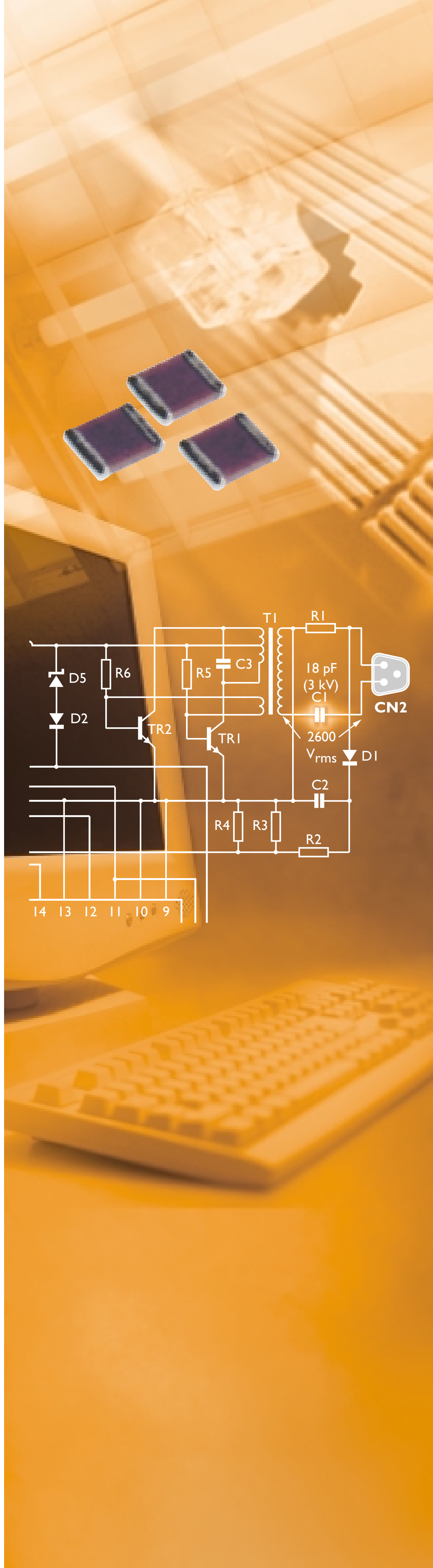
Innovative Service Around the Globe YAGEO

High-voltage MLCCs for power applications



www.yageo.com

Phicomp

High-voltage MLCCs for power applications

SUMMARY
Yageo's Phycomp branded high-voltage MLCCrange has been developed specifically for power systems such as SMPS, DC-DC converters and DC-AC inverters. Manufactured using the most modern mass-production techniques, the range is available in rated voltages of 200 V, 500 V, 1 kV, 2 kV, 3 kV and 4 kV, making the new products ideally suited to a wide range of power applications.

Switched-mode power supplies, DC-to-DC converters and DC-to-AC inverters are nowadays widely used in all kinds of consumer equipment. Moreover, demand for such compact, highly-efficient power-conversion systems is expected to grow even further with the continual migration toward ever smaller equipment with ever lower weight, cost and power usage, plus lower EMI levels to satisfy modern EMC requirements. This in turn will place increasing demands on components, especially capacitors which must combine a high degree of miniaturization with the ability to reliably handle the relatively-high voltages often occurring in power supplies. Here, Yageo's range of high-voltage Multilayer Ceramic Capacitors (MLCCs) offer the ideal solution.

Yageo's high-voltage chip capacitors offer the answer

High reliability, large capacitance, small size and excellent high-frequency characteristics are essential requirements for capacitors operating in high-voltage systems. Yageo's high-voltage MLCC range has been developed specifically to meet these requirements. Manufactured using the most modern mass-production techniques, the range is available in rated voltages of 200 V, 500 V, 1 kV, 2 kV, 3 kV and 4 kV and offers the important benefit of low cost. This makes the range ideally suited to a wide range of applications in, for example, by-pass, coupling, and resonant functions such as snubbers in high-frequency power converters, resonators in SMPS, and high-voltage coupling/DC blocking in inverters. The new range, moreover, exhibits low ESR at high frequencies.

Offering an attractive alternative to film capacitors

Used in power circuits, Yageo's Phycomp branded high-voltage MLCC range offers an attractive alternative to leaded film capacitors. Compared with film capacitors, high-voltage MLCCs offer not only greater resistance to mechanical stress and resistance to static electricity and surge current, they also offer excellent high-frequency performance, lower ESR and stability against temperature variations.

