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Instructions for use of the DSC Technology

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1 Introduction

The DSC (**D**irect **S**older **C**onnect) technology has been introduced to eliminate plug-in connectors in existing phyCORE products. This is particularly attractive with price-sensitive end products.

With the application of the DSC technology, the final product, in terms of its features, much corresponds to a flat design in which the microcontroller component is realised as an integral part of the baseboard.

Advantages in comparison to the plug-in solution:

- No additional costs incurred by plug-in connectors
- Different complexity in the layer layout between baseboard and DSC module

Disadvantages in comparison to the plug-in solution:

- Inextricable connection between DSC module and baseboard makes repairs difficult

2 How a DSC module is built

Based on an existing phyCORE product or other suitable future product series, only the connector footprint or layout on the microcontroller module will be modified. The rest of the module layout remains unchanged to minimise the product maintenance effort, on the one hand, and ensure a maximum transferability of already existing measurement results, for instance relating to EMC, on the other hand.

The plug-in connector layout consists of two rows of elongated pads with a grid dimension of 0.5 mm. We modify this elongated pad geometry in a way that, in each case, we place significantly shorter and slightly oval pads instead.

By means of additional alternating offset, we achieve a larger pad spacing of at least 1 mm. This increases the process stability during the subsequent processing of the DSC modules by the customer.

In contrast to the plug-in type of the microcontroller module, the board of the DSC module derived therefrom could be slightly broadened by us in the area of the former connector to provide the contact surface required for electric testing. As this is a product-specific feature, please refer to the product-specific instructions for further details.

The modification results in a microcontroller module with pads for a direct soldering with an appropriately prepared baseboard – the DSC module. Prior to the delivery to the customer, it passes through a common two-sided SMD process at our premises.

3 Details on the Connection of a DSC Module with the Baseboard

The principle of connecting the DSC module to the baseboard corresponds to the principle applied to BTC components (Bottom Termination Components) in which the components are placed in solder paste and subsequently soldered.

In comparison, we now have the benefit of a two-side solder application as the DSC module pads have already been furnished with a solder depot at the production stage, which is created by the application of solder paste prior to the module reflow soldering. This constitutes another measure to increase the process stability while positively affecting the reliability of the connection.

The following figures show individual solder joints between a DSC module and a baseboard in a metallographic section analysis:

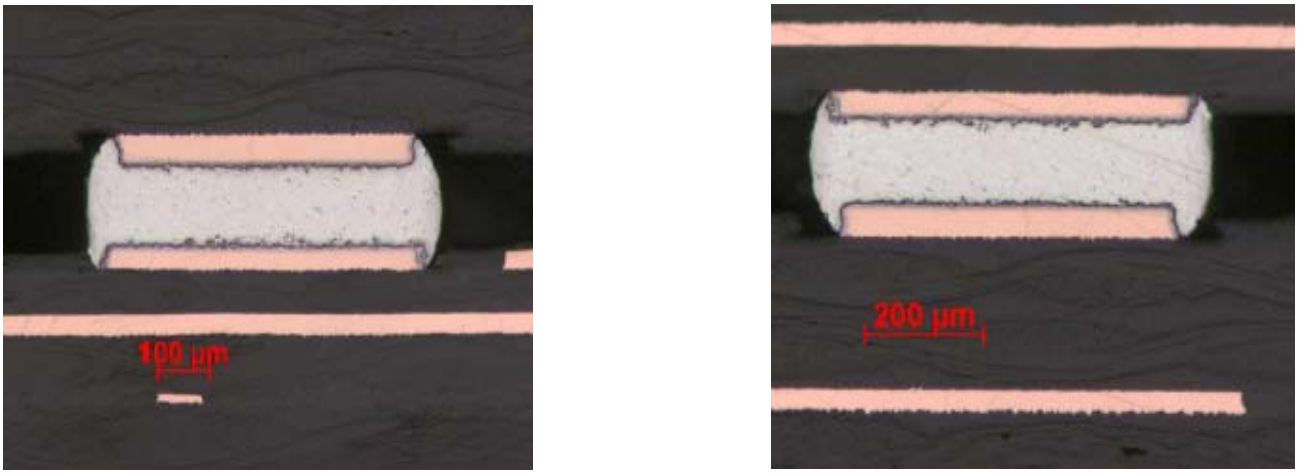

Figure 1: Solder Joints between a DSC Module and a Baseboard (metallographic section analysis)

Generally, we use and recommend NSMD (**N**on **S**older **M**ask **D**efined) pads as connection pads between module and baseboard as these only create a relatively small soldering gap. SMD technology can interfere with the module floating into position.

