Application Note
September 2002

Attachment of HW005 Modules on SMLW010 and PKF Footprints

1. INTRODUCTION

The HW005-series is a new-generation DC-DC converter family from TEPS (Tyco Electronics Power Systems) designed for low-power applications requiring tightly-regulated single output voltages ranging from 5V down to sub-1V. It provides up to 6A below 3.3V, 5A at 3.3V, and 4A at 5V, in an industry standard 25x50mm (1" x 2") platform with a low profile of only 8.5mm (0.335") max. The HW005-series (picture shown in Fig. 1) uses an innovative surface-mount connector called CPSB (Column Pin with Solder Ball). These connectors provide compliant SMT attachment with the ability to compensate for coplanarity.

For more detailed information on CPSB connectors, please refer to TEPS Application Note "Application Guidelines For Surface-Mount Power Modules Using Column Pins With Solder Balls." at http://power.tycoelectronics.com/pdf_general.html

Two other products in the 25x50mm (1" x 2") platform are the TEPS SMLW series (shown in Fig. 2) and the MacroDens™ PKF family of modules from Ericsson (not shown). All three series have comparable footprints and similar pin functions (*a complete comparison of the pin functions is given in the Appendix at the end of this document*). Both the SMLW series and the Ericsson PKF series have gull-wing leads, while the HW005-series uses the CPSB connectors. It is reasonable to question the attachment reliability of a HW005 module mounted on a board with SMLW or PKF footprints.

This application note provides details of extensive testing performed by TEPS to alleviate any concerns that might arise. It demonstrates that despite the differences in pad sizes and alignments, it is feasible to use HW005 series modules in place of either the SMLW010 series or PKF series modules without changing the pad layout on the circuit board. The attachments seem to be robust and reliable.

2. FOOTPRINTS AND PADS

The HW005 module has a different footprint when compared to the SMLW010 or PKF modules. Figure 3 shows the footprints of the three families of modules, while a detailed comparison of the recommended pads is shown in Fig. 4. The SMLW010 and PKF modules need rectangular pads while circular pads are recommended for the HW005 series. Both SMLW and PKF pads are larger than that of HW005. In addition to differences in pad shapes and dimensions, the pad centers are also not exactly aligned due to differences in the transverse lead pitch. The HW005 module has a transverse lead pitch of 26.16mm (1.030") while the SMLW holds 27.07mm (1.066") and the PKF 26.80mm (1.055"). As a result (shown in Fig.4), the pad centers are

Fig. 1. Picture of HW005 power module

Fig. 2. Picture of SMLW010 power module

offset by 0.45mm (0.018") when comparing the SMLW and HW005 pads and 0.32mm (0.0125") when comparing the PKF and HW005 pads.

3. SOLDER VOLUME AND SOLDER JOINT

The recommended pad area for HW005 is about 66% of that for the SMLW and 61% of the PKF pad. This implies that with full pad printing, both SMLW and PKF pads will supply sufficient solder paste for HW005. For example, with a standard 0.15mm (6-mil) printing, the solder paste volumes are 1.41mm^3 (85800 mil^3) and 1.54mm^3 (93720 mil^3) with SMLW and PKF pads respectively, while the HW005 requires 0.93mm^3 (57020 mil^3). Therefore, there is certainly no issue of solder shortage due to the different pads.

Of course, the ultimate measure is solder joint quality and reliability. All solder joints in our test samples were inspected and they all met IPC requirements on solder joint width, length, fillet height and minimum thickness (IPC-A610C, "Acceptability of Electronic Assemblies", January 2000, Section 12.2.8). This is evidenced in the cross-section picture of a sample solder joint shown in Fig.5. The solder joint appears robust and the base diameter is much larger than the pin diameter (IPC requires a minimum of the same size as the pin). The fillet height is roughly 1mm (0.040"), twice as much as that required by IPC. The solder also seems to be wetted well on the pad.

