HITEC Sensor Developments (Pvt) Ltd.
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Failure Analysis Report

OPA333AMDBVREP Amplifier Output Instability During Temperature Variation

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Electronic approvals:

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1 Scope

This report provides an overview of the issue of OPA333AMDBVREP amplifier output instability during the temperature testing and the details of the conducted investigation, root cause as well as the recommendations and preventive actions in the form of a failure analysis report.

1.1 References

Document Identification	Description
SGLS383B	OPA333AMDBVREP Datasheet

1.2 Abbreviations and Acronyms

The following is a list of abbreviations and acronyms used in this document:

Acronym	Definition
EMS	Electronic Manufacturing Service
ESD	Electrostatic Discharge
PCB	Printed Circuit Board
TBA	To Be Added

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2 Failure Identification:

2.1 Problem Overview:

OPA333AMDBVREP device has been used in designing the signal amplifier for an in-flight sensor which has gone through the qualification testing with no anomalies back in 2023 and now it is in the initial phase of production. Please refer the circuit schematic in the Appendix.

During the temperature cycling of the sensor with PCB assembly, some units started to show instability at certain temperature points which were random. Refer Figure 1. This is occurring at a 3% rate and needing a resolution for a smooth production process.

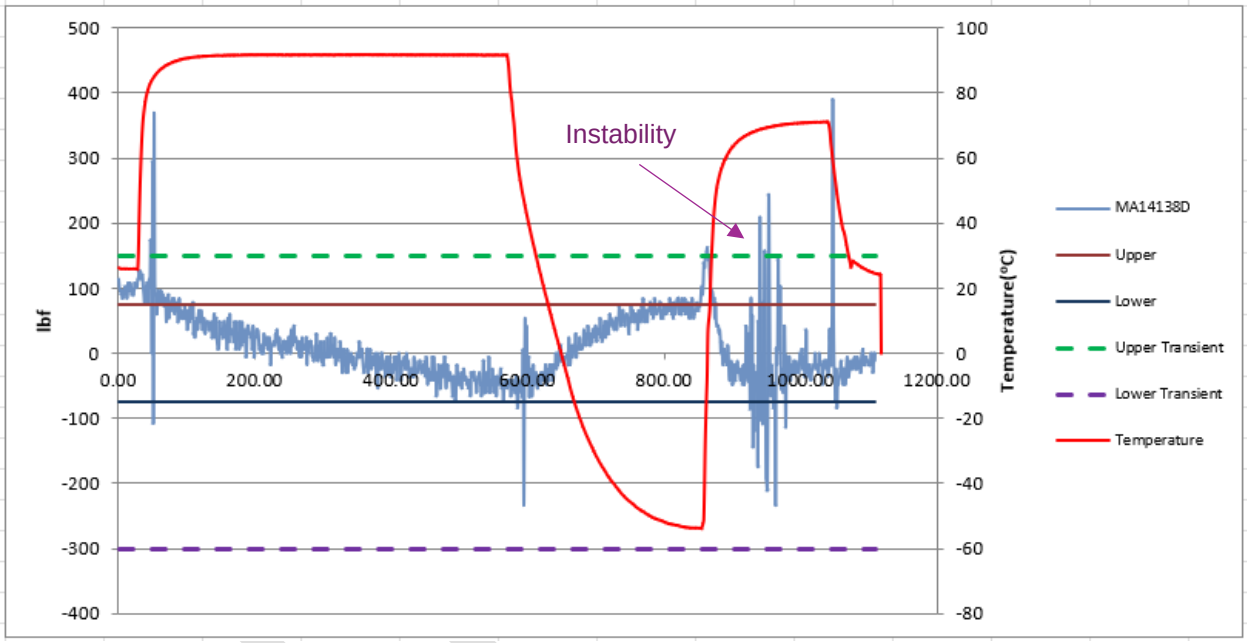

Figure 1: Output becomes unstable during temperature cycling

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3 Failure Analysis:

3.1 Initial Investigation:

Initially the data logging setup was investigated for any erroneous events and confirmed that the instability of the output was intrinsic to the sensor itself.

Then the sensing element was investigated if that was the source of the instability. It could be ruled out using two amplifiers; one was with no fault while the other was showing unstable output during the temperature cycling, with the same sensing element.

Next PCB level investigation was initiated. There it was observed either U2 and/or U8 replacement could cure the issue. Refer Figure 2

