

# DATA SHEET

## THIN-FILM CHIP RESISTORS

TFx23 series, 0.1% TC50

10  $\Omega$  TO 1 M $\Omega$

sizes 1210, 1206, 0805, 0603 and 0402



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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				
	TF523	TF023	TF123	TF223	TF323
Size code	1210	1206	0805	0603	0402
Resistance range	10 $\Omega$ to 1 M $\Omega$	10 $\Omega$ to 1 M $\Omega$	10 $\Omega$ to 1 M $\Omega$	10 $\Omega$ to 332 k $\Omega$	10 $\Omega$ to 100 k $\Omega$
Resistance tolerance and series	$\pm 0.1\%$ ; 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
TF523	1210	10 $\Omega$ to 1 M $\Omega$	$\pm 0.1$	5000	2390 412 4xxxx
TF023	1206	10 $\Omega$ to 1 M $\Omega$	$\pm 0.1$	5000	2390 411 4xxxx
TF123	0805	10 $\Omega$ to 1 M $\Omega$	$\pm 0.1$	5000	2390 401 4xxxx
TF223	0603	10 $\Omega$ to 332 k $\Omega$	$\pm 0.1$	5000	2390 404 4xxxx
TF323	0402	10 $\Omega$ to 100 k $\Omega$	$\pm 0.1$	10000	2390 407 4xxxx

#### 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 $\Omega$ to 97.6 $\Omega$	9
100 $\Omega$ to 976 $\Omega$	1
1 k $\Omega$ to 9.76 k $\Omega$	2
10 k $\Omega$ to 97.6 k $\Omega$	3
100 k $\Omega$ to 976 k $\Omega$	4
1 M $\Omega$	5

#### ORDERING EXAMPLE

The ordering code of a TF023 resistor, value 1000  $\Omega$  with 0.1% tolerance, supplied on paper tape of 5000 units per reel is: 2390 411 41002.

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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  $\pm 0.1\%$ .

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

#### Limiting values

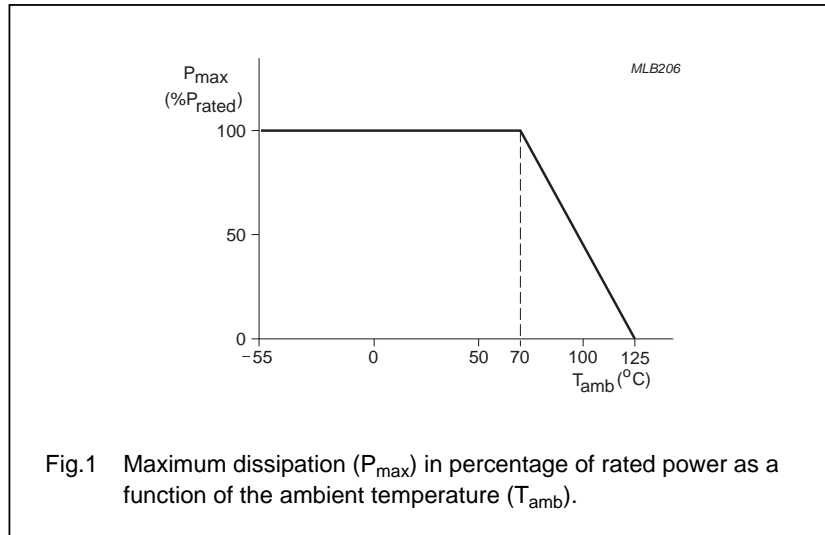
TYPE	LIMITING VOLTAGE <sup>(1)</sup> (V)	LIMITING POWER (W)
TF523	200	0.25
TF023	200	0.125
TF123	150	0.125
TF223	75	0.1
TF323	50	0.0625

#### Note

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

### DERATING

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



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### MECHANICAL DATA

#### Mass per 100 units

TYPE	MASS (g)
TF523	1.67
TF023	1
TF123	0.55
TF223	0.25
TF323	0.052

#### Marking

TYPE	E24	E96
TF523	4 digits	4 digits
TF023	4 digits	4 digits
TF123	4 digits	4 digits
TF223	3 digits	3 digits EIA-96
TF323	no marking	

