

DATA SHEET

TFx24 series, 0.05% TC50
10 Ω to 1 M Ω

Thin-film chip resistors
sizes 1210, 1206, 0805, 0603 and 0402

Product specification

2001 Sep 10 Rev.0

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FEATURES

- High precision
- High long-term stability
- Low temperature coefficient.

APPLICATIONS

- Converters
- Printer equipment
- Motherboards
- Telecom
- Consumer.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

| DESCRIPTION | VALUE | | | | |
|--|-----------------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|
| | TF524 | TF024 | TF124 | TF224 | TF324 |
| Size code | 1210 | 1206 | 0805 | 0603 | 0402 |
| Resistance range | 10 Ω to 1 M Ω | 10 Ω to 1 M Ω | 10 Ω to 1 M Ω | 10 Ω to 332 k Ω | 10 Ω to 100 k Ω |
| Resistance tolerance and series | $\pm 0.05\%$; E24 and E96 series | | | | |
| Temperature coefficient | $\leq \pm 50 \times 10^{-6}/K$ | | | | |
| Maximum dissipation at $T_{amb} = 70^\circ C$ | 0.25 W | 0.125 W | 0.125 W | 0.1 W | 0.0625 W |
| Maximum permissible voltage (DC or RMS) | 200 V | 200 V | 150 V | 75 V | 50 V |
| Climatic category (IEC 60068) | 55/125/56 | | | | |
| Basic specification | IEC 60115-8 and MIL-STD-202F | | | | |

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ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packing

| TYPE | SIZE CODE | RESISTANCE VALUE | TOL. (%) | PAPER TAPE ON REEL | 12NC ORDERING CODE |
|-------|-----------|-------------------------------|------------|--------------------|--------------------|
| TF524 | 1210 | 10 Ω to 1 M Ω | ± 0.05 | 5000 | 2390 412 3xxxx |
| TF024 | 1206 | 10 Ω to 1 M Ω | ± 0.05 | 5000 | 2390 411 3xxxx |
| TF124 | 0805 | 10 Ω to 1 M Ω | ± 0.05 | 5000 | 2390 401 3xxxx |
| TF224 | 0603 | 10 Ω to 332 k Ω | ± 0.05 | 5000 | 2390 404 3xxxx |
| TF324 | 0402 | 10 Ω to 100 k Ω | ± 0.05 | 10000 | 2390 407 3xxxx |

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2390; see Table 1.
- The subsequent 4 digits indicate the resistor type and packing.
- The remaining 4 digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

| RESISTANCE DECADE | LAST DIGIT |
|----------------------------------|------------|
| 10 Ω to 97.6 Ω | 9 |
| 100 Ω to 976 Ω | 1 |
| 1 k Ω to 9.76 k Ω | 2 |
| 10 k Ω to 97.6 k Ω | 3 |
| 100 k Ω to 976 k Ω | 4 |
| 1 M Ω | 5 |

ORDERING EXAMPLE

The ordering code of a TF024 resistor, value 1000 Ω with 0.05% tolerance, supplied on paper tape of 5000 units per reel is:
2390 411 31002.

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FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 and E96 series for resistors with a tolerance of $\pm 0.05\%$.

The values of the E24 and E96 series are in accordance with "IEC publication 60063".

Limiting values

| TYPE | LIMITING VOLTAGE (note 1) (V) | LIMITING POWER (W) |
|-------|-------------------------------------|-----------------------|
| TF524 | 200 | 0.25 |
| TF024 | 200 | 0.125 |
| TF124 | 150 | 0.125 |
| TF224 | 75 | 0.1 |
| TF324 | 50 | 0.0625 |

Note

- The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

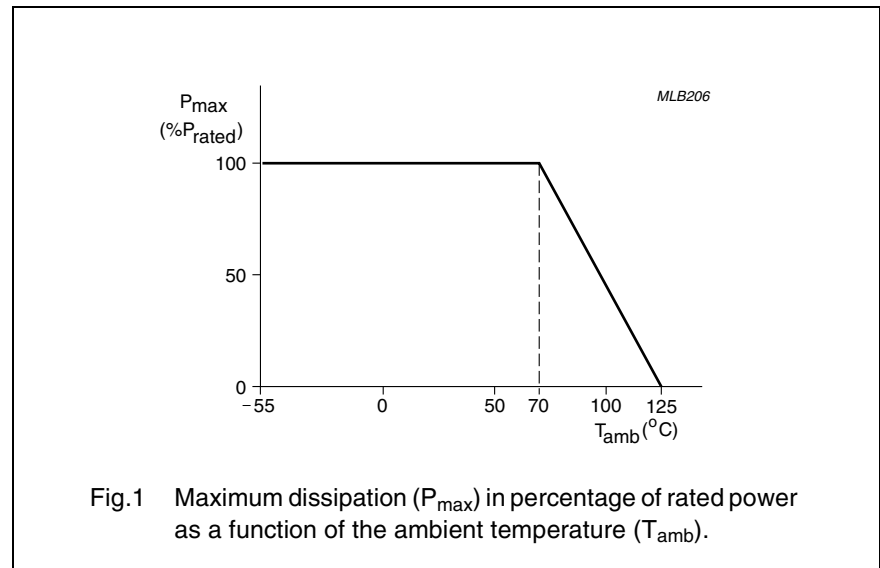


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

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MECHANICAL DATA

Mass per 100 units

| TYPE | MASS (g) |
|-------|----------|
| TF524 | 1.67 |
| TF024 | 1 |
| TF124 | 0.55 |
| TF224 | 0.25 |
| TF324 | 0.052 |