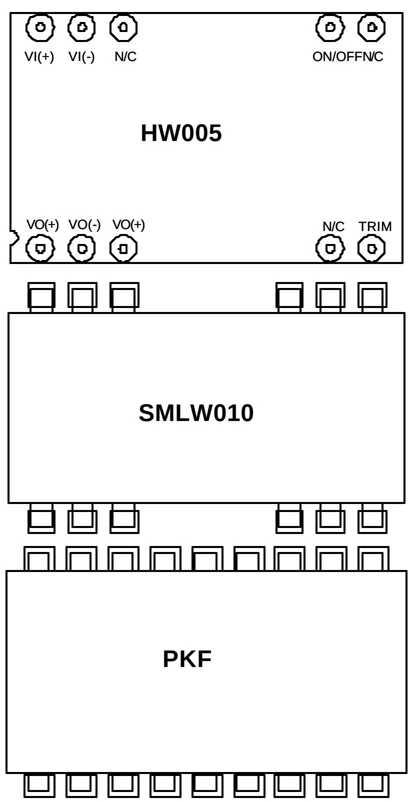


Fig. 3 Footprints of HW005, SMLW010 and PKF

4. THERMAL CYCLING TEST

The thermal cycling test was conducted per MIL-STD-202F, method 107G. The purpose of the test is to ensure that extreme temperature changes do not damage the product. HW005 test

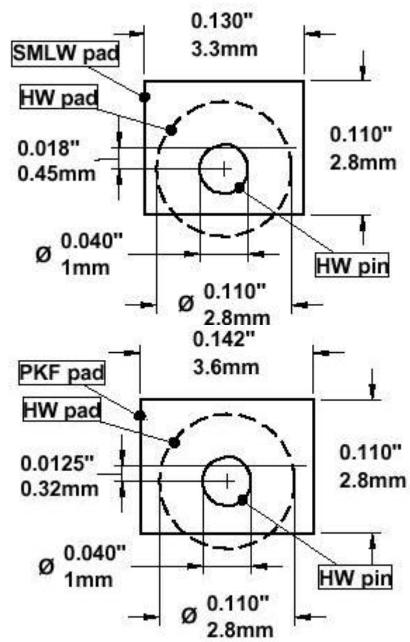


Fig. 4. Detailed sketches of differences between HW005 and SMLW010 pads (top) and HW005 and PKF pads (bottom).

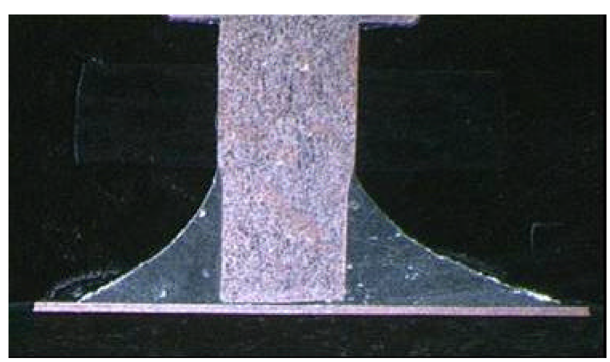


Fig. 5. Picture of a solder joint cross-section

samples were soldered on to daughter cards (Fig. 6) with SMLW010 and PKF footprints. Stencils designed for these footprints were used to screen-print solder paste onto the daughter cards. A total of 24 samples were tested, with 12 each on SMLW and PKF footprints, respectively. The test was performed for 1000 cycles in the temperature range of -55ºC to +125ºC with a dwell time of 30 minutes at each temperature extreme. After every 200 cycles, all units were inspected for physical damage and functionally tested per TEPS Manufacturing Test Requirements (MTR). The acceptance criterion was that there be no evidence of physical damage or failure to pass electrical tests. All 24 samples passed the test without any failures.

5. VIBRATION TEST

The random vibration test is designed to evaluate the robustness of power modules as they are soldered to an evaluation board. The test was performed at random frequencies in a HALT (Highly Accelerated Life Test) chamber. The HW005 units were first soldered to daughter cards then soldered onto a test board (as shown in Fig. 7), which was mounted on a holding plate in the HALT Chamber. There were four modules per test board.