Benefits of Yageo's new high-voltage MLCCs

- Available in a wide range of capacitances
- Small size
- High reliability
- Excellent high-frequency characteristics
- Low ESR at high-frequencies

Specifications and mechanical details

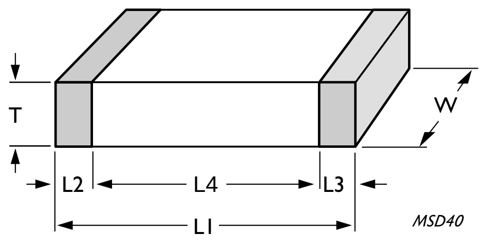
Table 1 NP0 dielectric

Rated voltage U_r (DC)	0805	1206	1210	1808	1812
200 V	10 pF~560 pF	10 pF~1.5 nF	1.8 nF ~ 3.3 nF	-	3.9 nF~5.6 nF
500 V	-	10 pF ~1 nF	47 pF~1.8 nF	-	2.2 nF~3.3 nF
1000 V	-	120 pF~390 pF	-	-	100 pF~1.5 nF
2000 V	-	22 pF~100 pF	-	-	-
3000 V	-	-	-	3.3 pF~120 pF	10 pF~220 pF
4000 V	-	-	-	10 pF~22 pF	10 pF~47 pF
Capacitance tolerance	±5%				
Termination	Ni/Sn				

Table 2 X7R dielectric

Rated voltage U_r (DC)	0805	1206	1210	1808	1812
200 V	220 pF~6,8 nF	680 pF~33 nF	22 nF~47 nF	-	47 nF ~100 nF
500 V	-	470 pF~3.3 nF	3.3 nF~6.8 nF	-	10 nF ~15 nF
1000 V	-	470 pF~3.3 nF	-	470 pF~3.3 nF	1 nF~10 nF
2000 V	-	-	-	470 pF~2.2 nF	1 nF~4.7 nF
Capacitance tolerance	±10%, ±20%				
Termination	Ni/Sn				

Yageo's high-voltage MLCCs for power circuits



Size	L1	W	T	L2/L3		L4
			max	min.	max	min
0805	2.0 ± 0.10	1.25 ± 0.10	1.3	0.25	0.75	0.55
1206	3.2 ± 0.15	1.6 ± 0.15	1.3	0.25	0.75	1.40
1210	3.2 ± 0.15	2.5 ± 0.15	1.8	0.25	0.75	1.40
1808	4.5 ± 0.20	2.0 ± 0.20	1.3	0.25	0.75	2.20
1812	4.5 ± 0.20	3.2 ± 0.20	1.3	0.25	0.75	2.20
2220	5.7 ± 0.20	5.0 ± 0.20	1.3	0.25	0.75	2.90

Fig.1 Mechanical dimensions (in mm) of Yageo's Phycomp branded high-voltage MLCCs

High-voltage MLCCs in operation

Able to suppress high-frequency power surges and perform coupling/DC-blocking functions in high-voltage circuits, Yageo's high-voltage MLCCs protect ICs and transistors against transient voltages (even in telecommunications equipment) and against electro-static discharge.

Be sure to use a capacitor only within its rated operating voltage range. When DC-rated capacitors are to be used in AC or ripple-voltage circuits, it is also important to maintain the maximum amplitude value of the applied voltage within the rated voltage range.

For relatively low frequencies, that is below about 10 kHz, the use of the capacitor is limited by its dielectric strength. In this case the sum of the DC voltage and the AC voltage must not exceed the DC rated voltage specification of the capacitor. For example, a 500 V rated NP0 capacitor that is used at 100 V DC may have an additional AC load at frequencies below about 10 kHz with a maximum amplitude of 400 V, giving an RMS voltage of 283 V.

At higher frequencies, i.e. above about 10 kHz, the use of the capacitor is limited by the power dissipation and the heat flow to the surroundings. A multilayer ceramic capacitor at continuous AC load will dissipate power and hence will rise in temperature. The temperature rise can be calculated for a steady-state situation in which the dissipated power equals the heat loss to the surroundings.