Marking

| TYPE | E24 | E96 |
|-------|------------|--------------------|
| TF524 | 4 digits | 4 digits |
| TF024 | 4 digits | 4 digits |
| TF124 | 4 digits | 4 digits |
| TF224 | 3 digits | 3 digits EIA-96 |
| TF324 | no marking | |

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

Example

| MARKING | RESISTANCE |
|---------|------------|
| 10R0 | 10 Ω |
| 10R2 | 10.2 Ω |
| 1001 | 1 kΩ |

OUTLINES

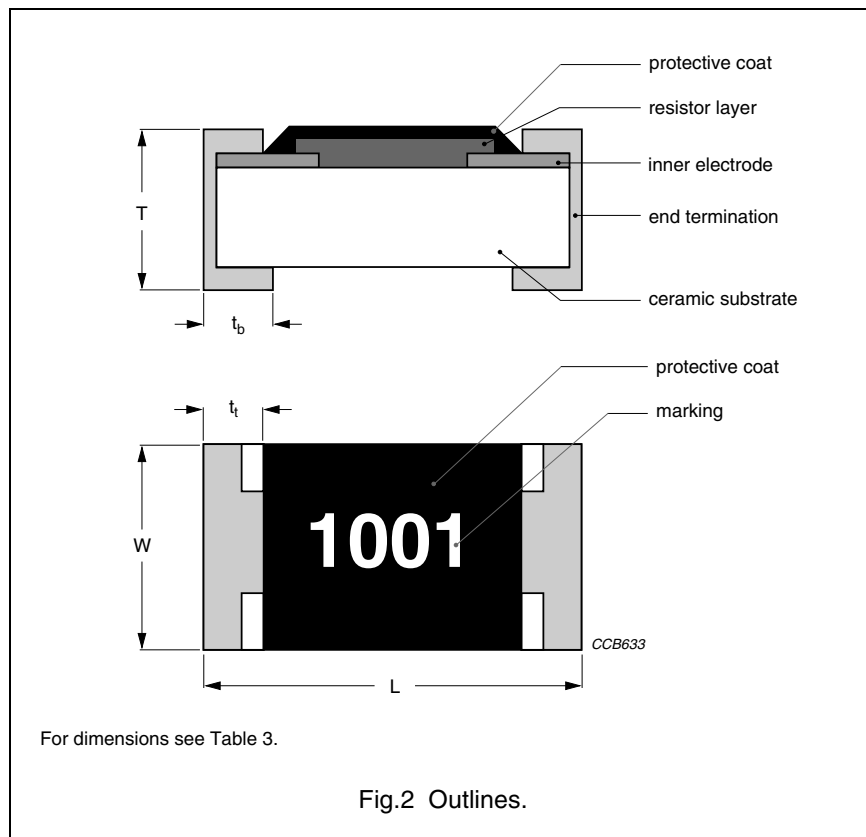


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

| TYPE | L (mm) | W (mm) | T (mm) | t _t (mm) | t _b (mm) |
|--------------|----------|------------|------------|---------------------|---------------------|
| TF524 (1210) | 3.1 ±0.1 | 2.6 ±0.1 | 0.55 ±0.1 | 0.50 ±0.2 | 0.5 ±0.2 |
| TF024 (1206) | 3.1 ±0.1 | 1.6 ±0.1 | 0.55 ±0.1 | 0.45 ±0.2 | 0.4 ±0.2 |
| TF124 (0805) | 2.0 ±0.1 | 1.25 ±0.1 | 0.50 ±0.1 | 0.35 ±0.2 | 0.35 ±0.2 |
| TF224 (0603) | 1.6 ±0.1 | 0.8 ±0.1 | 0.45 ±0.1 | 0.25 ±0.15 | 0.25 ±0.15 |
| TF324 (0402) | 1.0 ±0.1 | 0.50 ±0.05 | 0.25 ±0.05 | 0.20 ±0.1 | 0.25 ±0.1 |

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3-DIGIT MARKING

The first 2 digits apply to the resistance value and the third indicates the number of zeros to follow.

Example

| MARKING | RESISTANCE |
|---------|----------------|
| 120 | 12 Ω |
| 123 | 12 k Ω |
| 124 | 120 k Ω |

3-DIGIT EIA-96 MARKING

The first 2 digits apply to the resistance value and the third character indicates the multiplier as shown in Tables 4 and 5.

Example

| MARKING | RESISTANCE |
|---------|-----------------|
| 10X | 12.4 Ω |
| 10C | 12.4 k Ω |
| 10D | 124 k Ω |

MARKING OF PACKING MATERIAL

The packing material is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Table 4 First two digits of the resistance code