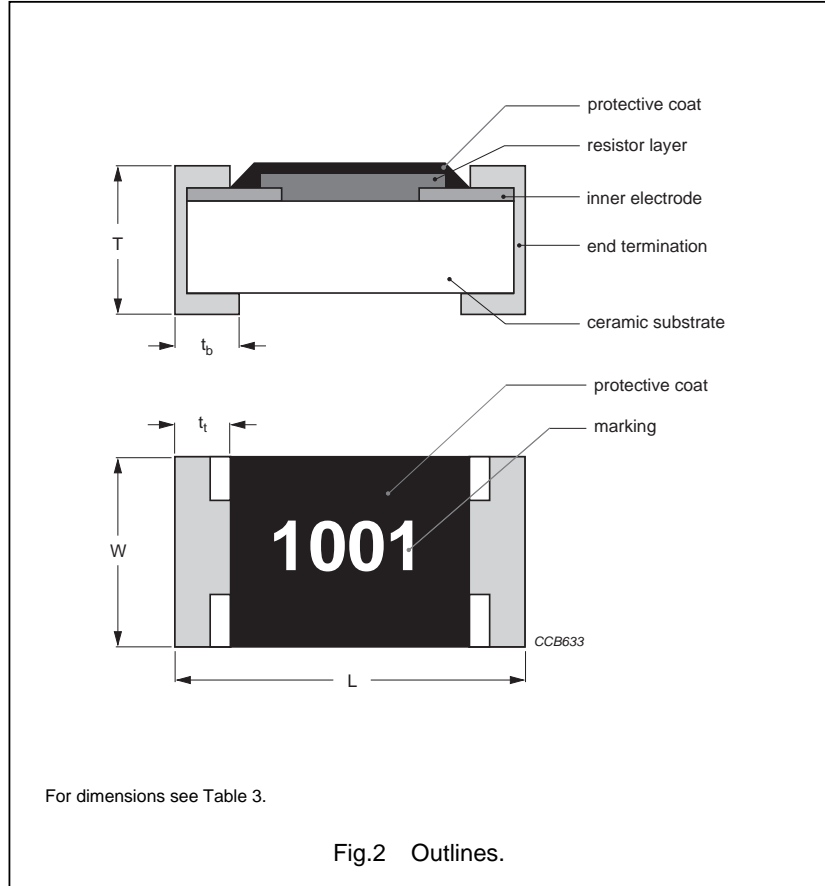
#### 4-DIGIT MARKING

For values up to 97.6 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 <sub>t</sub> (mm)	t <sub>b</sub> (mm)
TF523 (1210)	3.1 ±0.1	2.6 ±0.1	0.55 ±0.1	0.50 ±0.2	0.5 ±0.2
TF023 (1206)	3.1 ±0.1	1.6 ±0.1	0.55 ±0.1	0.45 ±0.2	0.4 ±0.2
TF123 (0805)	2.0 ±0.1	1.25 ±0.1	0.50 ±0.1	0.35 ±0.2	0.35 ±0.2
TF223 (0603)	1.6 ±0.1	0.8 ±0.1	0.45 ±0.1	0.25 ±0.15	0.25 ±0.15
TF323 (0402)	1.0 ±0.1	0.50 ±0.05	0.30 ±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 $\Omega$
123	12 k $\Omega$
124	120 k $\Omega$