The heat loss to the surrounding is built up of two parts. One part is the heat loss via the outer surface of the MLCC by convection and radiation. The second part is the heat loss via the solder bonds to the PC board and thence to the air. The latter is the dominant contribution. The relevant parameter here is the thermal transfer coefficient or heat resistance R_{th}. In a steady-state situation:

$$P = I_{RMS}^2 \, ESR = \frac{\Delta T}{R_{th}}$$

in which I_{RMS} is the RMS value of the current, ESR is the equivalent series resistance of the capacitor at a given frequency and ΔT is the maximum allowed temperature rise upon AC load.

Values of R_{th} are given in the table below:

size	0805	1206	1210	1808	1812
R_{th} (K/W)	172	153	137	130	118

Typical application

Modem/LAN card or hub

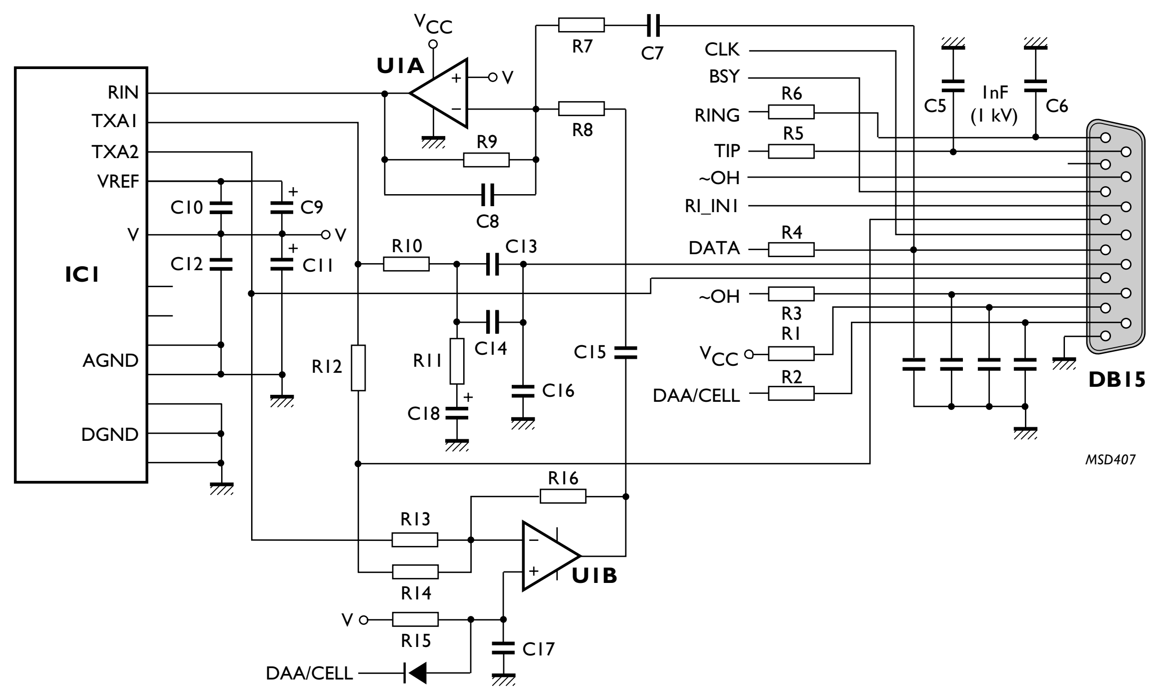


Fig.2 Application of high-voltage MLCCs in a modem/LAN card or hub

The maximum allowed temperature rise depends on the application. It is often set to 10 °C or it may also be calculated from the expression: maximum rated temperature – application temperature, i.e. 125 °C – T_{appl}.

The ESR value depends on the capacitor type and on the frequency f. Typical values may be found in the various detailed specifications of the capacitors. Conversion from current to voltage can be done using the approximation $V_{RMS} = 2\pi.f.I_{RMS}$.

At thermal non-equilibrium, i.e. for short-term electrical loading, the above-mentioned criteria may be relaxed and a capacitor may be loaded to higher values. In this case the DC and AC breakdown values of the capacitor may be the limiting factors. These latter values are published in the Application Note "DC, AC and pulse load of multilayer ceramic capacitors" available from our web site.