| CODE | VALUE | CODE | VALUE | CODE | VALUE | CODE | VALUE |
|------|-------|------|-------|------|-------|------|-------|
| 01 | 100 | 25 | 178 | 49 | 316 | 73 | 562 |
| 02 | 102 | 26 | 182 | 50 | 324 | 74 | 576 |
| 03 | 105 | 27 | 187 | 51 | 332 | 75 | 590 |
| 04 | 107 | 28 | 191 | 52 | 340 | 76 | 604 |
| 05 | 110 | 29 | 196 | 53 | 348 | 77 | 619 |
| 06 | 113 | 30 | 200 | 54 | 357 | 78 | 634 |
| 07 | 115 | 31 | 205 | 55 | 365 | 79 | 649 |
| 08 | 118 | 32 | 210 | 56 | 374 | 80 | 665 |
| 09 | 121 | 33 | 215 | 57 | 383 | 81 | 681 |
| 10 | 124 | 34 | 221 | 58 | 392 | 82 | 698 |
| 11 | 127 | 35 | 226 | 59 | 402 | 83 | 715 |
| 12 | 130 | 36 | 232 | 60 | 412 | 84 | 732 |
| 13 | 133 | 37 | 237 | 61 | 422 | 85 | 750 |
| 14 | 137 | 38 | 243 | 62 | 432 | 86 | 768 |
| 15 | 140 | 39 | 249 | 63 | 442 | 87 | 787 |
| 16 | 143 | 40 | 255 | 63 | 453 | 88 | 806 |
| 17 | 147 | 41 | 261 | 65 | 464 | 89 | 825 |
| 18 | 150 | 42 | 267 | 66 | 475 | 90 | 845 |
| 19 | 154 | 43 | 274 | 67 | 487 | 91 | 866 |
| 20 | 158 | 44 | 280 | 68 | 499 | 92 | 887 |
| 21 | 162 | 45 | 287 | 69 | 511 | 93 | 909 |
| 22 | 165 | 46 | 294 | 70 | 523 | 94 | 931 |
| 23 | 169 | 47 | 301 | 71 | 536 | 95 | 953 |
| 24 | 174 | 48 | 309 | 72 | 549 | 96 | 976 |

Table 5 Multiplier codes

| CODE | Y | X | A | B | C | D | E | F |
|------------|------------------|------------------|---|----|-----------------|-----------------|-----------------|-----------------|
| Multiplier | 10 ⁻² | 10 ⁻¹ | 1 | 10 | 10 ² | 10 ³ | 10 ⁴ | 10 ⁵ |

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TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to $+125$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and MIL-STD-202F.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 25% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 6 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8, 60068 and MIL-STD"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 6 Test procedures and requirements

| IEC 60115-8 CLAUSE | IEC 60068-2 TEST METHOD | MIL-STD | TEST | PROCEDURE | REQUIREMENTS |
|--------------------|-------------------------|--------------------------|------------------------------|--|--|
| 4.4.1 | | | visual examination | | no holes; clean surface; no damage |
| 4.4.2 | | | dimensions (outline) | gauge | see Table 3 |
| 4.5 | | | resistance | applied voltage (+0/-10%): 10 Ω \leq R < 100 Ω : 0.3 V 100 Ω \leq R < 1 k Ω : 1 V 1 k Ω \leq R < 10 k Ω : 3 V 10 k Ω \leq R < 100 k Ω : 10 V 100 k Ω \leq R < 1 M Ω : 25 V 1 M Ω : 50 V | R - R _{nom} : max. \pm 0.05% |
| 4.18 | 20 (Tb) | 202F method 210C | resistance to soldering heat | unmounted chips; 10 \pm 1 s; 260 \pm 5 °C | no visible damage Δ R/R max.: \pm (0.5% +0.05 Ω) |
| 4.17 | 20 (Ta) | 202F method 208G | solderability | unmounted chips completely immersed for 5 \pm 0.5 s in a solder bath at 230 \pm 5 °C | good tinning (\geq 95% covered); no damage |
| 4.7 | | 202F method 301 | voltage proof on insulation | maximum voltage (RMS) during 1 minute, metal block method | no breakdown or flashover |
| 4.13 | | MIL-R 55342D para. 4.7.5 | short time overload | room temperature; V = 2.5 \times V _{rated} ; 5 s (voltage not more than 2 \times V _{max}); specimen stabilized at room temperature for 30 minutes | Δ R/R max.: \pm (0.5% +0.05 Ω) |

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| IEC 60115-8 CLAUSE | IEC 60068-2 TEST METHOD | MIL-STD | TEST | PROCEDURE | REQUIREMENTS |
|--------------------|-------------------------|--------------------------|---------------------------|---|--|
| 4.33 | | | bending | resistors mounted on a 90 mm glass epoxy resin PCB (FR4); bending: 2 mm for 1210 2 mm for 1206 3 mm for 0805 3 mm for 0603 2 mm for 0402 | no visual damage $\Delta R/R$ max.: $\pm(0.25\% + 0.05 \Omega)$ |
| | | MIL-R 55342D para. 4.7.4 | low temperature operation | -65 +0/-5 °C for 1 hour; loaded with V_{rated} for 45 +5/-0 minutes ON, and 15 +5/-0 minutes OFF; specimen stabilized at room temperature for 24 hours after test | no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$ |
| 4.19 | 14 (Na) | 202F method 107 | thermal shock | 2 minutes at LCT and 2 minutes at UCT; 5 cycles | no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$ |
| 4.25.1 | | 202F method 108A | endurance | 1 000 +48/-0 hours; 70 \pm 2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off; specimen stabilized at room temperature for 1 hour min. after test | $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$ |
| 4.8.4.2 | | 202F method 304 | temperature coefficient | at 25/LCT/25 °C and 25/UCT/25 °C | $\leq \pm 50 \times 10^{-6}/K$ |
| 4.6.1.1 | | 202F method 302 | insulation resistance | after 1 minute, metal block method 1210: 400 V (DC) 1206: 400 V (DC) 0805: 300 V (DC) 0603: 150 V (DC) 0402: 100 V (DC) | R_{ins} min.: 10 ⁴ M Ω |
| EIA 575 3.13 | | | leaching | unmounted chips; 60 \pm 1 s; 260 \pm 5 °C | good tinning; no leaching |
| EIA/IS 703 4.6 | | 202F method 106 | moisture resistance | 65 \pm 2 °C; 95 +3/-5% RH; loaded with 0.01 P_n or V_{max} for 42 damp heat cycles. (1 cycle consists of 7 steps. see Fig.3) | $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$ |