### 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 $\Omega$
10C	12.4 k $\Omega$
10D	124 k $\Omega$

### 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	$10^2$	$10^3$	$10^4$	$10^5$

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

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### TEST 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 $\Omega$ $\leq$ R < 100 $\Omega$ : 0.3 V 100 $\Omega$ $\leq$ R < 1 k $\Omega$ : 1 V 1 k $\Omega$ $\leq$ R < 10 k $\Omega$ : 3 V 10 k $\Omega$ $\leq$ R < 100 k $\Omega$ : 10 V 100 k $\Omega$ $\leq$ R < 1 M $\Omega$ : 25 V 1 M $\Omega$ : 50 V	R - R <sub>nom</sub> : max. $\pm$ 0.1%
4.18	20 (Tb)	202F method 210C	resistance to soldering heat	unmounted chips; 10 $\pm$ 1 s; 260 $\pm$ 5 °C	no visible damage $\Delta$ R/R max.: $\pm$ (0.5% + 0.05 $\Omega$ )
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 <sub>rated</sub> ; 5 s (voltage not more than 2 $\times$ V <sub>max</sub> ); specimen stabilized at room temperature for 30 minutes	$\Delta$ R/R max.: $\pm$ (0.5% + 0.05 $\Omega$ )

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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 visible 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	1000 +48/-0 hours; 70 $\pm$ 2 °C; loaded with $P_n$ or $V_{max}$ ; 1.5 hours on, 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.: $10^4 M\Omega$
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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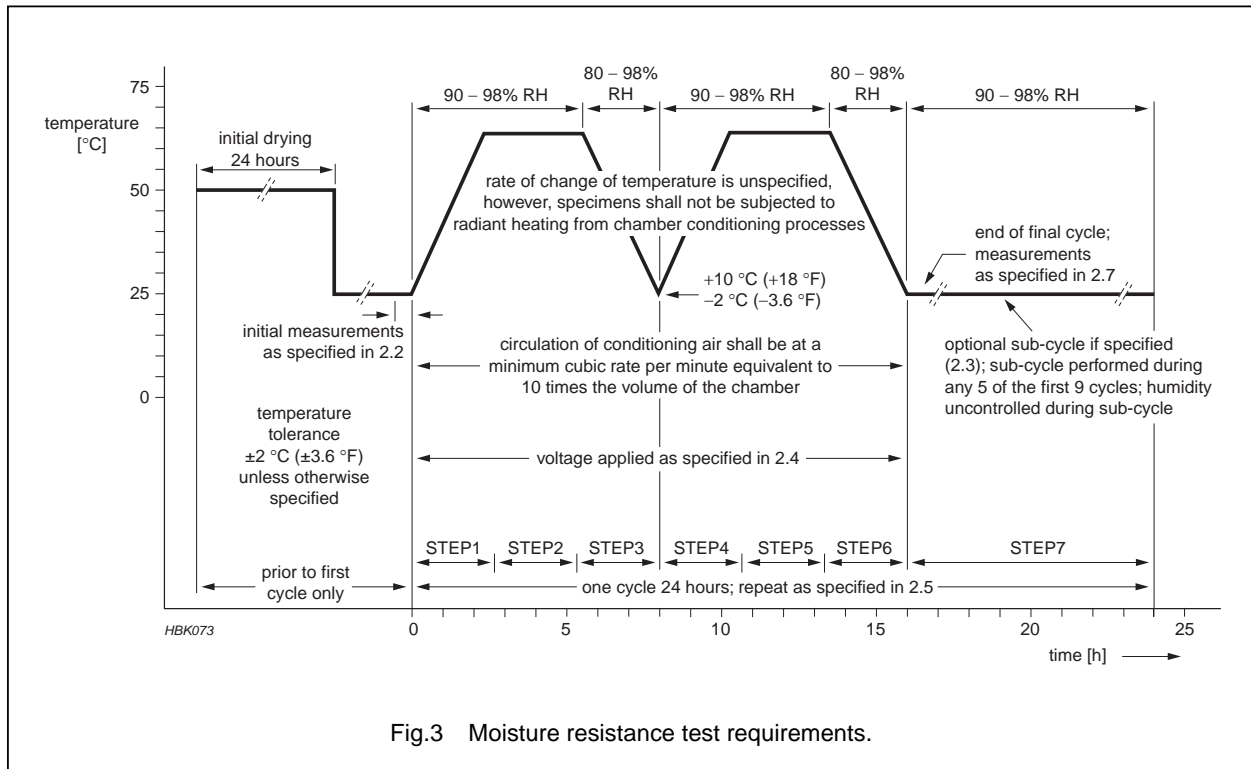


Fig.3 Moisture resistance test requirements.

