideband transformers and more effective damping of harmonics in mains input filters.

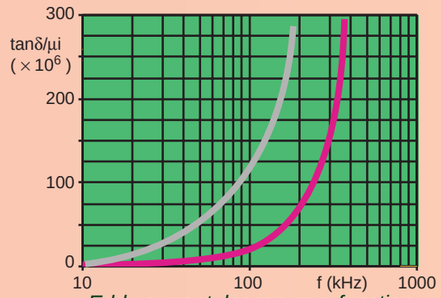
### Features

- Very high permeability at frequencies up to well over 100 kHz*
- Stable temperature behaviour in the usual operating range
- Comparatively high Tc of more than 130 °C

* *For large sizes the influence of eddy current losses can result in a lower cut-off frequency.*

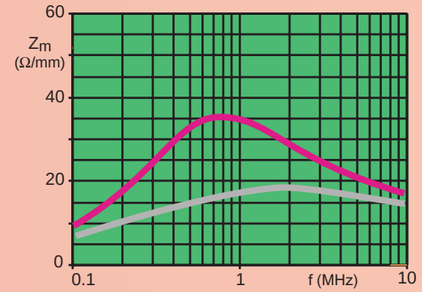



*Effective permeability as a function of frequency*




*Eddy-current losses as a function of frequency*

Measurements carried out on 3E6 toroids with dimensions of ∅ 25 × ∅ 15 × h 10 mm.