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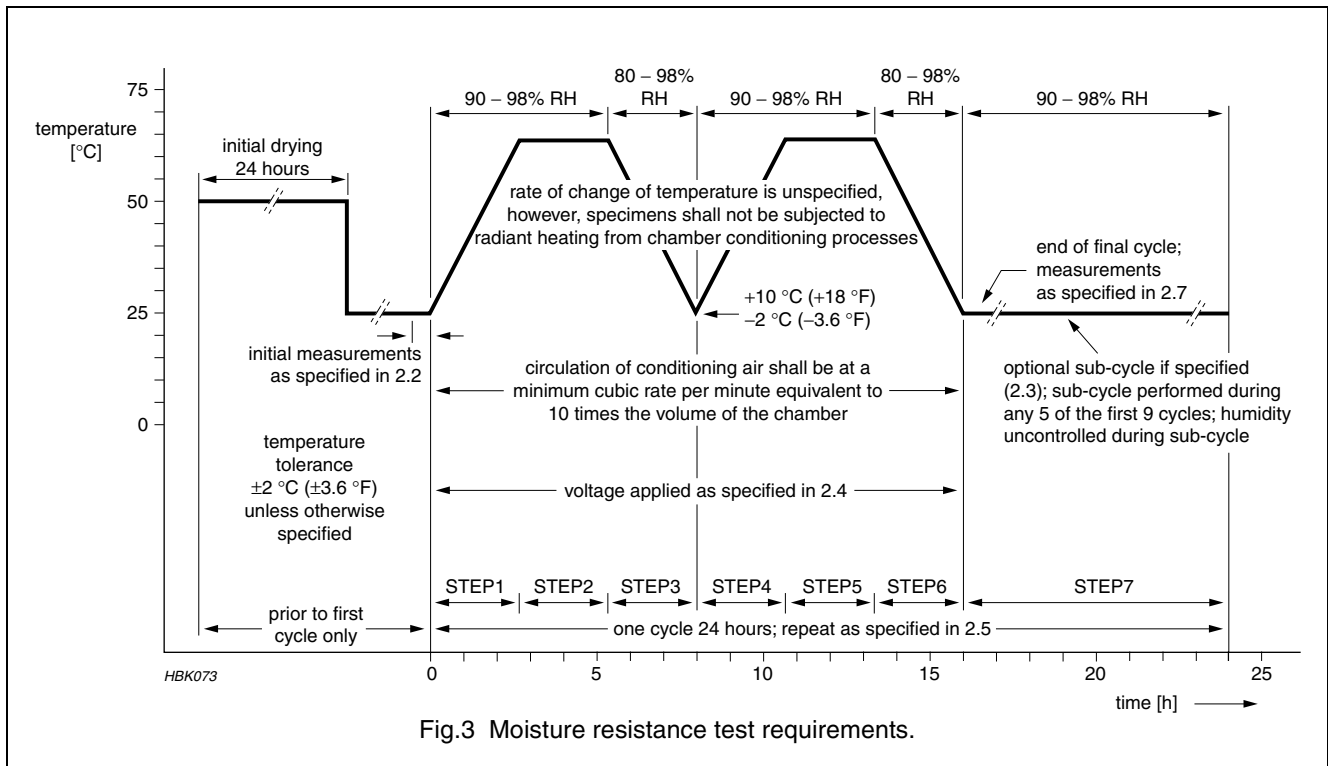


Fig.3 Moisture resistance test requirements.

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MOUNTING

Due to their rectangular shape and small dimensional tolerances, surface-mounted resistors are suitable for handling by automatic placement systems. Chip placement can be on ceramic substrates and

printed-circuit boards (PCBs). Electrical connection to the circuit is by soldering. The finishing of the end terminations guarantees a reliable contact.

