Innovative Service Around the Globe YAGEO

MLCCs size 0201

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Phycomp

MLCC size 0201
Meeting the drive for miniaturization

SUMMARY
To meet the drive to ever-greater levels of miniaturization, Yageo has introduced size 0201 MLCCs under its Phycomp brand. Typical features include small dimension and superior high-frequency behaviour compared with 0402 MLCCs.

New 0201 MLCCs

Under its Phycomp brand, Yageo has introduced 0201 (metric 0603) MLCCs (0.6 x 0.6 x 0.3 mm) as the next step in the drive to ever-greater levels of miniaturization. Over the past decades, the dimensions of electronic components have shrunk dramatically. In the 1980s the common dimension was 0805, followed by 0603 in the 1990s. By the end of the millennium, 0402 was introduced and this size will be the most widely used by the end of this year.

Usage trend in descrete passives

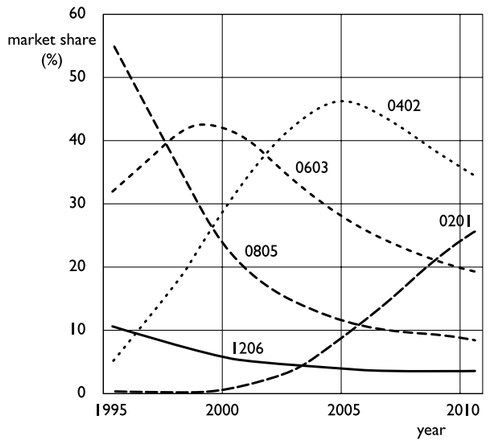


Fig.1 Trends in passive components

At this moment, 0201 is in its introductory phase and is used only in miniaturization-driven applications such as high-frequency modules, mobile phones and other mobile equipment. In the coming years, however, 0201 products will find their way into a broader application field.

Benefits and applications

The ability to shrink passive components into the 0201 package size has come about mainly thanks to the lower working voltage, current, and power dissipation requirements in today's high-frequency circuits. Compact circuit design and smaller components result in better high-frequency capability, due to minimization of component ESL and of the required path length on the PC-boards.

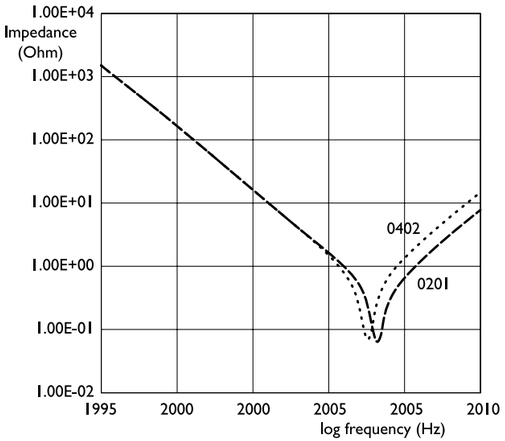


Fig.2 Impedance of 1 nF 0201 MLCC vs 0402

Besides their superior high-frequency behaviour, 0201 MLCCs are only one third the size and one fifth the weight of their 0402 counterparts, which makes them attractive for use in today's small, light equipment.

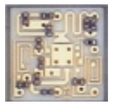


Fig.3 Identical power amplifier using 0402 (top) and 0201 products

Equipment in which the use of 0201 products is expected to grow dramatically in the future includes

- low-voltage, high-frequency, processor-based and hand-held products such as PDAs, GPS receivers, cell phones and digital cameras
- medical electronic equipment such as pacemakers and hearing aids
- electronic modules, e.g. VCOs and power amplifiers
- and general electronics such as tuner and sensors

