



## CLP0603 Package for Diodes

By Henry Karrer

### 1. SCOPE

This application note applies to all products in Vishay's CLP0603 package. Because of the package's small size, it is important to follow the recommended guidelines in regards to:

- PCB footprint design
- Solder mask opening
- PCB soldering pad metallization
- Screen print process
- Solder paste type
- Reflow soldering process parameters

### 2. PACKAGE DESCRIPTION

With its 0.6 mm by 0.3 mm outline, the CLP0603 package is the smallest diode package to date.

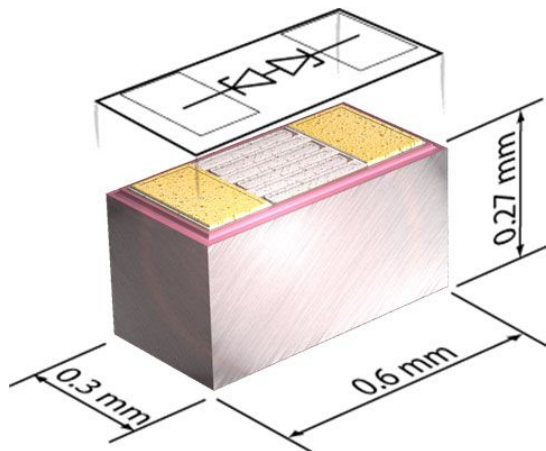


Fig. 1 - Demo of CLP0603 Package

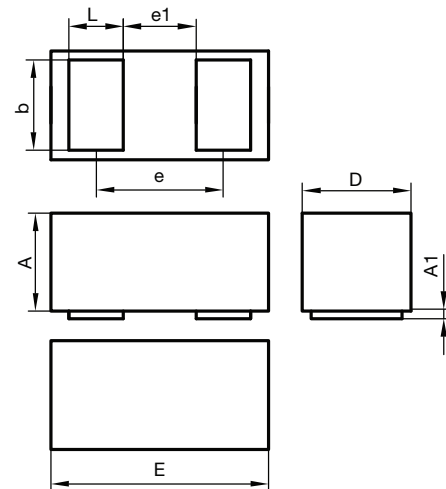


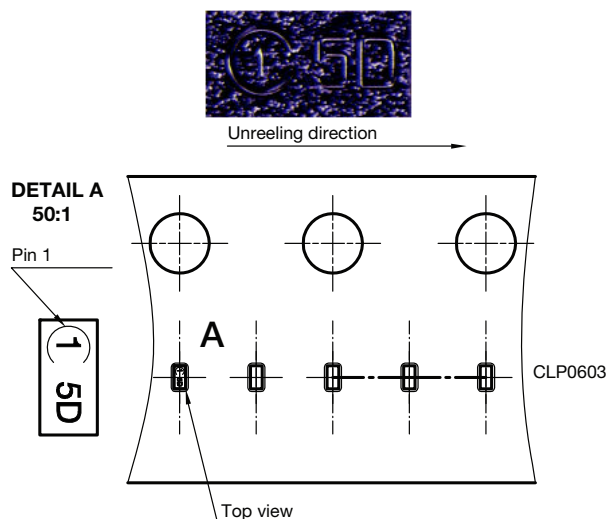
Fig. 2 - Package Dimensions

TABLE 1 - PACKAGE DIMENSIONS

	MILLIMETERS			MILS		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.24	0.27	0.30	9.44	10.63	11.81
A1	-	-	0.02	-	-	0.79
b	0.22	0.25	0.28	8.66	9.84	11.02
D	0.27	0.30	0.33	10.62	11.81	12.99
E	0.57	0.60	0.63	22.44	23.62	24.80
e	-	0.40	-	-	15.75	-
e1	-	0.25	-	-	9.84	-
L	0.12	0.15	0.18	4.72	5.91	7.09

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### 3. DEVICE ORIENTATION IN CARRIER TAPE



The CLP0603 package carries a pin1/cathode identification mark. The orientation of the component is in accordance to IEC 60286 (refer to the attached drawing).

### 4. PCB FOOTPRINT DESIGN

Verified by internal tests, Vishay recommends the soldering pad and solder mask opening design as shown in fig. 3. We recommend using a non-solder mask defined (NSMD) design, as shown below. The reason is that with a NSMD design, the size of the actual solder pad is more accurate (tolerances for copper etchings are smaller compared to a solder mask defined process).

