DSC 1.0 Technology Application Guideline

We have identified problems with some customers using DSC 1.0 technology due to the soldering process or manufacturing quality and mechanical precision of the carrier board. The use of the DSC 1.0 technology has high demands on the precision and consistency of the manufacturing process.

We urge you to carry out an in-process random sample inspection of the production using X-ray. Due to the basic irreparability of the DSC 1.0 connection, a high reject rate arises in the event of a process error., PHYTEC assumes no liability for these errors. Be sure to perform appropriate tests to verify the suitability and stability of your board delivery and manufacturing for DSC 1.0.

Content

1 Introduction 3
2 DSC 1.0 SOM Design 4
3 Application and Processing 5
3.1 DSC 1.0 SOM Processing..................................5
3.2 DSC 1.0 SOM Delivery Forms..............................5
3.3 Carrier Board Preparation for a Future Change to DSC 1.0 Technology...5
3.4 DSC 1.0 SOM Soldering Requirements.....................6
3.5 Solder Connection Reliability between DSC 1.0 SOM and Carrier Board..7
3.6 Base Board Requirements.................................8
4 Revision History 11

Figures

Figure 1:Solder joints between DSC 1.0 module and base board (metallogra

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1 Introduction

Direct Solder Connect (DSC) technology was introduced to eliminate connectors on existing phyCORE products. This is particularly interesting for very price-sensitive end products.

By using DSC technology, the end product is similar to a flat design with all its characteristics of form factor, with the microcontroller as a integral part of the base board.

This document refers to the first version of DSC technology, hereinafter referred to as DSC 1.0. Meanwhile, we also use advanced versions of DSC technology, which follow other design rules and can be considered separately in its characteristics and application. These advanced versions of DSC technology are not addressed to this document.

Advantages compared to the connector solution:

- No additional costs due to connectors
- Different complexity in the layer structure between base board and DSC 1.0 module

Disadvantages compared to the connector solution:

- Inseparable and irreparable connection between DSC 1.0 module and carrier board makes it difficult to repair the assembly

2 DSC 1.0 SOM Design

Based on an existing phyCORE product, only the footprint or layout of the connector is modified on the microcontroller module. The remaining layout of the module remains unchanged. This is done ,on one hand, to minimize the effort for product maintenance and, on the other hand, to ensure the maximum transferability of existing measurement results (for example, with regard to EMC).

The connector layout consists of two rows of elongated pads in 0.5 mm pitch. We are modifying this elongated pad geometry to place significantly shorter, slightly oval pads instead.

Through additional, mutual offset we achieve a larger pad spacing of at least 1 mm. This increases process stability during later customer processing of the DSC 1.0 modules.

In contrast to the connected version of the microcontroller module, the derived board of the DSC 1.0 module may have been slightly widened by us in the area where connectors used to be. This is done to provide the contact surface required for the electrical test. This feature is product-specific, please refer to the product-specific notes for details.

The result of the modifications is a microcontroller module with pads for direct soldering to a properly prepared base board, the DSC 1.0 module. The manufacturing process is a standard two-sided SMD process in our facility before being delivered to customers.

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3 Application and Processing

3.1 DSC 1.0 SOM Processing

The DSC 1.0 modules - like other SMD components - are set in solder paste by your placement machine. For this purpose, your placement machine must have a sufficiently large vacuum sensor or comparable gripper to remove the module from the delivery packaging. The module must be optically measured by the automatic placement machine so that it can be placed precisely into the holes in the base board.

3.2 DSC 1.0 SOM Delivery Forms

The DSC 1.0 modules are offered in special trays. The trays have standard JEDEC dimensions. However, as the trays are custom-made, they are comparatively expensive. We offer a return and refund of intact trays.

3.3 Carrier Board Preparation for a Future Change to DSC 1.0 Technology

Generally, when we offer a DSC 1.0 variant for the connected microcontroller module, a later change to the DSC 1.0 technology can be carried out with manageable effort.

The following points must be considered in the basic board layout for the connected (plug-in) SOM variant:

- Do not place any components in the area in which the DSC 1.0 module will later rest (directly on your base board). Please note that the DSC 1.0 module may be slightly wider at the connector sides than the plug-in version.
- Prepare the future hole cutout under the module in such a way that no conductors - and of course no components - are placed there.
- Do not place the module too close to the edge of your base board. Do not allow the remaining web of your base board to become too narrow after the hole has been cut out, which could cause the web to bend during soldering. We generally recommend a minimum of 15 mm of remaining web.
- Depending on your vibration requirements, provide base board mounting points near the module to minimize vibration transmission to the module.

