

VSWR Testing of NPTB00050

Introduction

This application note describes VSWR stress testing of the NPTB00050 device operated at P_{3dB} and being subjected to 10:1 and 20:1 VSWR conditions at both room temperature and at an elevated flange temperature of 90°C.

Previous qualification of Nitronex transistors involved stressing devices with 10:1 VSWR mismatch at room temperature, however, in order to meet more stringent customer requirements characterization has been extended to a higher mismatch condition of 20:1 at an elevated flange temperature of 90°C.

Test Setup and Procedure

The NPTB00050 was mounted in a 50 ohm application board tuned for CW operation at 3.0 GHz. The device was biased at 28V, 300mA and operated at P_{3dB} to nominally deliver 45-50W and 55% drain efficiency at room temperature.

Ten different devices from two different process lots were utilized for the room temperature testing. Under P_{3dB} operation, the output port of the application board was subjected to two different VSWR conditions: a 10:1 and 20:1 mismatch. Load-pull tuners were used to rotate the phase angle of the mismatch from 0° to 360° in 10° increments over a time span of 40 seconds.

Three different devices from a single process lot were utilized for the 90°C flange temperature testing. Under P_{3dB} operation, the output port of the application board was subjected to two different VSWR conditions: a 10:1 and 20:1 mismatch. Load-pull tuners were used to rotate the phase angle of the mismatch from 0° to 360° in 5° increments over a time span of 120 seconds which is equivalent to a dwell time of ~1.6 seconds at each phase angle.

CW power sweeps are collected prior to VSWR stress testing and also after being subjected to a 10:1 VSWR mismatch and again after being subjected to a 20:1 VSWR mismatch.

Figure 1 depicts the test setup in the load-pull system, and figure 2 depicts a typical power sweep of a device pre-stress, post 10:1 and post 20:1 VSWR testing.

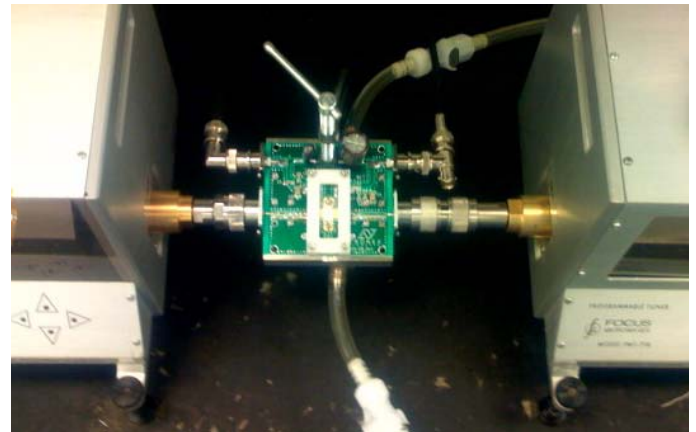


Figure 1: VSWR Test board in Load-pull system.

Test Results at Room Temperature

Changes in power, gain, and peak drain efficiency (DE) are monitored and compared between pre-stress and post-VSWR testing.

As exhibited by the results in figure 2, the impact of the VSWR testing on the NPTB00050 was minimal, resulting in approximately 0.5 dB loss in P_{3dB} power and a few percentage point loss of DE. Moreover, the difference between the 10:1 and 20:1 VSWR was negligible.