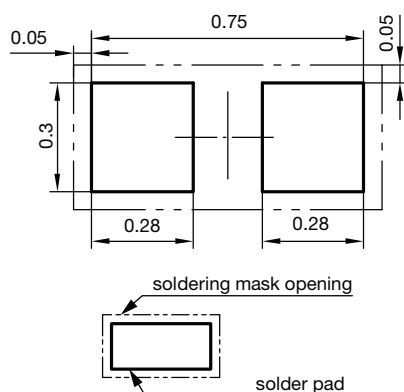


Fig. 3 - Recommended Soldering Pad Design

### 5. PCB SOLDERING PAD METALLIZATION

There are several common pad metallization/finishes, including OSP (Organic Solderability Protectant), HASL (Hot Air Solder Level), and ENiAu. Because of the CLP0603's extremely small size, Vishay only recommends using the electroless Ni/immersion gold over copper pad plating.

### 6. SCREEN PRINT PROCESS

The solder paste is applied to the PCB by using a screen print process. The recommended stencil thickness for the CLP0603 package is 80  $\mu\text{m}$  (the absolute maximum is 100  $\mu\text{m}$ ). The recommended dimensions for the stencil openings are 12 mil (300  $\mu\text{m}$ ) by 8 mil (200  $\mu\text{m}$ ) for both pads. The side wall of the stencil openings should be tapered approximately 5 degrees. An electro-polished finish will support a better release of the paste.

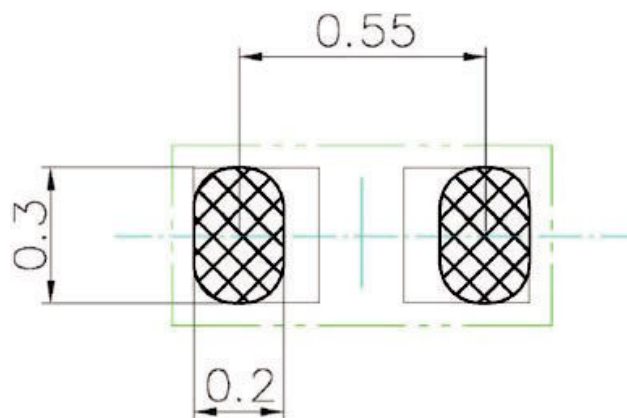


Fig. 4 - Maximum Stencil Openings - for a Stencil Thickness of 80  $\mu\text{m}$

#### Note

- A wider stencil opening will result in a better solder paste release from the stencil. So the best quality can be obtained by using the optimum between the stencil quality, thickness, and opening.

If a tilting of the package is observed, the amount of solder paste should be reduced slightly. Please also take into consideration the direct relation between the amount of solder paste and the package shear strength.

### 7. SOLDER PASTE TYPE

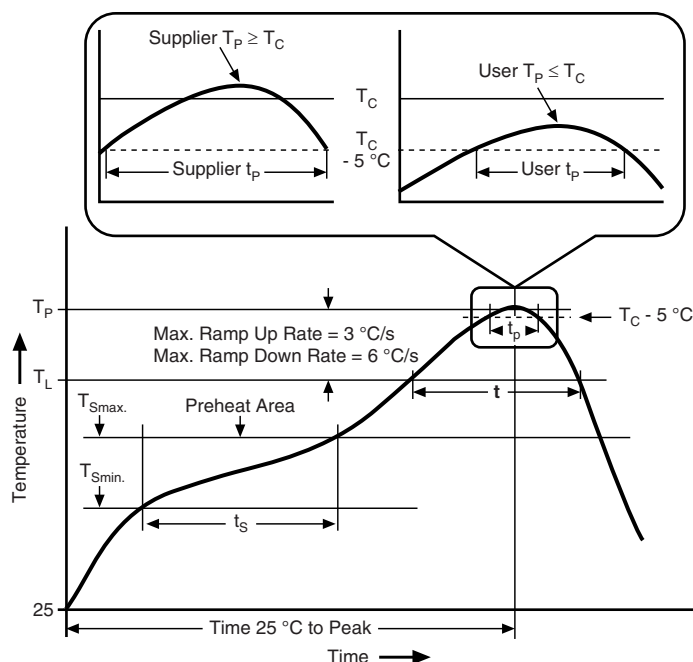
Type 4 solder pastes (or smaller powder sizes) are recommended. In our evaluation we used the Cookson Electronics' Alpha OM-338 CSP (96.5 % Sn/3 % Ag/0.5 % Cu) solder paste.

