Application Note

Output Amplitude Variation in TX08D Under HTOL Stress

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ABSTRACT

Most semiconductor devices have lifetimes that extend over many years at normal use. However, we cannot wait years to study a device; we have to increase the applied stress. Applied stresses enhance or accelerate potential fail mechanisms, help identify the root cause, and help TI take actions to prevent the failure mode.

In semiconductor devices, some common accelerants are temperature, humidity, voltage, and current. In most cases, the accelerated testing does not change the physics of the failure, but does shift the time for observation.

The TX08D device (referred to as *device* in remainder of document) is a highly integrated 8-channel linear amplifier available in 12mm × 12mm package and capable of generating arbitrary waveform up to 180Vpp signal swing. This device is an excellent choice as a transmitter for designing premium ultrasound systems. The application note explores the variation in the amplifier gain, a key parameter of the device, when subjected to accelerated tests according to the JESD22A-108 standard.

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Trademarks

1 Introduction

1.1 High Temperature Operating Life

High Temperature Operating Life (HTOL) is used to determine the reliability of a device at high temperature while under operating conditions. The test is usually run over an extended period of time according to the JESD22-A108 standard. This is a part of standard Texas Instruments Qualification test.

The conditions used for HTOL of TX08D are mentioned below:

1. All the channels are excited in both linear amplifier and pulser mode.
2. The devices are operated at a temperature of 125°C to accelerate any parameter drift.
3. The pattern transmitted by the linear amplifier is a single cycle, 5MHz, 180Vpp pattern which drives a load of 220Ω||220pF, while that transmitted by pulser is 200Vpp and covers all the possible device transitions (shown in Figure 1-1).

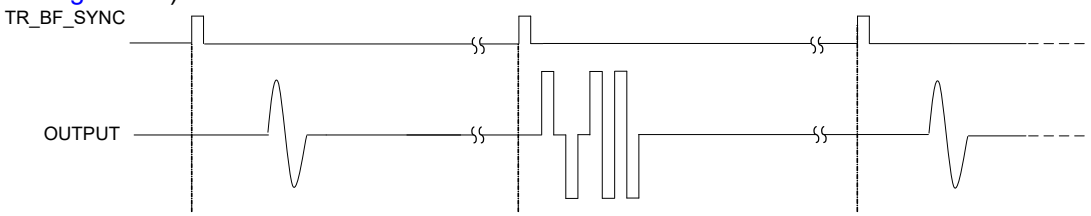

Figure 1-1. HTOL Pattern

4. This condition is maintained for 1000 hours in such a way that the linear amplifier transmits over 1 Million cycles.
5. Around 80 devices are stressed in this condition.

The HTOL stress can lead to some variation in different parameters. The gain of the linear amplifier channel is one such parameter which is being explored here.

1.2 Amplifier Gain

The output swing of the amplifier is controlled by two knobs – digital gain and analog gain. The digital gain sets the 12 bits input to the DAC, which then converts the DAC code to 2Vpp swing at the input of the amplifier. The analog gain is controlled by changing the input resistor (RGAIN) and keeping the feedback resistor fixed, as shown in Figure 1-2.

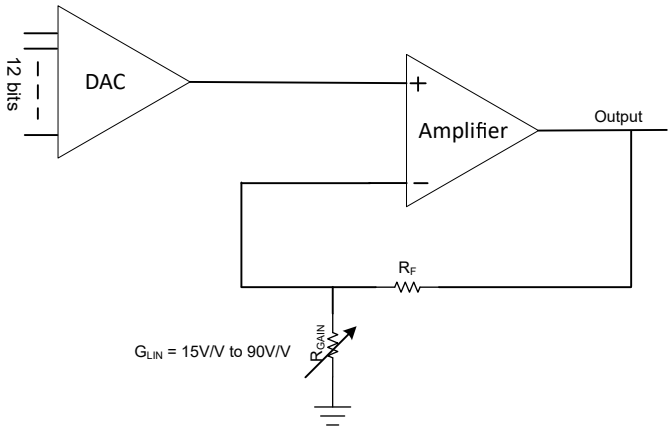

Figure 1-2. Simplified Block Diagram

$$\text{Output Swing}\left(\text{Vpp}\right) = \left(\text{ANA\_GAIN\_CHn} \times \text{DIG\_GAIN\_CHn} \times 2\right) / \left(2^{12} - 1\right) \quad (1)$$

Of the parameters that determine the output swing, only the analog gain (ANA_GAIN_CHn) has a possibility of varying as this is determined by components like resistors, which can have drift variations over time.