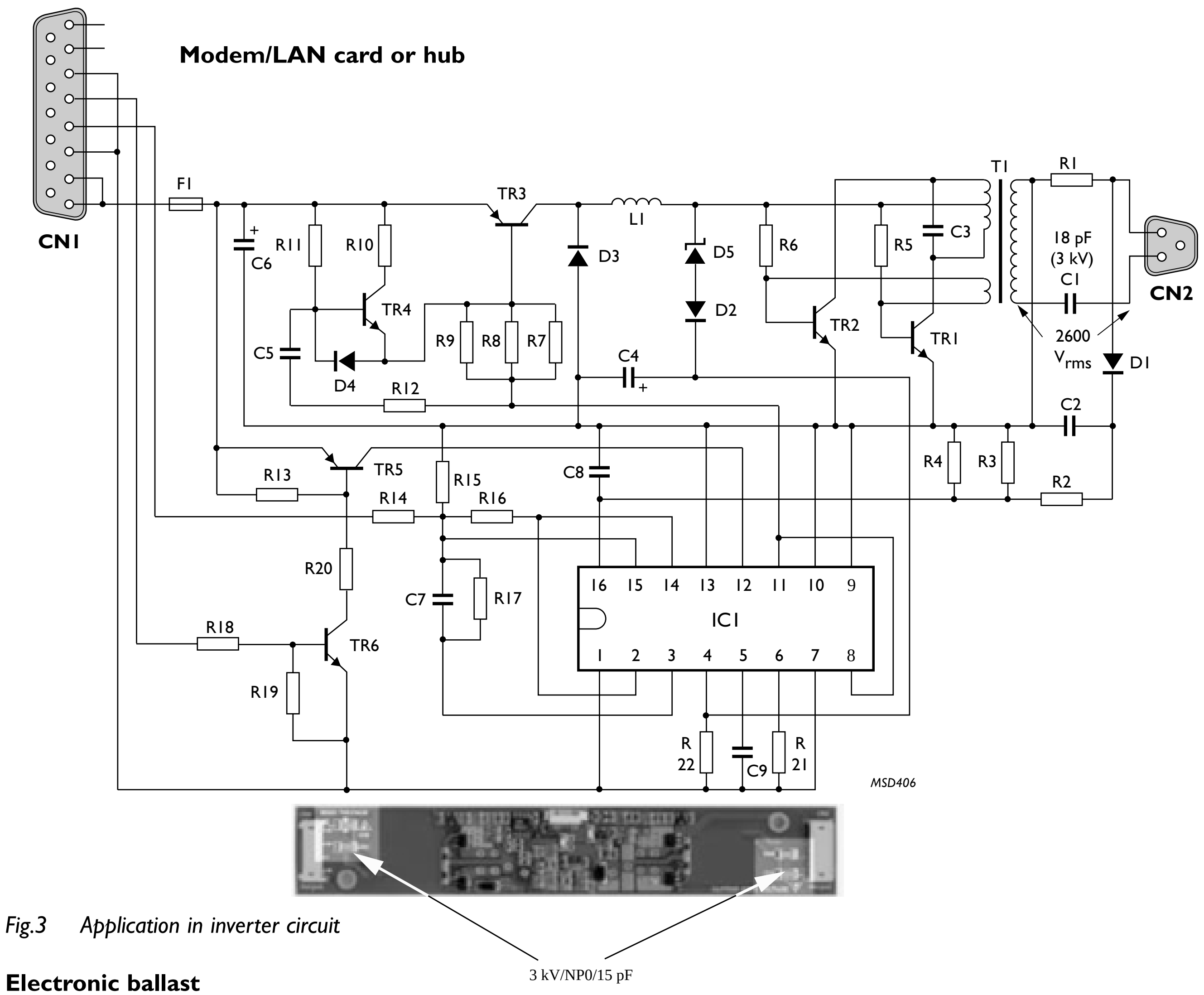


Fig.3 Application in inverter circuit

Electronic ballast

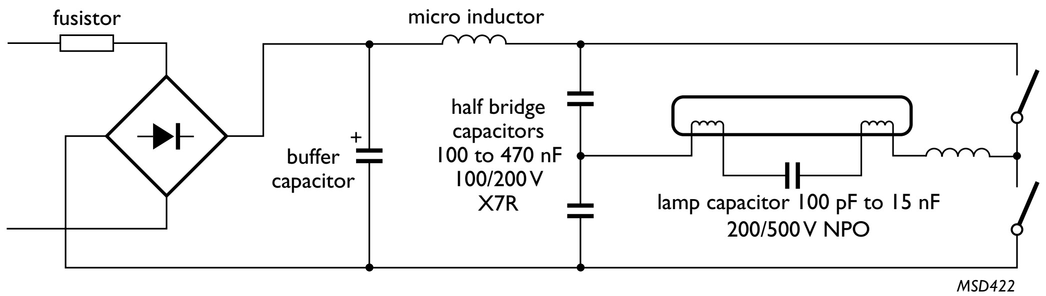


Fig.4 X7R MLCCs in an electronic ballast circuit for fluorescent lighting

Component soldering

Surface-mount components are tested for solderability at a temperature of 235 °C for 2 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Figs 5 and 6.

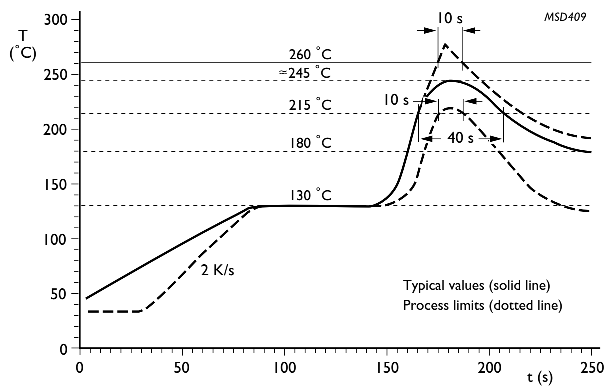


Fig.5 Recommended infrared soldering profile

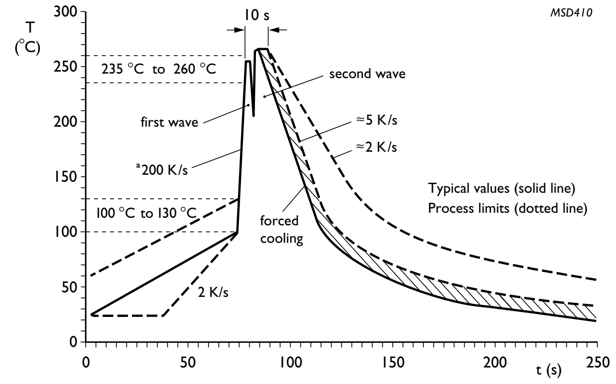
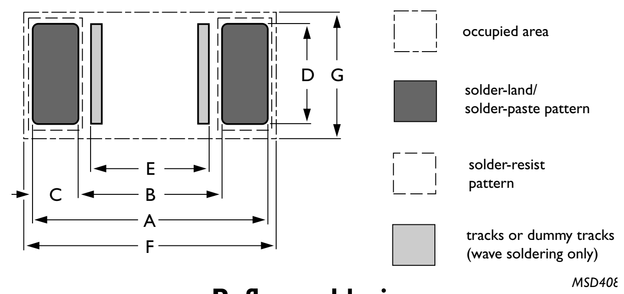


Fig.6 Recommended double-wave soldering profile

Solder footprint



Reflow soldering

Size code	Footprint dimensions							Processing remarks	Placement accuracy
	A	B	C	D	E	F	G		
0805	2.8	0.9	0.95	1.4	0.45	3.2	2.1	IR or hot-plate soldering	±0.25
1206	4.0	2.0	1.0	1.8	1.4	4.4	2.5		
1210	4.0	2.0	1.0	2.7	1.4	4.4	3.4		
1808	5.4	3.3	1.05	2.3	2.7	5.8	2.9	ceramic substrate only	
1812	5.4	3.3	1.05	3.5	2.7	5.8	4.1		

Wave soldering

Size code	Footprint dimensions							Dummy* tracks	Placement accuracy
	A	B	C	D	E	F	G		
0805	3.2	1.4	0.9	1.3	0.36	4.1	2.5	1 x (0.3 x 1.3)	±0.15
1206	4.8	2.3	1.25	1.7	1.25	5.9	3.2	3 x (0.25 x 1.7)	±0.25
1210	5.3	2.3	1.5	2.6	1.25	6.3	4.2	3 x (0.25 x 2.6)	

Fig.7 Soldering footprint (dimensions in mm)

Handling precautions

Soldering precautions

- Note that this product will be easily damaged by rapid heating, rapid cooling or local heating
- Do not subject the product to thermal shock by the use of soldering temperatures greater than 100 °C. We recommend the use of preheating and annealing (gradual cooling) stages during the soldering cycle