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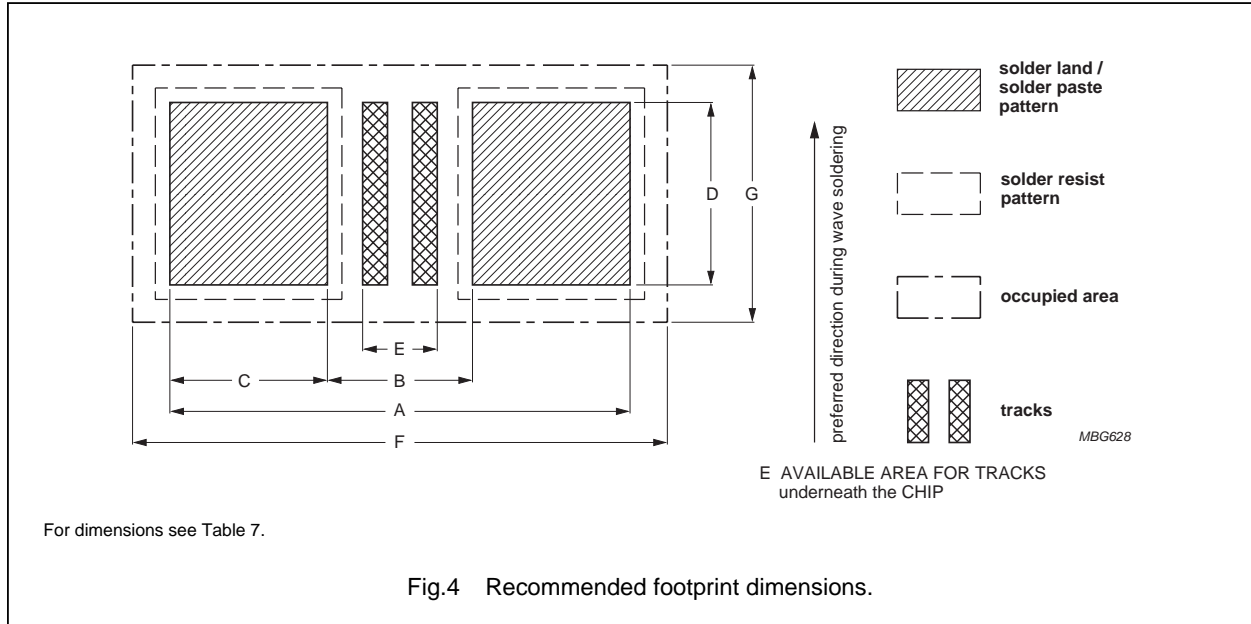
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### MOUNTING

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		
TFx323	0402	1.5	0.5	0.5	0.6	0.1	1.9	1.0	IR soldering	±0.15
TFx223	0603	2.1	0.5	0.8	0.9	0.0	2.5	1.7		±0.25
TFx123	0805	2.6	0.9	0.85	1.4	0.5	3.0	2.1		±0.25
TFx023	1206	3.8	2.0	0.9	1.8	1.4	4.2	2.5		±0.25
TFx523	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		
TFx223	0603	2.7	0.9	0.9	0.8	0.15	3.2	1.9	1 × (0.15 × 0.8)	±0.25
TFx123	0805	3.3	1.3	1.0	1.3	0.34	3.9	2.4	1 × (0.3 × 1.3)	±0.25
TFx023	1206	4.5	2.5	1.0	1.7	1.25	3.9	2.4	3 × (0.25 × 1.7)	±0.25
TFx523	1210	5.3	2.3	1.5	2.6	1.25	6.3	4.2	3 × (0.25 × 2.6)	±0.25