Footprint dimensions

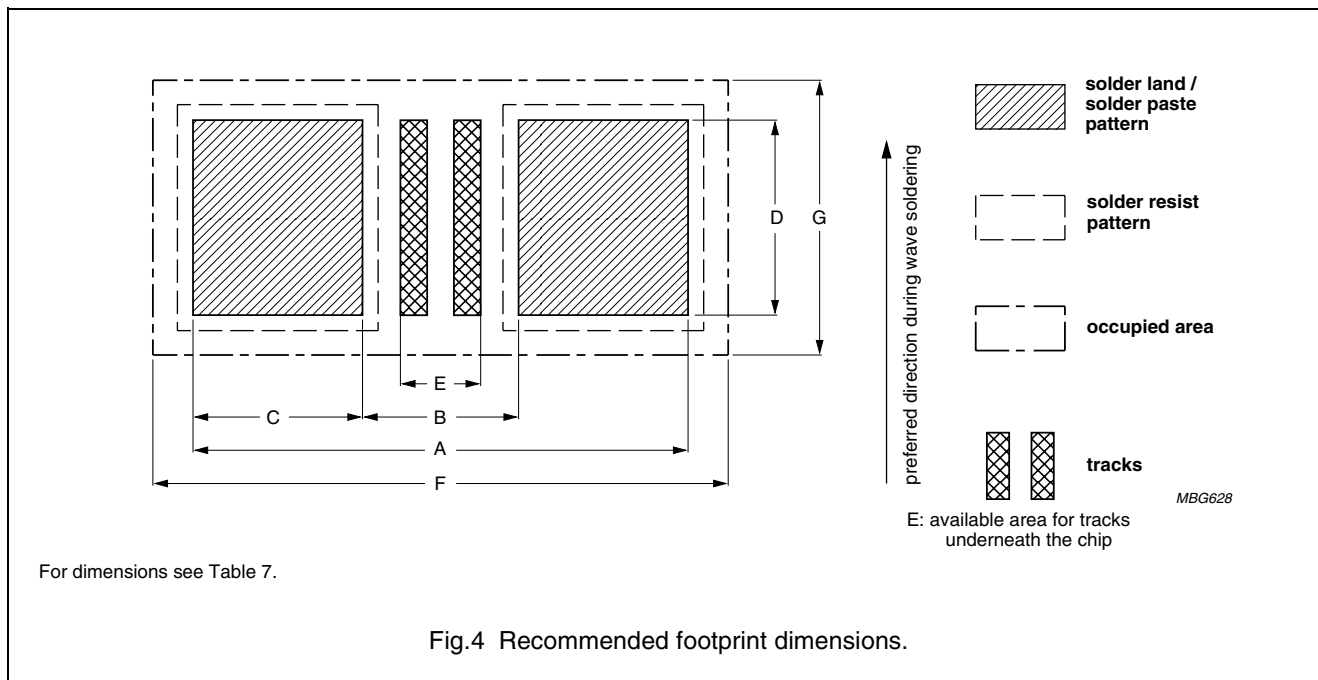


Table 7 Reflow soldering; for dimensions see also Fig.4

| TYPE | SIZE CODE | FOOTPRINT DIMENSIONS (mm) | | | | | | | PROCESSING REMARKS | PLACEMENT ACCURACY (mm) |
|--------|-----------|---------------------------|-----|------|-----|-----|-----|-----|--------------------|-------------------------|
| | | A | B | C | D | E | F | G | | |
| TFx324 | 0402 | 1.5 | 0.5 | 0.5 | 0.6 | 0.1 | 1.9 | 1.0 | IR soldering | ±0.15 |
| TFx224 | 0603 | 2.1 | 0.5 | 0.8 | 0.9 | 0.0 | 2.5 | 1.7 | | ±0.25 |
| TFx124 | 0805 | 2.6 | 0.9 | 0.85 | 1.4 | 0.5 | 3.0 | 2.1 | | ±0.25 |
| TFx024 | 1206 | 3.8 | 2.0 | 0.9 | 1.8 | 1.4 | 4.2 | 2.5 | | ±0.25 |
| TFx524 | 1210 | 3.8 | 2.0 | 0.9 | 2.7 | 1.4 | 4.2 | 3.4 | | ±0.25 |

Table 8 Wave soldering; for dimensions see also Fig.4

| TYPE | SIZE CODE | FOOTPRINT DIMENSIONS (mm) | | | | | | | PROPOSED NUMBER AND DIMENSIONS OF DUMMY TRACKS (mm) | PLACEMENT ACCURACY (mm) |
|--------|-----------|---------------------------|-----|-----|-----|------|-----|-----|---|-------------------------|
| | | A | B | C | D | E | F | G | | |
| TFx224 | 0603 | 2.7 | 0.9 | 0.9 | 0.8 | 0.15 | 3.2 | 1.9 | 1 × (0.15 × 0.8) | ±0.25 |
| TFx124 | 0805 | 3.3 | 1.3 | 1.0 | 1.3 | 0.34 | 3.9 | 2.4 | 1 × (0.3 × 1.3) | ±0.25 |
| TFx024 | 1206 | 4.5 | 2.5 | 1.0 | 1.7 | 1.25 | 3.9 | 2.4 | 3 × (0.25 × 1.7) | ±0.25 |
| TFx524 | 1210 | 5.3 | 2.3 | 1.5 | 2.6 | 1.25 | 6.3 | 4.2 | 3 × (0.25 × 2.6) | ±0.25 |

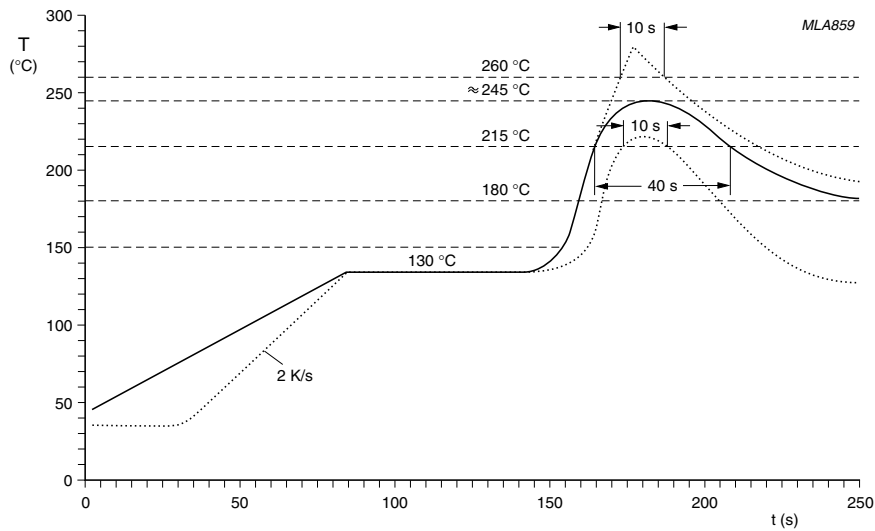
Thin-film chip resistors sizes 1210, 1206, 0805, 0603 and 0402

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SOLDERING CONDITIONS

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260 °C for one minute. Therefore, it is possible to mount surface-mount resistors on one side of a PCB and other components on the reverse side (mixed PCBs).