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- If you plan to contact the surface of the module during assembly (e.g. for cooling purposes), you have to consider the later change of position of the module. In the plug-in version, the height difference from module board to base board is approx. 4 mm - 5 mm. In the DSC 1.0 version, this will only be a few tenths of a millimeter.
- The DSC 1.0 module must be placed on the top or component side of the motherboard so that it is not exposed upside down to a reflow process. The DSC 1.0 module - like other heavy components - would come loose from the base board if placed on the bottom or solder side during the second reflow soldering process in upside down position, which would inevitably lead to an unpredictable degradation of the connection quality.

3.4 DSC 1.0 SOM Soldering Requirements

The solder joint between the DSC 1.0 module and the base board is a normal SMD solder joint which is remelted in the reflow process. Internally, we use the extremely reliable vapor phase reflow technique and recommend it because of its extremely good heat transfer. Vapor phase soldering reliably prevents the formation of cold solder joints due to insufficient thermal input by means of a temperature-controlled soldering time.

The reflow technology used in each case must be factory-configured by you in such a way that your solder paste and our pre-tinning can be safely remelted on the DSC 1.0 module. We tin with a SAC305 alloy (96.5 Sn/3.0 Ag/0.5 Cu) with a melting range of 217°C to 220°C. Your reflow system must reach these temperatures reliably under all load conditions to avoid cold solder joints and head-in-pillow errors. Use SAC305 compatible solder paste.

Twisting or bending during soldering endangers the uniform contact of the DSC 1.0 solder joints. Ensure sufficient support of the base board during soldering.

We strongly recommend an appropriate and individual qualification of the soldering process before the start of series production, ideally using metallographic cross section analysis. In addition to purely mechanical statements on the solder joint (offset, deflection, etc.), these also allow the energy input to the solder joints to

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be assessed. In addition, we strongly recommend that you read the instructions for appropriate, process-accompanying X-ray control of the soldering process, in order to check the quality of the soldered joints and, in the event of any irregularities, to immediately to stop the flow.

Due to the fact that the pre-tinning of the DSC 1.0 module was also carried out with solder paste, a greater proportion of shrinkage must be expected in the solder connections than in BGAs where balls made of pure tin were applied. This must be taken into account when considering and evaluating the solder joints.

Please bear in mind that the DSC connection is irreparable and we accept no liability for process-related failures.

The following pictures show individual solder joints between a DSC 1.0 module and a base board in a metallographic microsection analysis:

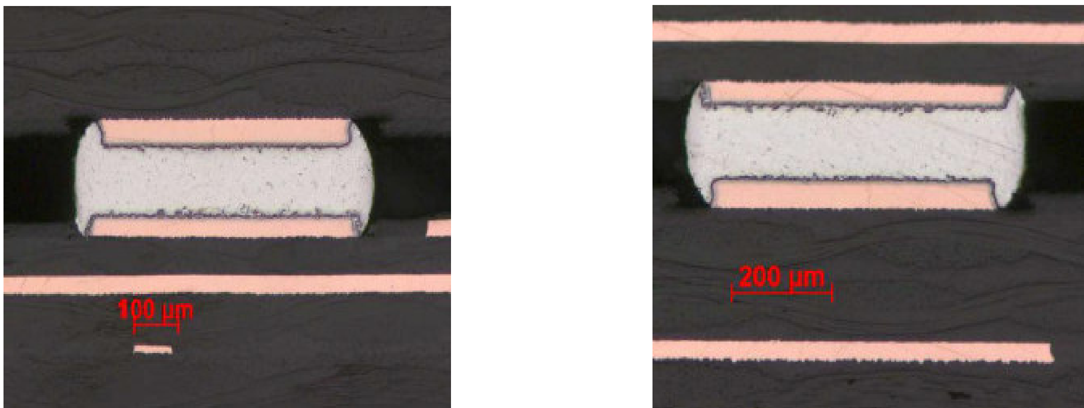

Figure 1: Solder joints between DSC 1.0 module and base board (metallographic microsection analysis)

3.5 Solder Connection Reliability between DSC 1.0 SOM and Carrier Board

In principle, the same statements apply to soldered connections as to other BTC components and their reliability. The aim is to achieve the largest possible soldering gap between the DSC 1.0 module and the base board by applying solder paste as thickly as possible. Keep this

in mind when defining the screen thickness for your solder paste printing.