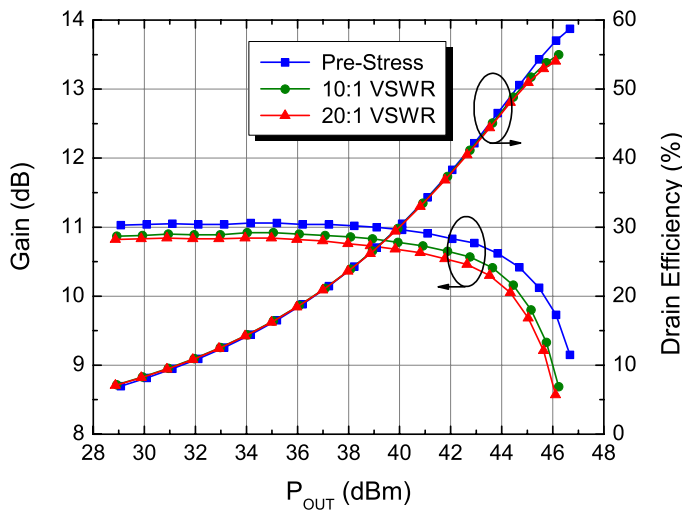
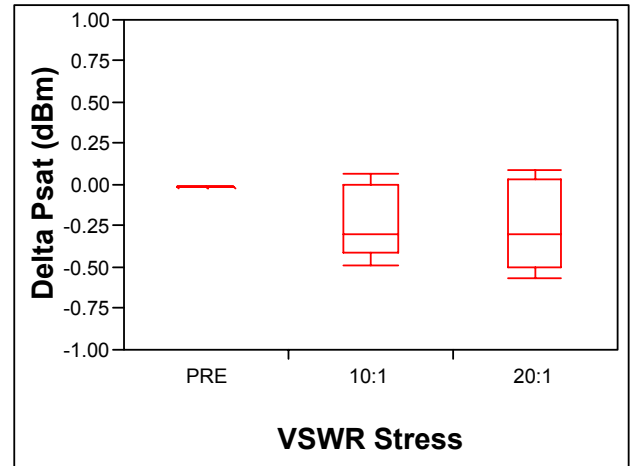


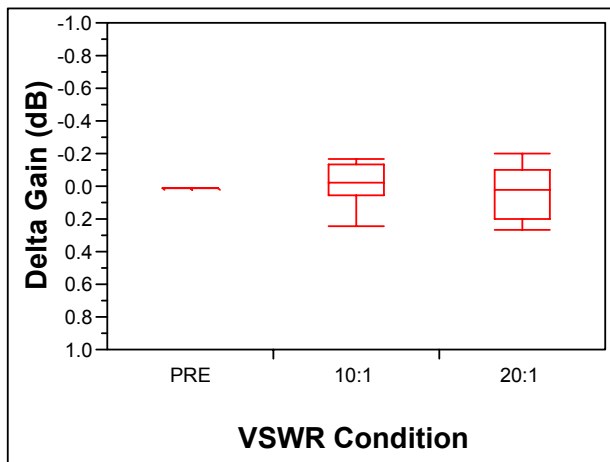
Figure 2: Room temperature CW power sweep of a typical NPTB00050; Pre-Stress, Post 10:1 and Post 20:1 VSWR testing.

The statistical results from testing ten devices under pre, post 10:1 and post 20:1 VSWR conditions for changes in gain, P_{3dB}, and DE, are shown in figures 3, 4, and 5 respectively.



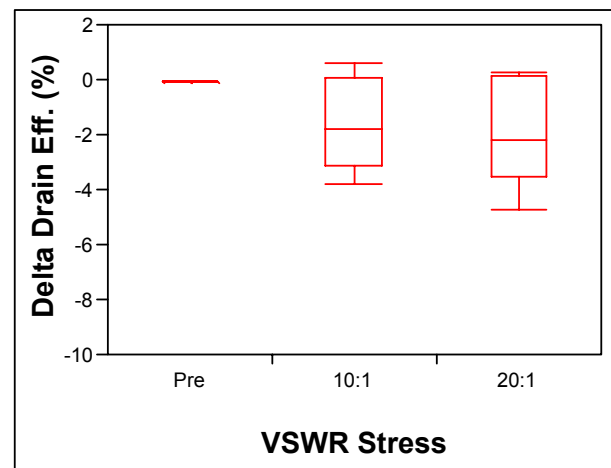
Level	Min.	25%	Median	75%	Max.
Pre	0	0	0	0	0
10:1	-0.48	-0.41	-0.29	0.00	0.07
20:1	-0.56	-0.50	-0.29	0.04	0.09

Figure 4: Statistical change in P_{3dB} power; Pre-Stress, Post 10:1 and Post 20:1 VSWR. Based upon 10 samples.