Surface-mount resistors are tested for solderability at 235 °C during 2 seconds. The test condition for no leaching is 260 °C for 60 seconds. Typical examples of soldering processes that provide reliable joints without any damage, are given in Figs 5 and 6.

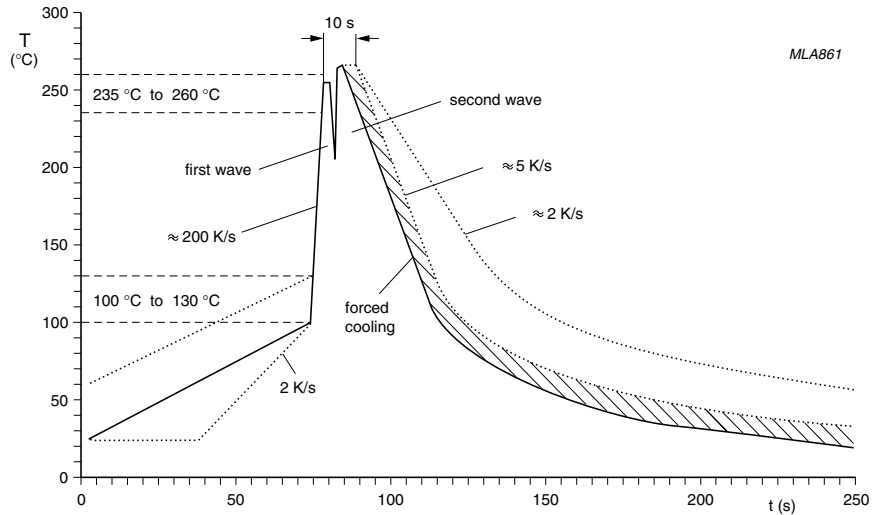


Typical values (solid line).
Process limits (dotted lines).

Fig.5 Infrared soldering.

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Typical values (solid line).

Process limits (dotted lines).

The resistors may be soldered twice in accordance with this method if desired.

Fig.6 Double wave soldering.

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PACKING

Tape and reel specifications

All tape and reel specifications are in accordance with "IEC 60286-3". Basic dimensions are given in Figs 7, 8 and 9 and Tables 9, and 10.

Peel-off force

Peel-off forces of both paper and blister tapes are in accordance with "IEC 60286-3"; that is, at a peel-off speed of 300 ± 10 mm/minute, 0.1 N to 1.0 N for 8 mm tape. The peel-off angle should be between 165° and 180° .