The random vibration was controlled through the z-axis accelerometer mounted on the vibration plate. As shown in the test profile in Fig. 8, the test was started at an acceleration-level of 10 Grms (G root mean square) as measured in the z-axis. The vibration level was ramped from zero to the controlled level in five minutes while the temperature was cycled to –40ºC. Both the vibration at the controlled level and temperature at –40ºC were maintained for 15 minutes. The temperature was then cycled to 100ºC in five minutes, and vibration level and temperature of 100ºC were maintained for 15 minutes. The vibration level ramped to zero in five minutes while the temperature was cycled to 25ºC. The vibration level was increased in 5 Grms increments until a level of 30 Grms was reached with temperatures cycled from –40ºC to 100ºC. The vibration levels and temperatures were recorded and the combined root sum square (rss) vibration levels calculated. All solder joints were inspected between tests at the different vibration levels.

In the first of the two tests conducted, eight HW005 modules were used, with three mounted on SMLW010 footprints, three on PKF footprints and two on HW005 footprints. All eight modules passed the 30 Grms vibration test without failures.

The second vibration test was designed to demonstrate the combined effect of thermal fatigue and mechanical vibration. Four HW005 modules (with two each mounted on SMLW010 and PKF footprints respectively) that passed the 1000-cycle thermal test were checked again in the HALT chamber at a fixed vibration level of 10Grms for 45 minutes. All four modules passed this test without failures.