Level	Min.	25%	Median	75%	Max.
Pre	0	0	0	0	0
10:1	-0.17	-0.14	-0.03	0.05	0.24
20:1	-0.20	-0.11	0.02	0.20	0.27

Figure 3: Statistical change in small signal gain; Pre-Stress, Post 10:1 and Post 20:1 VSWR. Based upon 10 samples.



Level	Min.	25%	Median	75%	Max.
Pre	0	0	0	0	0
10:1	-3.76	-3.11	-1.74	0.10	0.64
20:1	-4.69	-3.48	-2.15	0.17	0.32

Figure 5: Statistical change in drain efficiency; Pre-Stress, Post 10:1 and Post 20:1 VSWR. Based upon 10 samples.

The median and maximum variation in gain, DE, and P_{3dB} are tabulated below the figures and demonstrate relatively small degradation in performance after subjecting the devices to high VSWR conditions. No hard failures were observed on any of the 10 devices tested after being subjected to a 20:1 VSWR condition.

Test Results at 90°C Flange Temperature

Three different NPTB00050's were mounted in the 50 ohm matched application board and the temperature of the board was increased until the device flange reached 90°C. CW power sweeps were collected prior to VSWR stress testing and also after being subjected to a 10:1 VSWR mismatch and again after being subjected to a 20:1 VSWR mismatch condition. It is interesting to note that during the VSWR stress condition the calculated junction temperature exceeds 300°C for one third of the phase cycle.

The RF test results from a representative device is shown in figure 6 and demonstrates the NPTB00050 not only survives a 20:1 VSWR but also undergoes only minor performance degradation while operating at P_{3dB} and a 90°C flange temperature. The small signal gain degraded by 0.5 dB after being subjected to a 20:1 VSWR but the saturated power and DE were unchanged.

Summary

Ten different NPTB00050's were subjected to a 10:1 and 20:1 VSWR condition while operating at P_{3dB} . No hard failures were observed on any of the 10 devices and no significant change in small-signal gain, DE, or P_{3dB} was observed. The largest power drop from pre-stress to post 20:1 VSWR is ~0.5dB in P_{3dB} with a median change of ~0.3dB.

Three different NPTB00050's were subjected to a 10:1 and 20:1 VSWR condition while operating at a flange temperature of 90°C and P_{3dB} . No hard failures were observed on any of the devices and no significant change in DE, or P_{3dB} was observed while small signal gain reduced by less than 0.5dB after being subjected to a 20:1 VSWR condition.

The NPTB00050 device has demonstrated to be a very robust RF transistor which is capable of operating into high mismatch conditions with very high junction temperatures while subsequently still being able to deliver good RF performance. The robustness achieved in this test is an indication of the robustness associated with the underlying NRF1 GaN technology and all products built using Nitronex NRF1 technology are tested against similar robustness requirements.

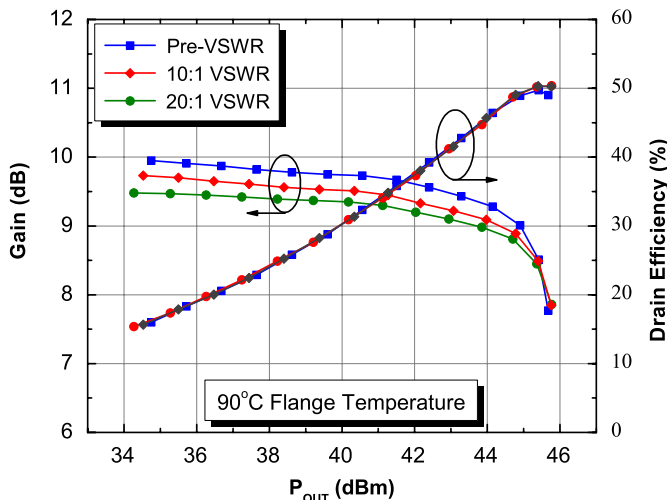


Figure 6: Typical CW power sweep of a NPTB00050 at 90°C flange temperature; Pre-Stress, Post 10:1 and Post 20:1 VSWR testing.