*Specific impedance as a function of frequency*


*Permeability as a function of temperature*

conventional μ 10000 toroids

new generation μ 10000 toroids

# The product range

| Type Number | OD | ID | h | core factor | Ve (mm³) | le (mm) | Ae (mm²) | AL ± 30% (nH) |
|---|---|---|---|---|---|---|---|---|
| TC2.5/1.3/1.3-3E6 | 2.54±0.13 | 1.27±0.13 | 1.27±0.13 | 7.14 | 4.29 | 5.53 | 0.78 | 1835 |
| TC2.5/1.5/0.8-3E6 | 2.5±0.1 | 1.5±0.1 | 0.8-0.1 | 16.4 | 2.21 | 6.02 | 0.37 | 765 |
| TC2.5/1.5/1-3E6-S | 2.5±0.1 | 1.5±0.1 | 1.0±0.1 | 12.3 | 2.94 | 6.02 | 0.489 | 1020 |
| TC4/2.2/1.1-3E6 | 4±0.15 | 2.2±0.1 | 1.1±0.1 | 9.55 | 8.82 | 9.18 | 0.961 | 1315 |
| TC4/2.2/1.6-3E6 | 4±0.15 | 2.2±0.1 | 1.6±0.1 | 6.57 | 12.84 | 9.2 | 1.4 | 1915 |
| TC4/2.2/1.8-3E6 | 4±0.15 | 2.2±0.1 | 1.78±0.1 | 5.9 | 14.3 | 9.18 | 1.56 | 2130 |
| TC5.8/3.1/3.2-3E6 | 5.84±0.15 | 3.05±0.15 | 3.18±0.15 | 3.04 | 55.8 | 13 | 4.27 | 4130 |
| TC6/4/2-3E6 | 6±0.15 | 4±0.15 | 2±0.1 | 7.75 | 30.2 | 15.3 | 1.97 | 1620 |
| TC6.3/3.8/2.5-3E6 | 6.3±0.25 | 3.8±0.15 | 2.5±0.15 | 4.97 | 46.5 | 15.2 | 3.06 | 2530 |
| TC9/6/3-3E6 | 9±0.2 | 6±0.2 | 3±0.15 | 5.17 | 102 | 22.9 | 4.44 | 2435 |
| TC9.5/4.8/3.2-3E6 | 9.5±0.35 | 4.75±0.15 | 3.2±0.15 | 2.83 | 151 | 20.7 | 7.3 | 4390 |
| TL10/6/4-3E6 | 10.25±0.4 | 5.75±0.3 | 4.25±0.3 | 3.07 | 188 | 24.1 | 7.8 | 4085 |
| TX13/7.1/4.8-3E6 | 12.95±0.25 | 6.85±0.25 | 5±0.15 | 2.28 | 381 | 29.5 | 12.3 | 5400 |
| TL13/7.5/5-3E6 | 12.75±0.4 | 7.25±0.35 | 5.25±0.3 | 2.46 | 368 | 30.1 | 12.2 | 5095 |
| TX13/7.9/6.4-3E6 | 12.95±0.25 | 7.65±0.25 | 6.6±0.25 | 2.09 | 465 | 31.2 | 14.9 | 5900 |
| TL14/9/5-3E6 | 14.25±0.4 | 8.75±0.35 | 5.25±0.3 | 2.84 | 430 | 35 | 12.3 | 4415 |
| TL14/9/9-3E6 | 14.25±0.4 | 8.75±0.35 | 9.25±0.4 | 1.58 | 774 | 35 | 22.1 | 7955 |
| TX16/9.1/4.7-3E6 | 16.13±0.13 | 8.82±0.18 | 4.95±0.13 | 2.527 | 547 | 37.2 | 14.72 | 5200 |
| TL16/9.6/6.3-3E6 | 16.25±0.5 | 9.3±0.4 | 6.55±0.4 | 1.95 | 760 | 38.5 | 19.7 | 6430 |
| TL20/10/7-3E6 | 20.25±0.6 | 9.78±0.4 | 7.25±0.45 | 1.3 | 1465 | 43.6 | 33.6 | 9685 |
| TX22/14/6.4-3E6 | 22.35±0.43 | 13.47±0.3 | 6.6±0.25 | 2.185 | 1346 | 54.18 | 24.8 | 6000 |
| TL22/14/13-3E6 | 22.35±0.7 | 13.47±0.3 | 12.95±0.6 | 1.064 | 2756 | 54.18 | 50.9 | 12080 |
| TX22/14/13-3E6 | 22.35±0.43 | 13.47±0.3 | 12.95±0.25 | 1.064 | 2756 | 54.18 | 50.9 | 12080 |
| TL25/15/10-3E6 | 25.25±0.7 | 14.75±0.6 | 10.25 | 1.23 | 2944 | 602 | 48.9 | 10200 |
| TL29/19/7.5-3E6 | 29.25±0.7 | 18.75±0.6 | 7.75±0.5 | 1.98 | 2704 | 73.2 | 36.9 | 6340 |
| TL29/19/15-3E6 | 29.25±0.7 | 18.75±0.6 | 15.45±0.6 | 0.978 | 5481 | 73.2 | 74.9 | 12850 |
| TX36/23/10-3E6 | 36.25±0.7 | 22.75±0.5 | 10.42±0.25 | 1.451 | 5538 | 89.7 | 61.8 | 9090 |
| TL36/23/15-3E6 | 36.25±0.9 | 22.75±0.7 | 15.25±0.6 | 0.935 | 8596 | 89.6 | 95.9 | 13400 |
| TX36/23/15-3E6 | 36.25±0.7 | 22.75±0.5 | 15.5±0.38 | 0.953 | 8439 | 89.7 | 94.1 | 13600 |
| T50/30/19-3E6 | 50±1 | 30±0.7 | 19±0.5 | 0.65 | 22378 | 120.4 | 186 | 19400 |
| TX51/32/19-3E6 | 51.05±1.2 | 31.5±0.64 | 19.3±0.38 | 0.73 | 21500 | 125 | 172 | 17300 |
| TL74/39/13-3E6 | 73.91±1.52 | 38.61±0.76 | 12.95±0.51 | 0.774 | 35298 | 165 | 207 | 15775 |
| T87/56/13-3E6 | 87±1.25 | 56±0.9 | 12.7±0.25 | 1.123 | 42133 | 217.5 | 194 | 11190 |

| Coating characteristics | T: Uncoated | TC: Parylene C coating | TL: Lacquer coating | TX: Epoxy coating |
|---|---|---|---|---|
| | | UL94-V2, file E94133(M)<br>max. operating temp. 90°C<br>uncoloured<br>isolation voltage:<br>>1000V | UL94-V2, file E45228(M)<br>max. operating temp. 90°C<br>colour: purple/white<br>isolation voltage:<br>>1000V (OD < 12mm)<br>>1500V (12 ≤ OD ≤ 20)<br>>2000V (OD > 20) | UL under approval<br>max. operating temp. 90°C<br>colour: purple/white<br>isolation voltage:<br>>1000V (OD < 12mm),<br>>1500V (12 ≤ OD ≤ 20)<br>>2000V (OD > 20) |

Note:Table reflects our current product range which is continually expanding