Paper tape specification

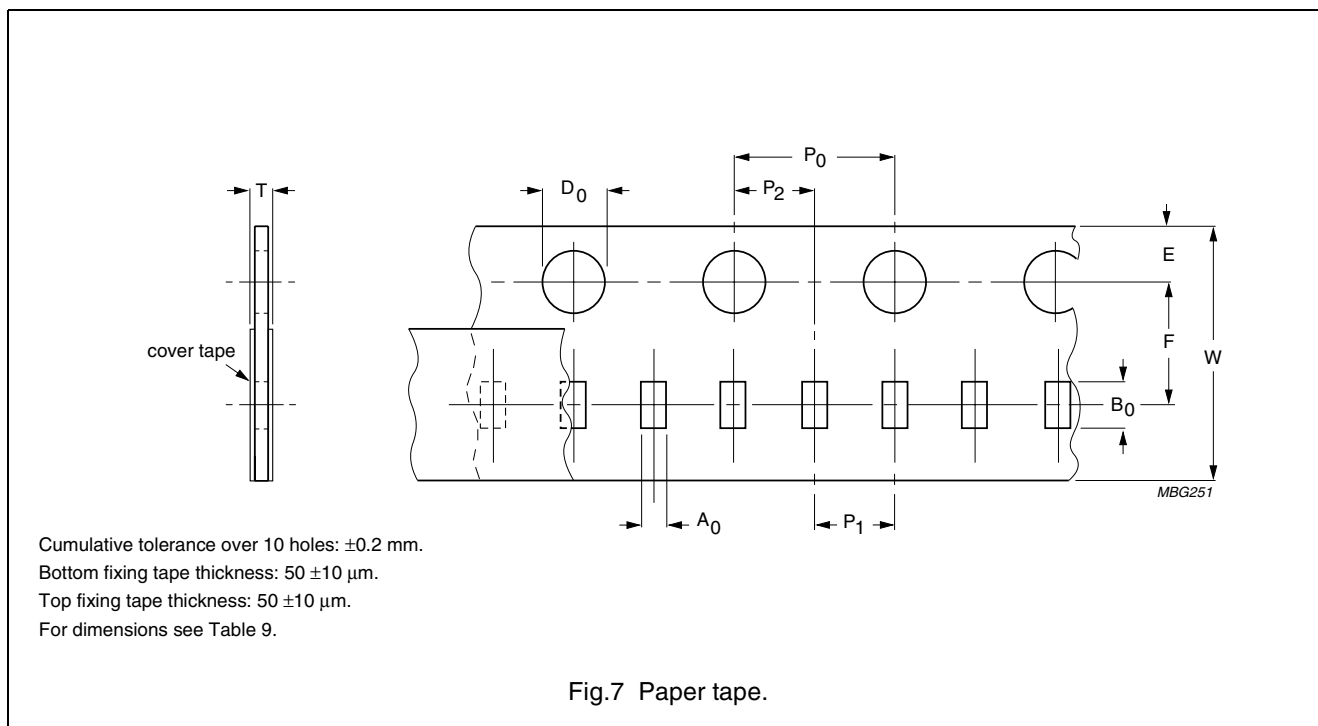


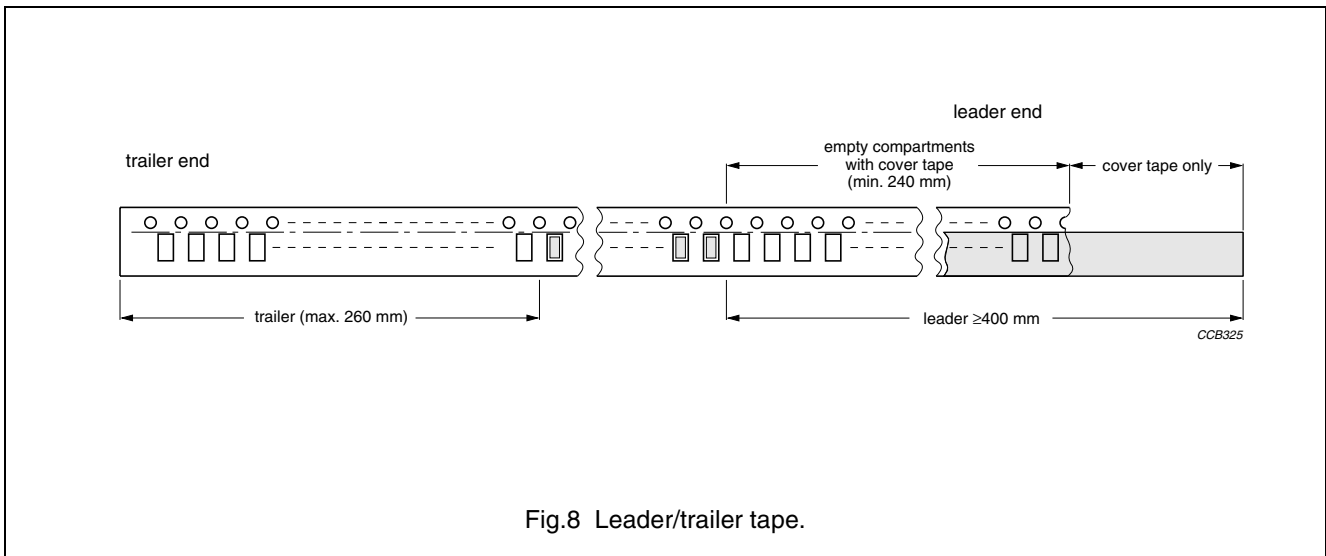
Table 9 Dimensions of paper tape for relevant chip size; see Fig.7

| SYMBOL | TYPE AND SIZE CODE | | | | | | | | | | UNIT |
|----------------|--------------------|------------|--------------|------------|--------------|------------|--------------|------------|--------------|------------|------|
| | TF324 (0402) | | TF224 (0603) | | TF124 (0805) | | TF024 (1206) | | TF524 (1210) | | |
| | SIZE | TOL. | SIZE | TOL. | SIZE | TOL. | SIZE | TOL. | SIZE | TOL. | |
| A ₀ | 0.65 | ± 0.1 | 1.10 | ± 0.1 | 1.65 | ± 0.1 | 1.90 | ± 0.1 | 2.80 | ± 0.1 | mm |
| B ₀ | 1.15 | ± 0.1 | 1.90 | ± 0.1 | 2.40 | ± 0.1 | 3.50 | ± 0.1 | 3.50 | ± 0.1 | mm |
| W | 8.0 | ± 0.2 | 8.0 | ± 0.2 | 8.0 | ± 0.2 | 8.0 | ± 0.2 | 8.0 | ± 0.2 | mm |
| E | 1.75 | ± 0.1 | 1.75 | ± 0.1 | 1.75 | ± 0.1 | 1.75 | ± 0.1 | 1.75 | ± 0.1 | mm |
| F | 3.50 | ± 0.05 | 3.50 | ± 0.05 | 3.50 | ± 0.05 | 3.50 | ± 0.05 | 3.50 | ± 0.05 | mm |
| D ₀ | 1.5 | $+0.1/-0$ | 1.5 | $+0.1/-0$ | 1.50 | $+0.1/-0$ | 1.5 | $+0.1/-0$ | 1.5 | $+0.1/-0$ | mm |
| P ₀ | 4.0 | ± 0.1 | 4.0 | ± 0.1 | 4.0 | ± 0.1 | 4.0 | ± 0.1 | 4.0 | ± 0.1 | mm |
| P ₁ | 2.0 | ± 0.05 | 4.0 | ± 0.05 | 4.0 | ± 0.05 | 4.0 | ± 0.05 | 4.0 | ± 0.05 | mm |
| P ₂ | 2.0 | ± 0.05 | 2.0 | ± 0.05 | 2.0 | ± 0.05 | 2.0 | ± 0.05 | 2.0 | ± 0.05 | mm |
| T | 0.53 | ± 0.1 | 0.7 | ± 0.1 | 0.85 | ± 0.1 | 0.85 | ± 0.1 | 0.85 | ± 0.1 | mm |

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Tape leader/trailer specification



Taping requirements

Resistance side facing up.