A DSC module is equipped with a connection element at each corner for a better mechanical interconnection to the baseboard. In this respect, there are two different elements and methods a soldered bushing, on the one hand, and a large retaining pad, on the other hand.

As the plug-in version of the microcontroller module is already equipped with 2 to 4 plated-through retaining holes for fixation with screws, we utilise these for the application of a metal bushing. This metal bushing is guided through the retaining hole from the assembly side and soldered to the module during the production of the DSC module. The bushings project on the solder side of the DSC module and are selected long enough to sufficiently penetrate a baseboard with a thickness of 1.6 mm and still have a slight projection.

As the bushings are simply soldered when the DSC module is soldered to the baseboard in a later step, the bushing automatically locates the module with the correct air gap height after the module floated into position. Additional and potentially harmful forces acting on the module, e.g. resulting from a screw connection, can reliably be prevented by this method, and the module is fixed in the momentum of force equilibrium.

To achieve a sufficient filling between the metal bushing and the plated-through hole an additional tin application is required. Despite the overprint, the amount of solder paste applied using a printer during the standard SMD process and prior to the insertion of the bushing is not sufficient. Use of the Paste-In-Hole technology is not viable, as the tip of the bushing would be contaminated with solder paste during positioning, which would result in an undefined tin application in this area. This impedes or even prevents the positioning of the module on the baseboard in a later stage as the tinned bushings would then not fit into the retaining holes.

For this reason, we decided to use so-called solder preforms. These preforms are cuboids made of pure solder in the size of regular SMD packages. For our purposes, the 0805 package size is well suited. These preforms are supplied on belts or reels in common sizes and can be processed the same way as SMD resistors or capacitors.

When manufacturing the DSC module, we apply the regular solder paste print on the edge of the plated-through hole for the bushing, while deliberately creating an overprint. Subsequently, we place the bushing into the paste and insert it into the hole using the automatic assembly machine. Due to the overprint, the collar of the bushing does not completely cover the paste leaving some parts of the paste visible. Now, using the automatic assembly machine several solder preforms are placed into this paste, which then melt during the reflow process, move to the solder joint, and provide these joints with additional solder. Hereby, we achieve excellent filling ratios in the air gap between bushing and hole. The following sections taken from a 3D model show the preforms placing principle (left: cross section, right: top view):