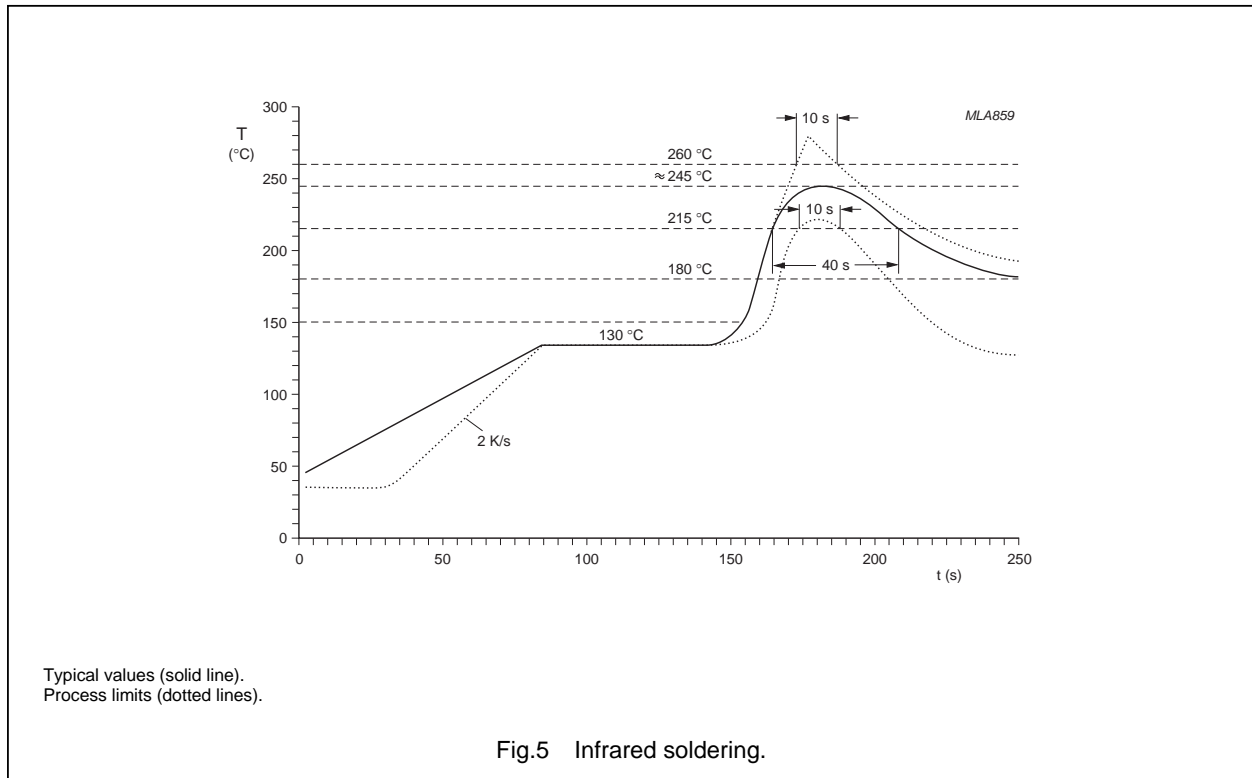
## Thin-film chip resistors sizes 1210, 1206, 0805, 0603 and 0402

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### SOLDERING CONDITIONS

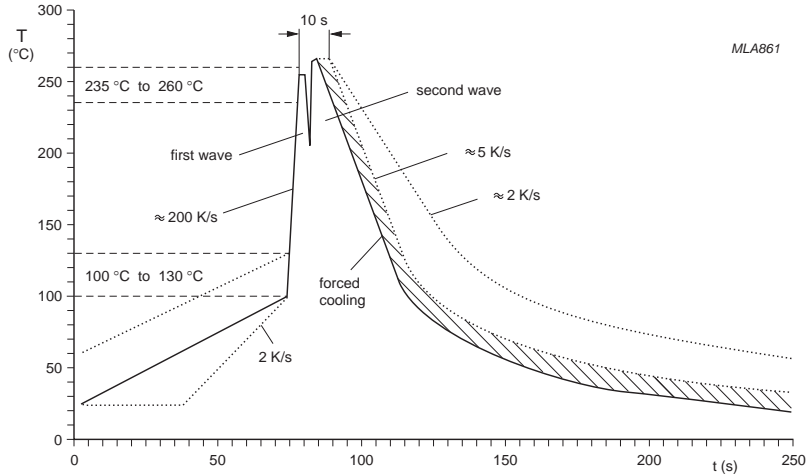
The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260 °C for one minute. Therefore, it is possible to mount surface-mount resistors on one side of a PCB and other components on the reverse side (mixed PCBs).