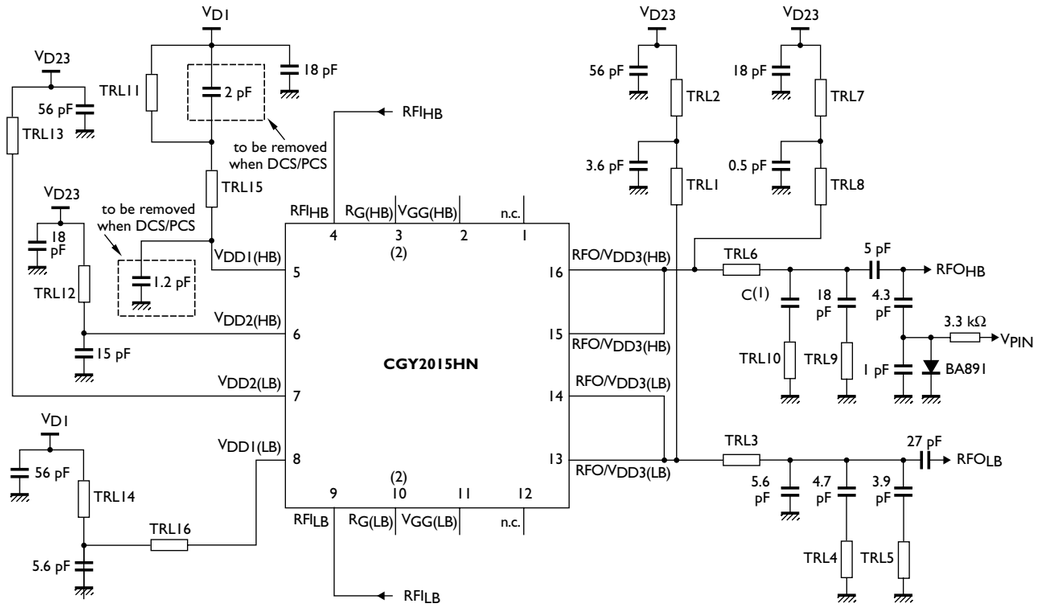


Fig.4 Schematic diagram of 0201 application in a power amplifier circuit for cell phone applications

Processing

One of the main differences between the introduction of 0201 and the earlier introduction of 0402 is that the processing of 0402 was not markedly different from that of the earlier generation 0603 components. In contrast, the introduction of 0201 components requires some adjustment to the assembly process (e.g. screen printing solder paste on to the PC-board, pick-and-place equipment and reflow soldering process).

These ultra miniature components also require solder pads nearly half the size of 0402 components, necessitating very high accuracy screen printing and a dedicated stencil.

(mm)	0201	0402	0603	0805
A	0.30	0.50	0.90	1.40
B	0.21	0.50	0.80	0.95
C	0.23	0.50	0.70	0.90

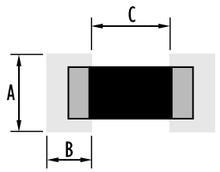


Fig.5 Soldering pad design

A stencil that is too thin would provide good solder-paste release for 0201 components but insufficient paste volume for other surface mount devices. Using a stencil that is too thick, on the other hand, would yield unacceptable solder paste transfer for 0201 components. Stencil thickness must be chosen carefully to determine the optimal, and sometimes a compromise has to be made.
Solder paste also has a high impact on 0201 process assembly yield. Characteristics of pastes that affect this yield include particle size, viscosity, alloy composition and the composition of the solder flux used.

Several manufacturers of screen-printing equipment, solder paste and stencils have now introduced developments to meet the specification for 0201 assembly.

Besides the adaptations in the screen-printing process, the small dimensions of 0201 also greatly influence the accuracy and mechanical lay-out of the pick and place equipment.
Three key issues play an important role:
- Packaging and presentation
- Pick-up tools
- Placement accuracy and repeatability

Packaging and presentation

All 0201 packages are delivered on 8 mm-wide paper tape-on-reel with a pitch spacing of 2 mm. All former feeders were adjusted to 4 mm pitch, which did not meet the necessary accuracy to deal with 0201 components and has become necessary to develop a dedicated feeder.

Pick-up tools

Typically, nozzles used to pick-and-place standard surface mount components are round "pipe" nozzle types which give unacceptable performance for 0201 components. To improve the performance, a rectangular nozzle was developed with two vacuum ports giving better grip on the tiny 0201 components.

Fig.6 The older "pipe" type nozzle (left) and 0201 nozzle (right).

Placement accuracy

The highly compact 0201 components also demanded improvement in placement accuracy. Nowadays there are several equipment manufacturers who offer a complete electronic assembly system that can handle 0201 components with a speed up to 96.000 components/hour, an accuracy of <0.09 mm (at 4 sigma) and a pick-up rate of 99.99 %.

Major defect causes

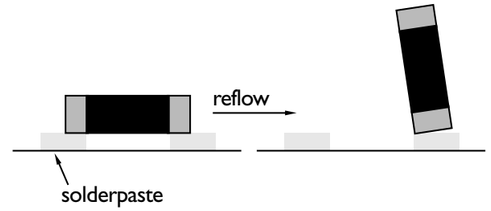
In the processing of 0201 components, some defects might arise. The major ones are:
- Tombstoning
- Solder bridging

These defects also occur with larger components but are more common with 0201 components.