### 8. REFLOW SOLDERING PROCESS

A standard surface-mount reflow soldering process can be used (reference: JPC/JEDEC J-STD-020D).

However, for an optimum process, recommendations from the solder paste supplier should be considered. Variations in chemistry and viscosity of the fluxer may require small adjustments to the soldering profile.

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**TABLE 2 - CLASSIFICATION REFLOW PROFILES**

PROFILE FEATURE	SnPb EUTECTIC ASSEMBLY	LEAD (Pb)-FREE ASSEMBLY
<b>PREHEAT AND SOAK</b>		
Temperature min. ( $T_{Smin.}$ )	100 °C	150 °C
Temperature max. ( $T_{Smax.}$ )	150 °C	200 °C
Time ( $T_{Smin.}$ to $T_{Smax.}$ ) ( $t_s$ )	60 s to 120 s	60 s to 120 s
Average ramp-up rate ( $T_{Smax.}$ to $T_P$ )	3 °C/s maximum	
Liquidous temperature ( $T_L$ )	183 °C	217 °C
Time to liquidous ( $t_L$ )	60 s to 150 s	60 s to 150 s
Peak package temperature ( $T_P$ ) <sup>(1)</sup>	See classification temperature in table 3	See classification temperature in table 4
Time ( $t_p$ ) <sup>(2)</sup> with 5 °C of the specified classification temperature ( $T_C$ )	20 s <sup>(2)</sup>	30 s <sup>(2)</sup>
Average ramp-down rate ( $T_P$ to $T_{Smax.}$ )	6 °C/s maximum	
Time 25 °C to peak temperature	6 min maximum	8 min maximum

### Notes

- <sup>(1)</sup> Tolerance for peak profile temperature ( $T_P$ ) is defined as a supplier minimum and user maximum
- <sup>(2)</sup> Tolerance for time at peak profile temperature ( $T_P$ ) is defined as a supplier minimum and user maximum

### Notes

1. All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow (e.g. live-bug). If parts are reflowed in other than the normal live-bug assembly reflow orientation (i.e. dead-bug),  $T_P$  shall be within  $\pm 2$  °C of the live-bug  $T_P$  and still meet the  $T_C$  requirements, otherwise, the profile shall be adjusted to achieve the latter. To accurately measure actual peak package body temperatures refer to JEP140 for the recommended thermocouple use.
2. Reflow profiles in this document are for classification/preconditioning and are not meant to specify board assembly profiles. Actual board assembly profiles should be developed based on specific process needs and board designs and should not exceed the parameters in table 2. For example, if  $T_C$  is 260 °C and time  $t_p$  is 30 s, this means the following for the supplier and the user:
  - For a supplier: The peak temperature must be at least 260 °C. The time above 255 °C must be at least 30 s.
  - For a user: The peak temperature must not exceed 260 °C. The time above 255 °C must not exceed 30 s.
3. All components in the test load shall meet the classification profile requirements.
4. SMD packages classified to a given moisture sensitivity level by using procedures or criteria defined within any previous version of J-STD-020, JESD22-A112 (rescinded), IPC-SM-786 (rescinded) do not need to be reclassified to the current revision unless a change in classification level or a higher peak classification temperature is desired.