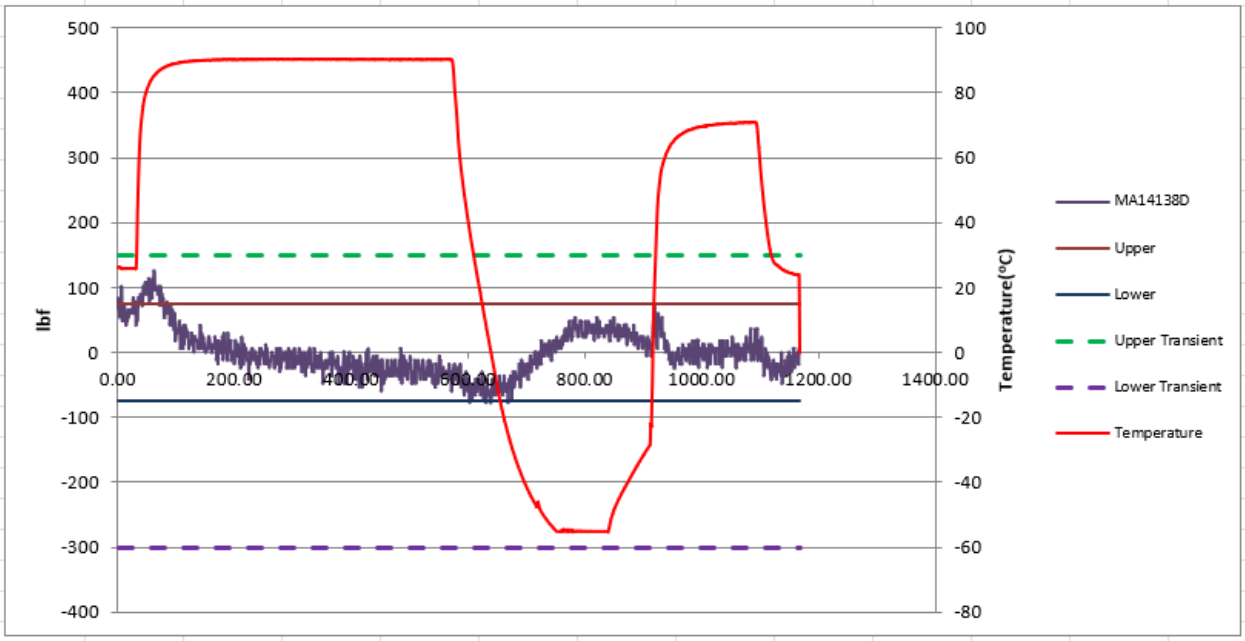

Figure 2: Instability disappeared after U2/U8 replacement

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3.2 Failure Mode Investigation:

Following potential failure modes were considered.

3.2.1 Design flaw which could result in lower phase margin at certain temperatures due to manufacturing tolerances.

During the design phase the stability was checked at nominal conditions with spice simulation. Refer Figure 3

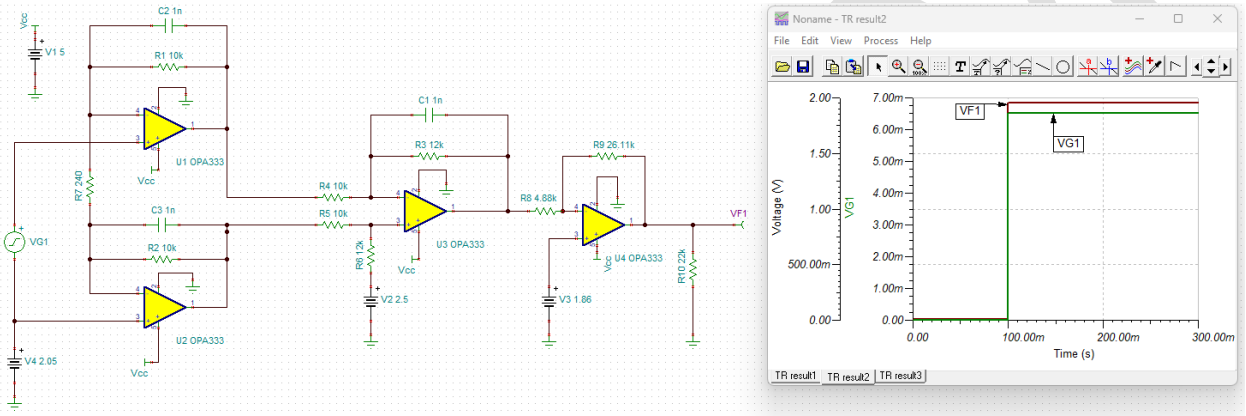

Figure 3: Spice Simulation

This was further verified in the TI E2E Amplifiers forum under the ticket "*OPA333A-EP: Stability check of OPA333*"

Therefore, this failure mode is considered to have a lower probability of occurrence.

3.2.2 Handling/Processing anomalies at EMS.

The EMS was audited for ESD and reflow profile. No anomaly could be found. Hence this failure mode is considered to have a very lower probability of occurrence.

3.2.3 Manufacturing inconsistency of OPA333AMDBVREP devices.

A lot of OPA333AMDBVREP is being used so far in the production PCBs and some devices from the lot showed the unstable behaviour during temperature cycling. The issue could be cleared by replacing the devices from an in-house batch. Corresponding lot/batch details are mentioned in the Appendix. Therefore, this failure mode is considered to have a higher probability of occurrence.

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4 Root Cause Analysis

As per section 3.2, Table 1 summarizes the root causes with an assigned probability of occurrence.

Table 1:Probable Root Causes

RC#	Probable Root Cause	Justification	Probability
1	Inadequate phase margin at certain temperatures due to manufacturing tolerances	Stability analysis was performed and no flaw was observed. This was verified by a TI expert in the E2E forum. Yet HITEC is open for any design improvement suggestions from TI expertise.	0.2
2	Handling/Processing anomalies at EMS	This was audited and confirmed to have no anomalies	0.1
3	Manufacturing inconsistencies	The issue could be observed with the same batch in random fashion and resolved by replacing from a different batch	0.7

TBA

5 Suggested Containment/Preventive/Corrective Actions

Containment Action: Screening the defective devices with in-process temperature cycling

Preventive Action: TBA

Corrective Action: TBA

6 Conclusion

TBA

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7 Appendix

7.1 Application circuit schematic

7.2 OPA333AMDBVREP Lot/Batch details

Lot/Batch Description	Date Code	Lot Code
Used in Production PCBs	2322+5	3097529UT2
In-house Buffer Stock	2321	3097529UT2