2 Gain Variation

To analyze the variation of gain, the fundamental power of the output waveform can be computed before and after HTOL. Figure 2-1 shows the difference between the gains before and after HTOL stress across all the devices and channels. As can be seen here, the variation in gain after the 1000-hour HTOL is in the order of ±0.05dB.

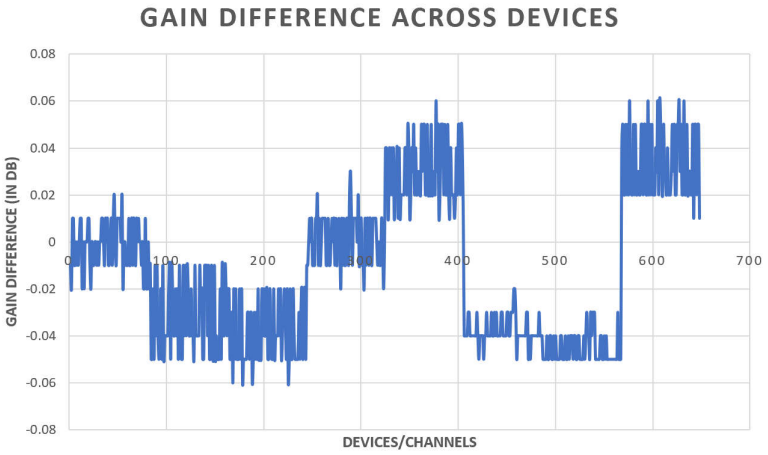

Figure 2-1. Gain Difference Before and After HTOL

To analyze the impact of the above variation to gain matching, the distribution of the fundamental power for a given gain can be computed. Figure 2-2 shows the distribution for gain 90V/V.

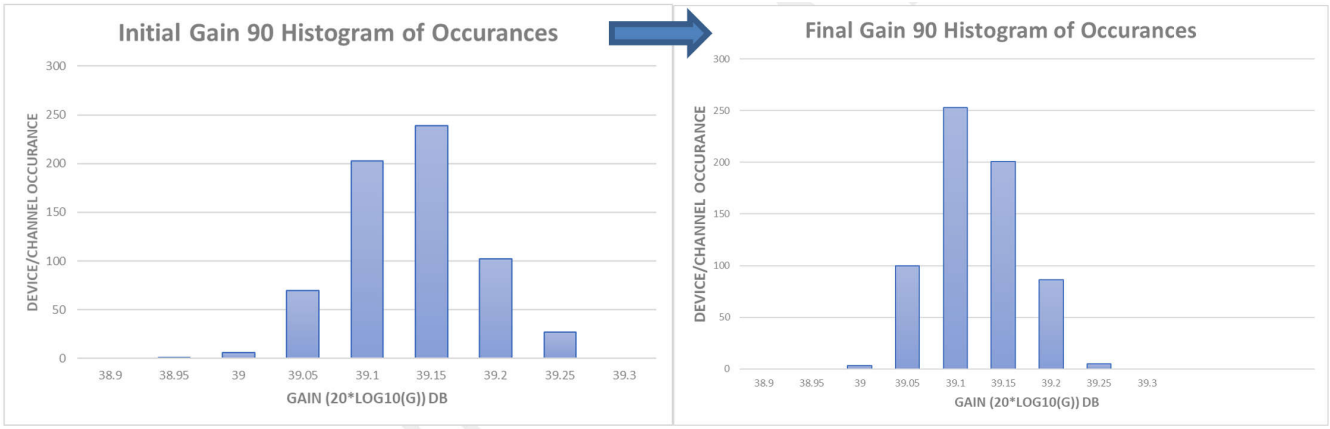

Figure 2-2. Gain Distribution Before and After HTOL

The previous data suggests that the gain across devices is more or less similar before and after HTOL and remains at around 0.3dB. Accounting for other process variations and adding some margin, the matching is within ±0.25dB.

3 Summary

HTOL test done on TX08D device, according to JESD22-A108 standard, suggests that even though the gain is varying due to the applied stress, the impact of the variation on gain matching is very small. Based on this, the conclusion can be that the gain matching of ±0.25dB or ±2.5% holds even when the device is subjected to standard HTOL stress tests.

4 References

- Texas Instruments, *TX08D 8-Channel Ultrasound Transmitter*, data sheet.

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