High Power ISL70003ASEH High Temperature Operating Life (HTOL) and Overcurrent Abuse

TB502
Rev.0.00
July 16, 2015

Abstract

The ISL70003SEH and ISL70003ASEH devices in the course of production are exposed to a High Temperature Operating Life (HTOL) of 180hrs at +135°C as part of production screening focused on voltage stress infant failures at temperature. This HTOL stress however, does not include a typical high power operational condition where the IC is subjected to both high voltage and high current. This technical brief will demonstrate that the ISL70003ASEH output power structure is robust to power excesses beyond that of nominal operating conditions.

Table of Contents

List of Figures

Introduction

Three ISL70003SEH devices (having the identical power output structure to the ISL70003ASEH) were subjected to a high power HTOL for 2500hrs at T_A = +100°C (T_J estimated to be ~+160°C) each with an input voltage of 13V, an output voltage of 3.3V at an output current of 11A and a switching frequency of 500kHz on the ISL70003SEHEV1Z evaluation platform. This condition produces a time averaged DC power level in the upper FET of 0.94W and in the lower FET of 1.91W. The purpose of this stress test was to monitor for any resulting deleterious effects on device performance, particularly efficiency.

Figure 1 displays the efficiency curves for the 2 devices having both pre and post 2500hr high power HTOL stress. There is minimal over HTOL time difference between the 2 parts shown. The 3rd part (12) did not have a paired pre HTOL curve to display. The pre data was taken to 10A the post data was taken to 11A.

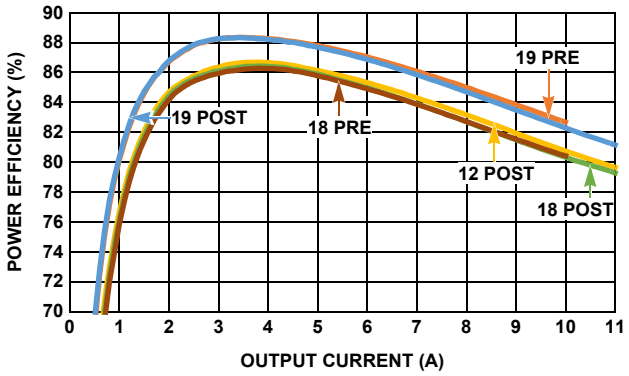

FIGURE 1. PRE AND POST HIGH POWER HTOL EFFICIENCY CURVES FOR $12V_{IN}$ AND $3.3V_{OUT}$

Derating Current Capability

Most space programs issue specific design derating guidelines for parts, but these guidelines take the pedigree of the part into account. For instance, a device built to MIL-PRF-38535, such as the ISL70003ASEH, is already heavily derated from a current density standpoint by the vendor.

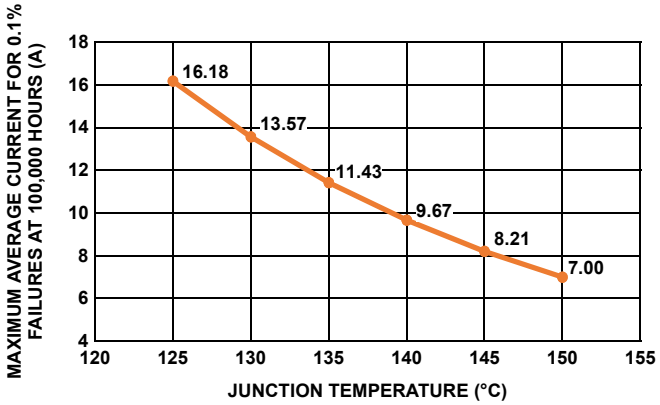

FIGURE 2. CURRENT vs TEMPERATURE

Figure 2 shows the maximum average output current of the ISL70003ASEH with respect to junction temperature. These plots take into account the worst-case current share mismatch in the power blocks and the current density requirement of MIL-PRF-38535 (< 2 x 10^5 A/cm^2). The plot clearly shows that the ISL70003ASEH can handle 7A at +150°C from a worst-case current density standpoint, whereas the device is rated to a maximum of 6A.

In the high power operational 2500hr test the devices junction temperatures were ~+160°C with an 11A current load, which is in excess of 2X the extrapolated maximum average current of 5A using Figure 2. This intentional overstressing of both die temperature and current through the devices was to prove that protracted operation at these levels has no detrimental effects.

Overcurrent Abuse Testing

Two abuse stress tests of the ISL70003ASEH output power structure were done at an ambient room temperature;

1. To confirm peak currents of ~30A upon turn on was not damaging. This was repeatedly done on a small number of devices and although all devices would not stay on at those current levels for longer than a few seconds, no functional degradation was evident.
2. Devices were turned on into 20A loads and each would stay on for a few minutes before turning off. Again under rated output current conditions no functional degradation was evident.

Conclusion

In conclusion, the ISL70003SEH and ISL70003ASEH devices (sharing a common output power structure design) have proven to be robust when subjected to a number of tests with excessively higher than nominal current loading conditions that would expose design and manufacturing weaknesses. Working within the recommended output current guideline and even with transient and temporary protracted excursions beyond it, the ISL70003ASEH is uncompromised in reliability and performance.

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(Rev.4.0-1 November 2017)

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