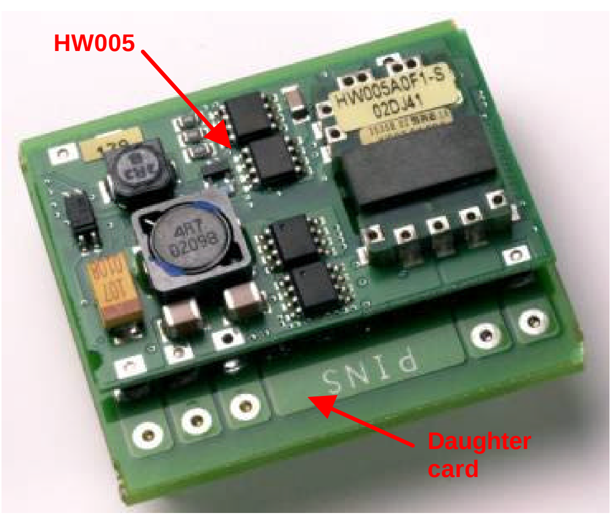


Fig. 6. Picture of a thermal cycling test sample

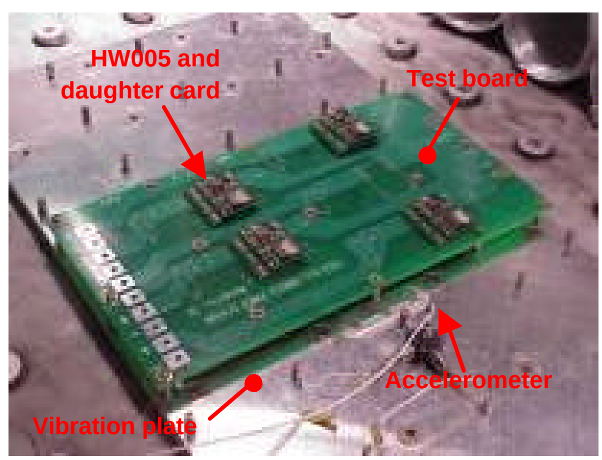


Fig. 7. Picture of vibration test fixture

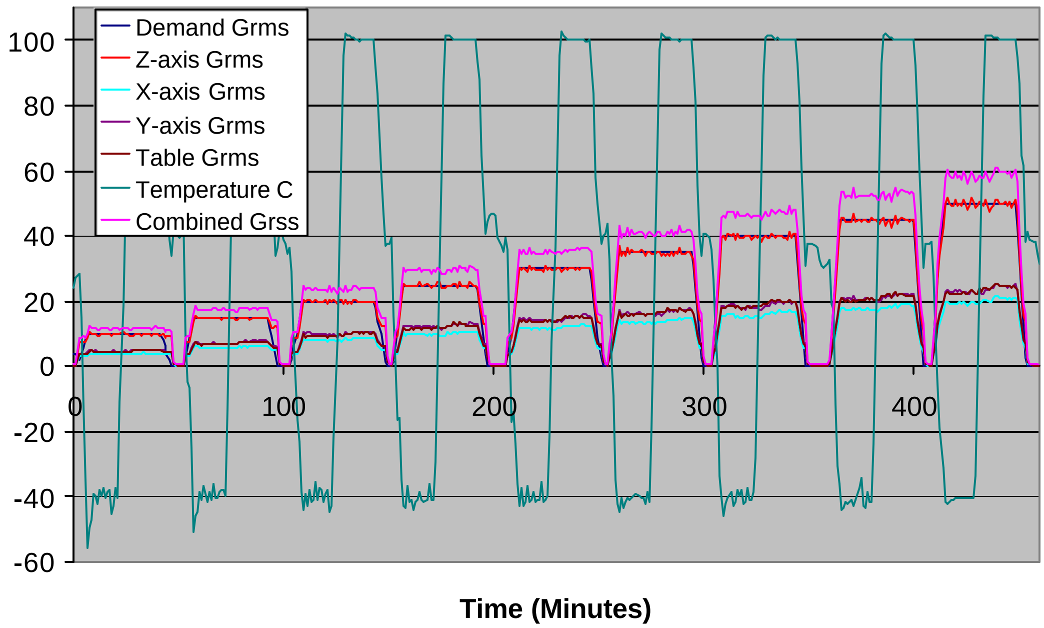
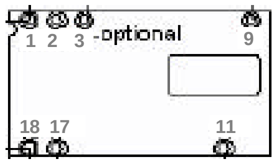
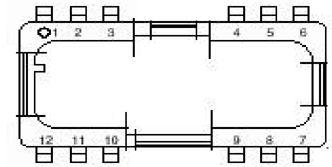
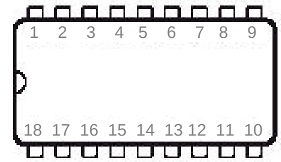


Fig. 8. Random vibration test profile

6. SUMMARY

Despite the differences in pad shapes and sizes, the test results indicate that HW005 modules with surface-mount CPSB connectors can be mounted successfully on a board with SMLW010 or PKF footprints. No design changes are required. Furthermore, the solder joints appear to be as robust and reliable as those of the HW005 soldered on to its recommended footprints.

APPENDIX COMPARISON OF PIN FUNCTIONS OF THE HW005, SMLW AND PKF MODULES

	 HW005 Bottom View	 SMLW Bottom View	 PKF Bottom View
Pin	**HW005 Function**	**SMLW Function**	**PKF Function**
1	V_{out} (+)	V_{out} (+)	V_{out} (+)
2	V_{out} (-)	V_{out} (-)	V_{out} (-)
3	Standard – NC Optional - V_{out} (+)	Trim	NC*
4		NC*	NC*
5		NC*	NC*
6		NC*	NC*
7		NC*	Synchronization input
8		On/Off	Output voltage adjust
9	Trim	Sync (optional)	Connection of Nominal Output voltage Resistor
10		NC*	Turn-on/off input voltage adjust
11	On/Off	V_{in} (-)	Remote control and turn-on/off input voltage adjust
12		V_{in} (+)	NC*
13			NC*
14			NC*
15			NC*
16			NC*
17	V_{in} (-)		V_{in} (-)
18	V_{in} (+)		V_{in} (+)
* NC – Not Connected			

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