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.



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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

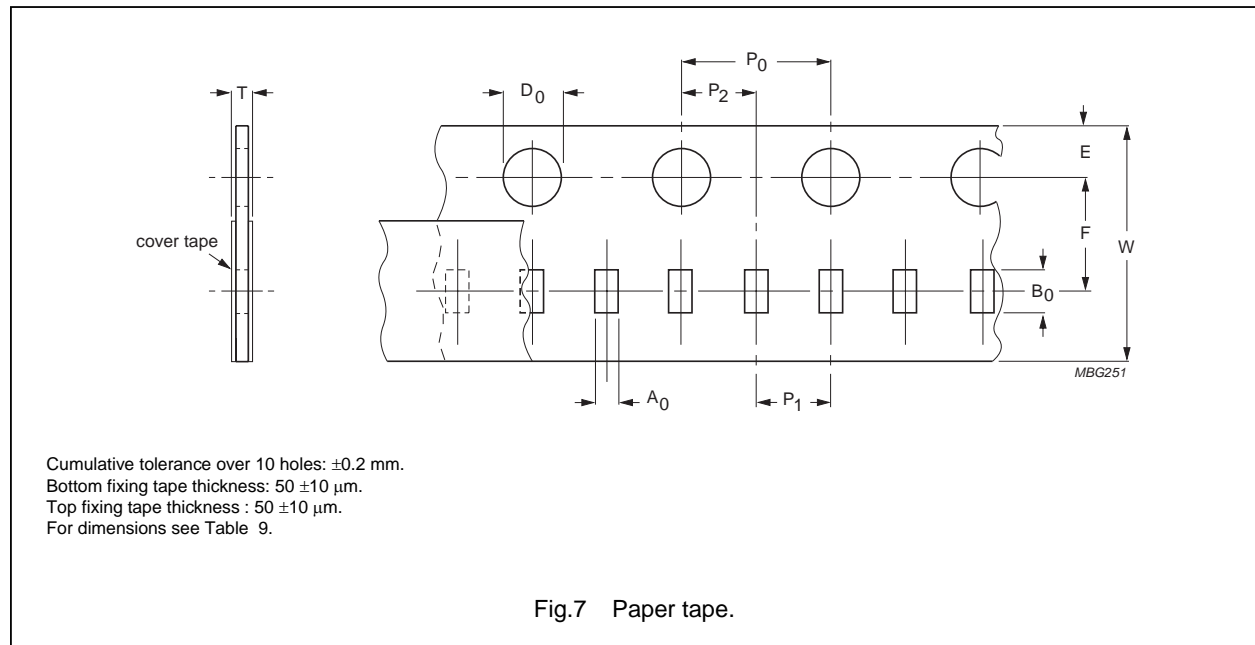
#### Tape and reel specifications

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.

#### Paper tape specification

#### 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  $300 \pm 10$  mm/minute, 0.1 N to 1.0 N for 8 mm tape. The peel-off angle should be between  $165^\circ$  and  $180^\circ$ .