Component is free and not sticking to top and/or bottom tape.

Component should be easy to remove from the carrier tape and the chip cavity should have no mechanical damage.

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Reel specification

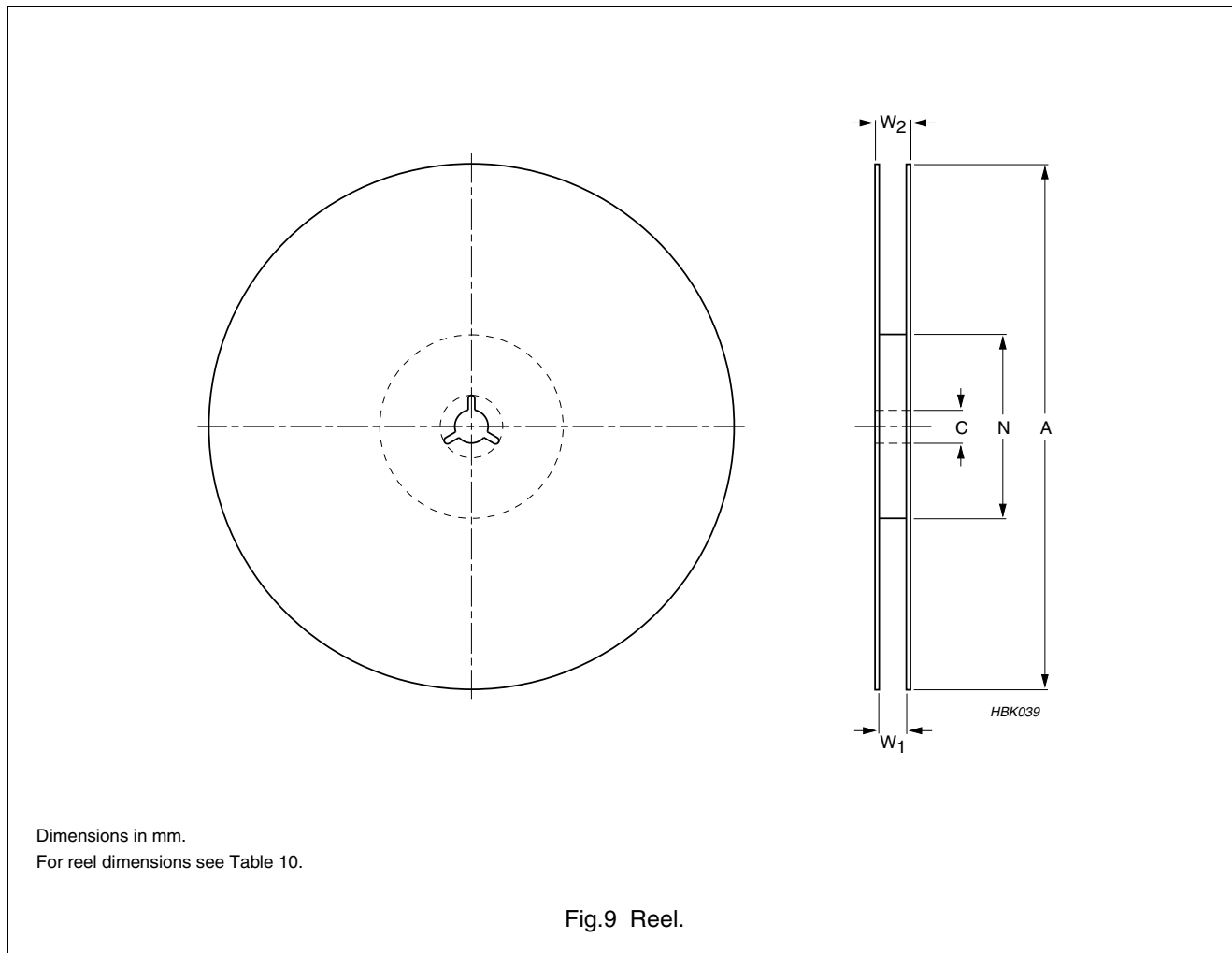


Table 10 Reel dimensions; see Fig.9

| TYPE | SIZE CODE | UNITS PER REEL | TAPE WIDTH (mm) | A (mm) | N (mm) | C (mm) | W ₁ (mm) | W ₂ MAX. (mm) |
|-------|-----------|----------------|-----------------|-----------|----------|-----------|---------------------|--------------------------|
| TF324 | 0402 | 10000 | 8 | 180 +0/-3 | 60 +1/-0 | 13.0 ±0.2 | 9.0 ±0.3 | 11.4 ±1 |
| TF224 | 0603 | 5000 | | | | | | |
| TF124 | 0508 | 5000 | | | | | | |
| TF024 | 1206 | 5000 | | | | | | |
| TF524 | 1210 | 5000 | | | | | | |

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REVISION HISTORY

| Revision | Date | Change Notification | Description |
|----------|-------------|---------------------|--|
| Rev.0 | 2001 Sep 10 | EBR-3240-01177 | - First issue of this specification - Expansion of the thin-film low-TC product range |