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**TABLE 3 - SnPb EUTECTIC PROCESS - CLASSIFICATION TEMPERATURES ( $T_c$ )**

PACKAGE THICKNESS	VOLUME mm <sup>3</sup> < 350	VOLUME mm <sup>3</sup> ≥ 350
< 2.5 mm	235 °C	220 °C
≥ 2.5 mm	220 °C	220 °C

**TABLE 4 - LEAD (Pb)-FREE PROCESS - CLASSIFICATION TEMPERATURES ( $T_c$ )**

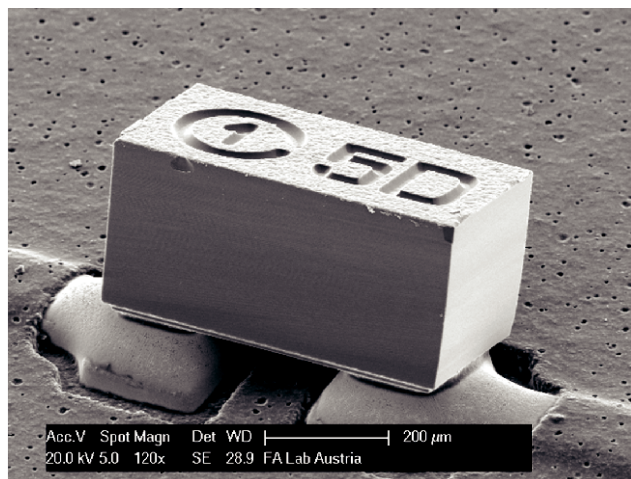
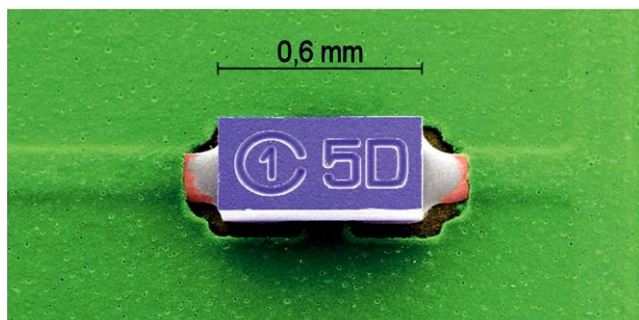
PACKAGE THICKNESS	VOLUME mm <sup>3</sup> < 350	VOLUME mm <sup>3</sup> 350 to 2000	VOLUME mm <sup>3</sup> > 2000
< 1.6 mm	260 °C	260 °C	260 °C
1.6 mm to 2.5 mm	260 °C	250 °C	245 °C
> 2.5 mm	250 °C	245 °C	245 °C

#### Notes

- At the direction of the device manufacturer, but not the board assembler/user, the maximum peak package body temperature ( $T_p$ ) can exceed the values specified in tables 3 and 4. The use of a higher  $T_p$  does not change the classification temperature ( $T_c$ ).
- Package volume excludes external terminals (e.g., balls, bumps, lands, leads) and/or nonintegral heat sinks.
- The maximum component temperature reached during reflow depends on package thickness and volume. The use on convection reflow processes reduces the thermal gradients between packages. However thermal gradients due to differences in thermal mass of SMD packages may still exist.
- Moisture sensitivity levels of components intended for use in a lead (Pb)-free assembly process shall be evaluated using the lead (Pb)-free classification temperatures and profiles defined in table 2 and 4, whether or not lead (Pb)-free.
- SMD packages classified to a given moisture sensitivity level by using procedures or criteria defined within any previous version of J-STD-020, JESD22-A112 (rescinded), IPC-SM-786 (rescinded) do not need to be reclassified to the current revision unless a change in classification level or a higher peak classification temperature is desired.

#### 9. SOLDERING QUALITY INSPECTION

An X-ray inspection system is required to find defects such as shorts between pads, open contacts, and voids within the solder. In addition, a visual inspection by microscope or camera (of appropriate magnification) can be used to inspect the sides of the solder joints for acceptable shape and molten solder.



#### 10. SHEAR TEST COMPARISON

The data below shows a comparison of shear strength after a reflow soldering process.

	VISHAY	COMPETITOR 1	COMPETITOR 2	COMPETITOR 3
Typical shear strength	500 g	350 g	600 g	440 g



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### 11. REWORK PROCEDURE

For rework, the CLP0603 package must be removed from the PCB if there is any issue with the solder joints. Standard SMT rework systems are recommended for this. Due to the small size of the package, the rework system should be equipped with a proper magnification aid.

### 12. INTERCHANGEABILITY OF THE CLP WITH A PLASTIC PACKAGE OF THE SAME SIZE

Based on our studies, the CLP is 100 % compatible with plastic packages of the same size.