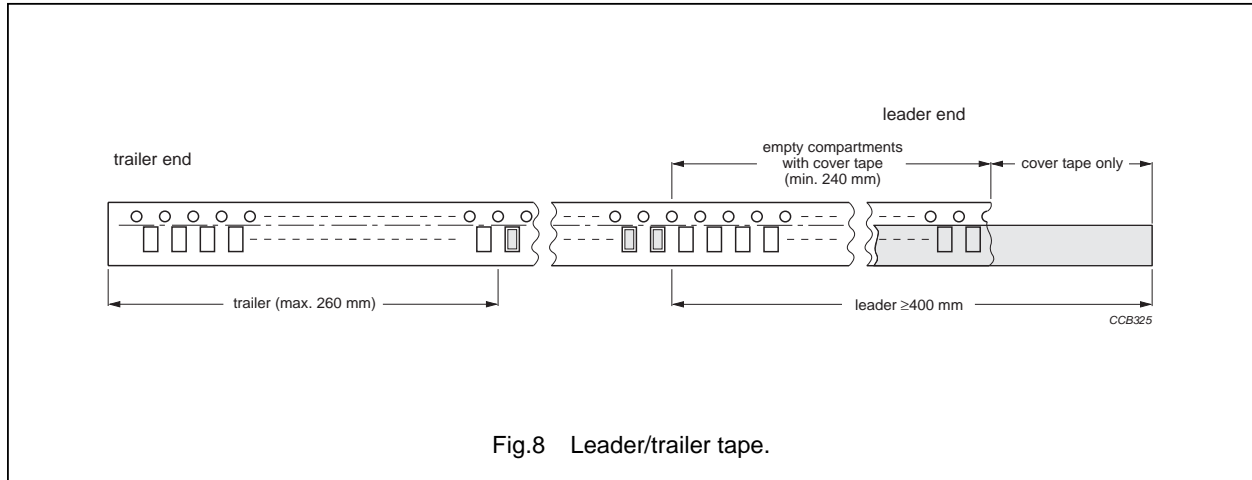
**Table 9** Dimensions of paper tape for relevant chip size; see Fig.7

SYMBOL	TYPE AND SIZE CODE										UNIT
	TF323 (0402)		TF223 (0603)		TF123 (0805)		TF023 (1206)		TF523 (1210)		
	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	
$A_0$	0.65	$\pm 0.1$	1.10	$\pm 0.1$	1.65	$\pm 0.1$	1.90	$\pm 0.1$	2.80	$\pm 0.1$	mm
$B_0$	1.15	$\pm 0.1$	1.90	$\pm 0.1$	2.40	$\pm 0.1$	3.50	$\pm 0.1$	3.50	$\pm 0.1$	mm
$W$	8.0	$\pm 0.2$	8.0	$\pm 0.2$	8.0	$\pm 0.2$	8.0	$\pm 0.2$	8.0	$\pm 0.2$	mm
$E$	1.75	$\pm 0.1$	1.75	$\pm 0.1$	1.75	$\pm 0.1$	1.75	$\pm 0.1$	1.75	$\pm 0.1$	mm
$F$	3.50	$\pm 0.05$	3.50	$\pm 0.05$	3.50	$\pm 0.05$	3.50	$\pm 0.05$	3.50	$\pm 0.05$	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	$\pm 0.1$	4.0	$\pm 0.1$	4.0	$\pm 0.1$	4.0	$\pm 0.1$	4.0	$\pm 0.1$	mm
$P_1$	2.0	$\pm 0.05$	4.0	$\pm 0.05$	4.0	$\pm 0.05$	4.0	$\pm 0.05$	4.0	$\pm 0.05$	mm
$P_2$	2.0	$\pm 0.05$	2.0	$\pm 0.05$	2.0	$\pm 0.05$	2.0	$\pm 0.05$	2.0	$\pm 0.05$	mm
$T$	0.53	$\pm 0.1$	0.7	$\pm 0.1$	0.85	$\pm 0.1$	0.85	$\pm 0.1$	0.85	$\pm 0.1$	mm

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### Tape leader/trailer specification



### Taping requirements

Resistance side facing up.