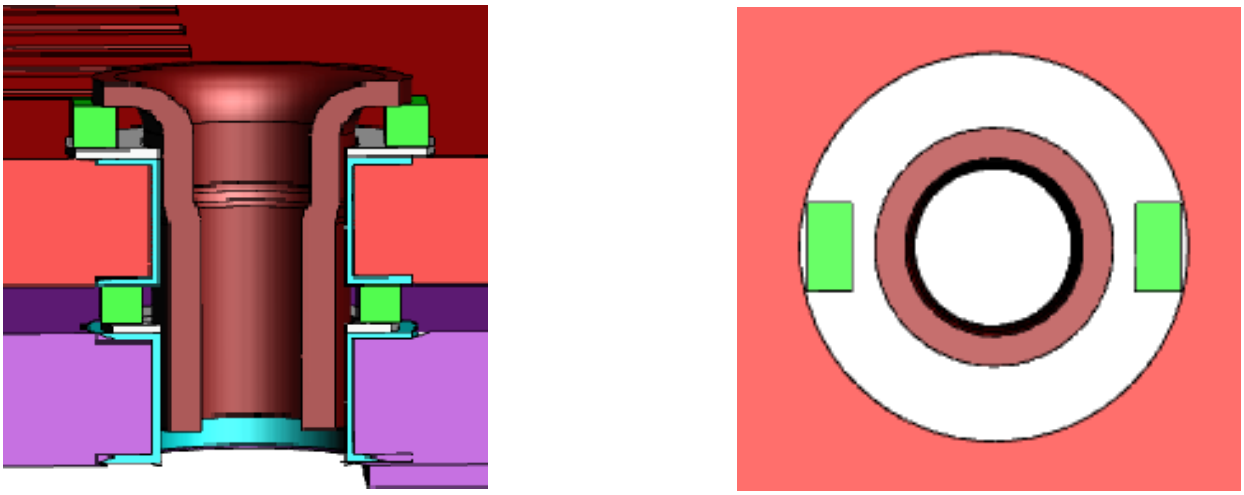

Figure 2: Preforms Placing Principle (3D model)

We recommend using the same procedure for soldering the DSC module to the baseboard. There, a plated-through retaining hole must also be provided, in which the projecting bushing of the DSC module can extend into and subsequently soldered. In this respect, a sufficient filling of the air gap is also important for a good mechanical fixation. Therefore, we also recommend a generous paste application with subsequent positioning of solder preforms on the baseboard. For details, please refer to our product-specific processing guidelines.

We support the otherwise not fixed edges of DSC modules with only two retaining holes with additional retaining pads between the module and the baseboard.

For the sake of completeness, it should be mentioned that we insert a special alignment tool into the bushings during the production of the DSC module ensuring the correct alignment of the bushings to each other. This is required to balance position tolerances of the bushings to achieve a secure and precise further processing on the baseboard.

This process step is only required for the manufacture of the DSC module. When soldering a DSC module to a baseboard this is not required. Thus, you will be only confronted with the tool if you manufacture a custom DSC module yourself.

In this case, module-specific alignment tools must be manufactured and used during the production process. We recommend placing the tool with the automatic assembly machine as the last step of the DSC module assembly process. The tool is made from FR4 and pass through the reflow process together with the module. After the reflow, the tool should be released from the DSC module and re-introduced to the manufacturing process. We recommend to re-introduce the tool on a customised tray with JEDEC dimensions so that a direct return after the soldering is possible within the tray change process. For further details, please contact the development team of your product.

4 Properties of a DSC Module Baseboard

The soldering gap height, i.e. the gap between the DSC module and the baseboard after soldering, will be within the range of a few decimillimetres. This means that there is no space for components on the bottom side of the DSC module and the baseboard, and the baseboard must therefore be provided with a matching hole cutout beneath the DSC module.

Furthermore, no components can be placed in the overlap area between the DSC module and the baseboard, i.e. the area where the DSC module is laid out flat in a later stage. Please note that the DSC module can be slightly wider than the plug-in version of the microcontroller module. For details, please refer to the product-specific instructions.

Depending on the strictness of the mechanical requirements regarding your product, the provision of fixation points in the baseboard near the DSC module is recommended. In principle, the DSC module is a relatively large and heavy SMD component. Any considerations and deliberations concerning such components in view of the specific shock and vibration requirements should also be carried out for the DSC module. By placing suitable fixation points for the baseboard, we were able to pass the vibration tests of the Railway Standards successfully.

We generally recommend to carry out vibration tests or HALT tests to assess the compliance with your specific requirements.

If the baseboard is manufactured as multiblock and soldered with the DSC module in your company, please make sure to utilise a suitable and gentle depanelling method. Avoid unnecessary mechanical stresses, such as baseboard deflection.

To ensure a sufficient mechanical stability during soldering and avoid deflection, the baseboard should not be designed too thin. We recommend a board thickness of 1.6 mm.

5 FAQs

5.1 How are DSC Modules processed?

As with other SMD components, also DSC modules are placed in solder paste by your automatic assembly machine. For this purpose, your automatic assembly machine must be equipped with a sufficiently dimensioned vacuum nozzle or a comparable gripper to remove the module from the delivery packaging.