Tombstoning

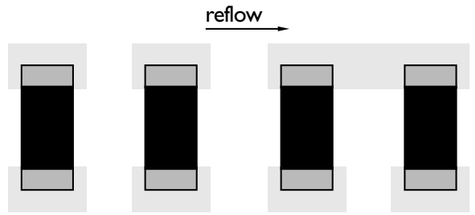
Tombstoning is the effect of the component standing on end after the reflow process. This typically happens when one side is pulled harder than the other, which can be caused by:
- the solder on one side of the component reaching a molten state before the other, resulting in the surface tension of the molten solder pulling the component vertically
- heterogeneous flux wetting speed (the time it takes the solder to wet)
- poor solderability of the component terminations
- heating too fast or inadequate flux activation time
- asymmetric pad design (e.g. one of the end termination on a large ground plane)
- bad positioning inside the reflow oven.

With respect to the last mentioned cause, the components should be mounted on the PC-board in such a way that both end terminations are in the same temperature region. If this isn't possible then it is advisable to reduce the rate of temperature rise within the pre-heat and soldering regions of the oven.
Fig.7 Tombstone



Solder bridging

Solder bridging is the unwanted formation of shortcuts when two adjacent solder pads end up forming one solder joint. Solder bridging is normally caused by poor solder paste deposition.
Fig. 8 Solder bridging



Soldering using nitrogen instead of air reflow is a potential cause of solder bridging since nitrogen produces less oxide and thus allows for faster wetting. Atmospheric reflow will wet the solder joints more slowly, maintaining a balanced force between both end terminations.

Our 0201 MLCCs can be used in assembly processes that use a lead-alloy or lead-free solder pastes. For lead-free soldering we recommend the use of SnAgCu paste (SAC 405). Recommended reflow profiles are shown in Figs 9 and 10.

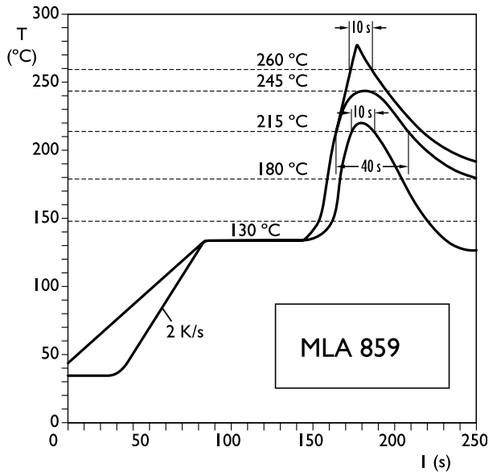
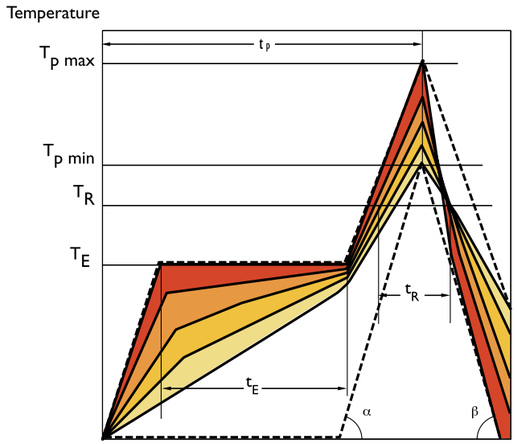


Fig.9 Reflow-profile non lead free.



	$T_{E\ max}$ = 180 °C	$t_{E\ max}$ = 60 s $\left(\text{at } T_{E\ max}\right)$	
		$\alpha_{\ max}$ ≤ 40 °C/s	α = 1•3 °C/s (typical)
T_R =217 °C		$t_{R\ max}$ = 80 s	t_R = 30•60 s (typical)
$T_{P\ mix}$ =235 °C	$T_{P\ max}$ =280 °C	$t_{p\ max}$ = 360 s	t_p = 240 s (typical)
		$\beta_{\ max}$ ≤ 6 °C/s	β = 2•4 °C/s (typical)

Note: 280°C is regarded as the temperature, at wich fast thermal degration takes place for organic meterials like printed boards

Fig.10 Reflow-profile Lead free

Remarks:
- To eliminate tombstoning, preheat to between 130 oC and 160 oC for 1 to 3 minutes
- De-centring by 50 _m is no problem because of the strong self alignment.

Slowly, but surely

0201 is still a niche market but further shrinkage of board sizes and applications will doubtless ensure that the use of 0201 components will slowly but surely increase in the future.

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