Due to the fact that the pre-tinning of the DSC 1.0 module was also done with solder paste, a greater proportion of shrinkage must be expected in the solder joints than in BGAs, where balls of pure tin were applied. This must be taken into account when considering and evaluating the solder joints.

The special situation that two elements with the same coefficient of thermal expansion - two printed circuit boards made of normal epoxy material - are soldered together has a positive effect on reliability. This prevents the stress on the solder joints caused by thermal expansion, which is otherwise variable, as is to be expected with other BTC components such as QFNs.

Considering the size and weight of the DSC 1.0 module, your vibration and shock requirements will be among the greatest challenges to solder joints. For mechanical relief, we have coupled the corners of the DSC 1.0 module to the maximum extent possible either by soldered metal sleeves or by large holding pads under compliance with the given boundary conditions. By means of constructive measures, you should eliminate possible oscillations and resonances of the base board as far as possible, for example by using mounting points close to the DSC 1.0 module.

Whether the DSC 1.0 connection meets your requirements in terms of reliability and robustness can ultimately only be proven by you through suitable HALT or comparable load and environmental tests. We strongly recommend that you carry out appropriate research and examinations before using DSC 1.0 technology in series production.

3.6 Base Board Requirements

The DSC 1.0 technology has relatively small signal pads due to the design specifications, as these were derived from the connector footprint (see paragraph 2). The guide elements of the DSC 1.0 module must be relatively precise in order to achieve IPC-compliant placement with regard to overhang and lateral offset for small pads. This includes in particular the through-hole (DK) pilot holes of the base board, which must be manufactured with the necessary

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precision and tolerance to ensure a clean fit and lowering of the DSC 1.0 module. Make sure that the holes are always drilled in accordance with the specifications.

The distortion and deflection of the base board before and during soldering is also an important factor influencing the soldering result. Badly dried printed circuit boards tend to become more twisted during soldering, which endangers contact with the DSC 1.0 module. Use appropriate qualifications and testing to ensure that your base board and soldering process are free of harmful distortion and deflection.

Generally, we use and recommend NSMD pads (Non Solder Mask Defined = not defined by solder resist) for the connection pads between module and base board since only a relatively small solder gap is created. SMD Pads (Solder Mask Defined = defined by the solder resist) can interfere with the module float or lead to short-circuits as there is not enough space for the solder to expand.

A DSC 1.0 module is equipped with a connector at each corner for better mechanical coupling to the motherboard. Two different elements and methods are used, either a soldered sleeve or a large holding pad. The sleeves protrude on the solder side of the DSC 1.0 module and their lengths are selected so that they later penetrate a 1.6 mm thick base board well and remain slightly protruding.

Both the sleeves and the alternative retaining pads must be provided with a sufficient quantity of tin during processing of the DSC 1.0 module. In the case of sleeves, enough tin must be added in order to create a sufficient adhesion to the base board. In the case of retaining pads, the correct amount of tin must be used to ensure that the module floats in smoothly during production and to prevent the module from tilting, with cold solder joints on the signal pads if necessary.

Depending on your vibration requirements, minimize the transmission of vibrations to the module by using mounting points on the base board near the module.

We recommend a base board thickness of 1.6 mm for good mechanical stability during and after soldering. The recess under the module required for the DSC 1.0 module should be

positioned so that the remaining webs of the base board do not become too narrow. Otherwise, deflection may occur during soldering. We recommend remaining webs of at least 15 mm.

We use certain sieve geometries and additional solder preforms in the 0402 design for this purpose, as not enough tin can be applied via the sieve opening alone.
Use our recommendations for the screen geometry and for the number and position of preforms to apply the correct amount of tin. However, the result depends on the design of your base board. As a result, you will need to perform specific tests and qualify the amount of tin based on your product. We are happy to assist you.

If you have any questions or require further information, please contact our support staff.

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4 Revision History

Version	Changes	Date	Author
1.0	Document creation	Aug 1st, 2017	B. Huber
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.A3	Content revision	March 18th 2019	B. Huber
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Kommentar [JE1]: Can be deleted if not needed