In addition, we recommend the use of so-called preforms that provide an additive amount of tin to the solder paste print (*chapter 3*). In this way, optimal tin fillets between the metal bushing and the plated-through retaining hole of your baseboard can be achieved. These preforms are offered on common 8 mm belts. For details, please refer to our product-specific processing guidelines.

5.2 What kind of machinable Delivery Forms are offered for DSC Modules?

The DSC modules are offered in special trays or belts. The trays have standard JEDEC dimensions. However, as these are customised products, the trays are comparatively expensive and we therefore offer a return and refund service for intact trays.

In the case of a delivery on belt or reel, you must ensure that you have a feeder for the required belt width at your disposal. Depending on the module, the width is 56 mm or 72 mm. Please refer to the product-specific details.

5.3 What do I have to do to prepare my Project to use a DSC Module in the Future?

In general, if we offer a DSC type for the plug-in microcontroller module switching to the DSC technology in future is possible with manageable effort.

For the plug-in type, the following items must already be provided at the baseboard layout stage:

- Do not place any components in the area on your baseboard where the DSC module will directly be laid out in a later stage. Please note that the DSC module may be slightly wider on each connector side in comparison to the plug-in version.
- Prepare the future hole cutout beneath the module by not placing any conducting paths and, of course, any components.
- Do not place the module too close to the edge of your baseboard to avoid that the remaining web of your baseboard is too thin after execution of the hole cutout. Generally, we recommend a remaining web of at least 15 mm.

- Depending on your vibration requirements, provide fixation points near the module to minimise vibrations at the module.
- If you plan to contact the module surface within the assembly process (e.g. for cooling purposes), in terms of design, you must consider the change in the module position. With the plug-in version, the height difference between the module board and the baseboard is approx. 4 mm – 5 mm. With the DSC version, this will be reduced to a few decimillimetres.
- The DSC module must be placed on the top or assembly side of the baseboard so that it is not subjected to a reflow process in upside down position. If the DSC module is placed on the bottom or soldering side it would detach itself from the baseboard during the second reflow soldering process in an upside down position as it is the case with other heavy components, which, as a consequence, leads to an unpredictable connection quality.

5.4 Do special Requirements apply to the Soldering?

The solder joint between the DSC module and the baseboard is a regular SMD solder joint that is fused during the reflow process. Internally, we utilise the remarkably process safe vapour phase reflow technology.

Due to the hole cutout in the baseboard a good heat supply from the bottom side is ensured, even to the internal DSC pads. This eliminates the risk of shadowing and an insufficient heat input.

Therefore, also tests with common convection reflow systems do not show any noticeable problems regarding the soldering process or soldering result.

Distortion or deflection during the soldering compromise the uniform contact of the DSC solder joints. Make sure that the baseboard is sufficiently supported during the soldering process.

We strongly advise to carry out an appropriate and individual qualification of the soldering process, ideally, using metallographic cross section analyses. Besides the purely mechanical assertions regarding the solder joint (misalignment, deflection, etc.) such analyses enable the assessment of the energy input in the solder joints.

5.5 How reliable is the Solder Connection between DSC Module and Baseboard?

In principle, the same assertions apply to the solder connections as to other BTC components and their respective reliability. The aim is to create a possibly large soldering gap between DSC module and baseboard through a possibly thick application of solder paste. Please take this into account when defining the screen mesh size for your solder paste print.

The unique situation that two elements with the same thermal expansion coefficient are soldered together, i.e. two printed circuit boards made of normal epoxy material, has a positive impact on the reliability. This prevents the stress otherwise caused in the solder connections by different thermal expansion as it can be expected in other BTC components such as QFN's.

Given the size and the weight of the DSC module, your requirements regarding vibration and shock will be one of the greatest challenges for the solder joints. For the purpose of mechanical relief, we have coupled the edges of the DSC module with maximum strength under the given edge conditions by either soldered metal bushings or large retaining pads. If possible, you should eliminate potential oscillations and resonances of the baseboard through design features such as fixation points near the DSC module.

Whether such features are sufficient for the compliance with your requirements can ultimately only be detected by suitable HALT tests or comparable testing procedures.

Please contact our technical support, if you need additional information, or if you have any questions.

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