Solder gun precautions

Note the following precautions when using a solder gun for replacement:

- The tip temperature must not exceed 280 °C for 3s. To ensure this, use a solder gun with a power of less than 30 W
- The solder gun tip must not come into direct contact with the product

Substrate handling precautions

- Ensure that the PC board is not flexed excessively after the product and other components have been soldered. If necessary, use a support pin to prevent excessive flexing of the PC board
- Mount the products as far as possible from the break line of the PC board and from any line of large holes on the board
- Do not break the PC board by hand. We recommend the use of a machine or jig to break the board

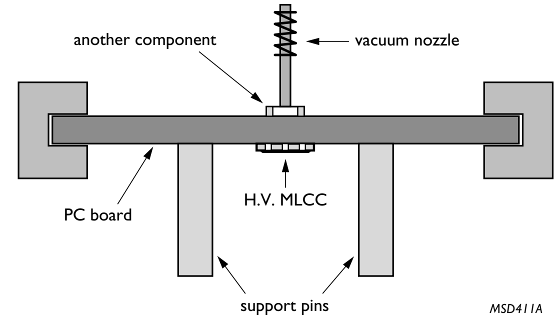


Fig.8 Precautions when handling substrate

Storage conditions

Note the following precautions when storing the product:

- Avoid high-temperature, high-humidity and dusty environments and atmospheres containing corrosive gases (e.g. hydrogen chloride, sulphuric acid gas, hydrogen sulphide) since these can degrade terminal solderability
- Keep the storage temperature less than 40 °C, relative humidity less than 70% and, if possible, do not keep in storage longer than 6 months
- Avoid direct heat and sunshine to prevent the packaging tape from melting and sticking to the product.

Application precaution

The high voltages across the terminations in applications of 1 kV and more may necessitate the addition of a surface coating to prevent external arcing. This is particularly likely in humid conditions.

More information

For more information and data contact your local Yageo sales representative (contact details on the back cover) or visit our web site on **http://www.yageo.com.**

YAGEO - A GLOBAL COMPANY

ASIA

China, Dongguan
Tel. +86 769 791 0053
Fax. +86 769 772 0295

China, Suzhou
Tel. +86 512 825 5568
Fax. +86 512 825 5386

Korea, Seoul
Tel. +82 2 515 0783
Fax. +82 2 3444 3979

Malaysia, Prai Penang
Tel: +60 4 397 3317
Fax: +60 4 397 3272

Malaysia, Puchong
Tel: +60 3 5882 2864
Fax: +60 3 5882 8700

Hong Kong
Tel. +852 2793 3130
Fax. +852 2763 6501

Japan, Tokyo
Tel. +81 3 5833 3331
Fax. +81 3 5833 3116

Singapore
Tel. +65 6244 7800
Fax. +65 6244 4943

Taiwan, Taipei
Tel. +886 2 2917 7555
Fax. +886 2 2917 0148

EUROPE

Benelux, Roermond
Tel. +31 475 385 357
Fax. +31 475 385 589

Finland, Espoo
Tel. +358 9 2707 5851
Fax. +358 9 2707 5852

Hungary, Budapest
Tel. +36 30 3777 441
Fax. +36 94 517 701

Italy, Milan
Tel. +39 02 2411 3055
Fax. +39 02 2411 3051

France, Paris
Tel. +33 1 55 51 84 00
Fax. +33 1 55 51 84 24

Germany, Hamburg
Tel. +49 4121 870-0
Fax. +49 4121 870-297

UK, Leatherhead
Tel. +44 1372 364500
Fax. +44 1372 364567

Spain, Barcelona
Tel. +34 93 317 2503
Fax. +34 93 302 3387

Sweden, Stockholm
Tel. +46 8514 933 55
Fax. +46 8514 933 51

Russia, Moscow
Tel. +7 095 778 5731
Tel. +7 501 430 9627
Fax. +7 095 567 0266

NORTH AMERICA

U.S.A., Addison TX
Tel. +1 214 561 2020
Fax. +1 214 561 2019

For more detailed and always up-to-date contact details of sales offices and distributors please go to our web site at:
www.yageo.com

Printed in The Netherlands

Document order number: 9398 084 33011

Date of release: October 2002

Innovative Service Around the Globe YAGEO

www.yageo.com