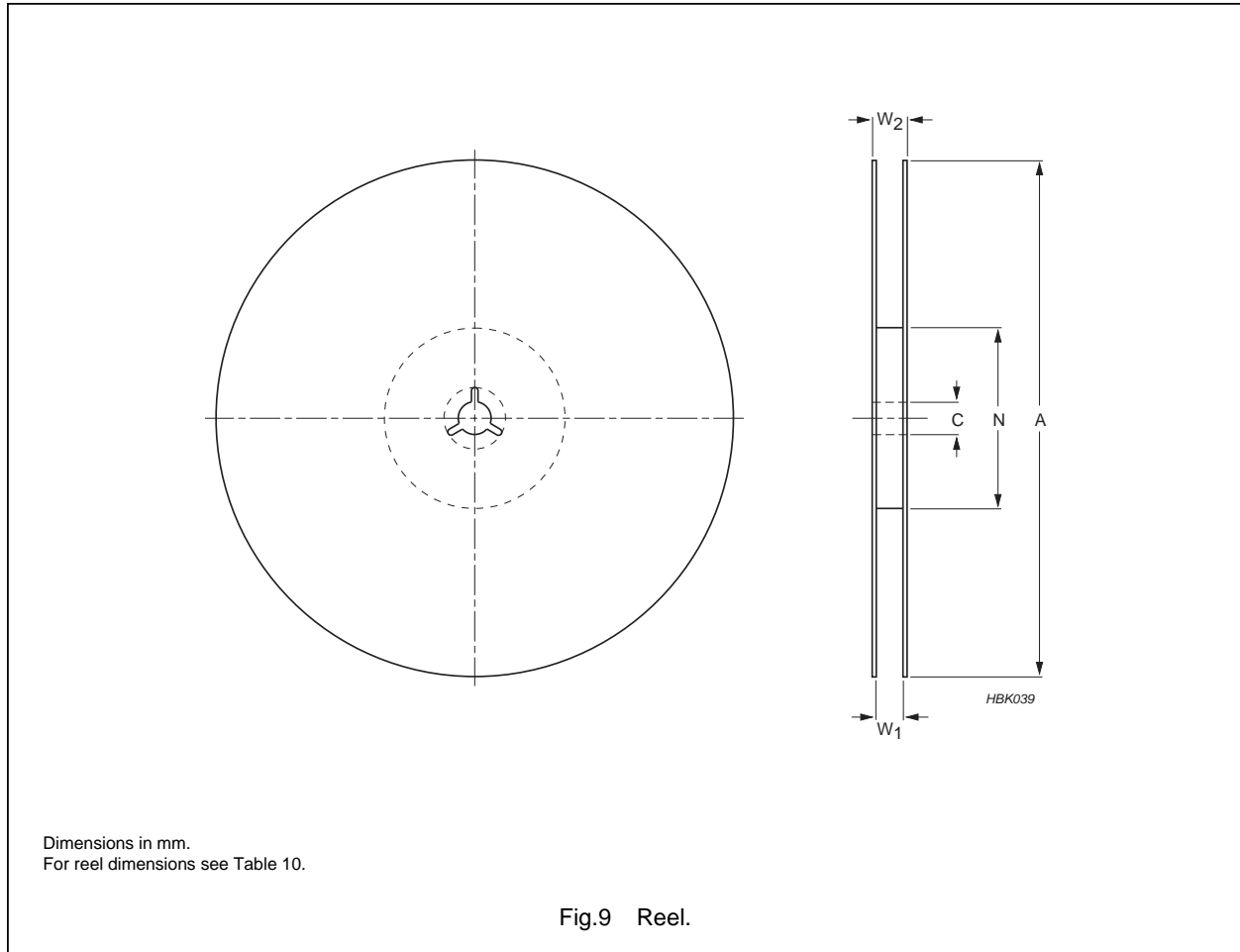
Component is free and not sticking to top and/or bottom tape.

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 <sub>1</sub> (mm)	W <sub>2</sub> MAX. (mm)
TF323	0402	10000	8	180 +0/-3	60 +1/-0	13.0 ±0.2	9.0 ±0.3	11.4 ±1
TF223	0603	5000						
TF123	0508	5000						
TF023	1206	5000						
TF523	1210	5000						

**Thin-film chip resistors  
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10  $\Omega$  to 1 M $\Omega$** **REVISION HISTORY**

<b>Revision</b>	<b>Date</b>	<b>Change Notification</b>	<b>Description</b>
Rev.0	2001 Jul 30	-	- First issue of this specification
Rev.1	2001 Sep 10	EBR-3240-01177	- Range expanded with 0.25 W size 1210 resistors - MIL-STD test procedures added
Rev.2	2003 Jul 10	-	- Updated company logo - Marking code revised