BFR740L3RH

Maximum RF Input Power of SiGe:C Bipolar Transistor BFR740L3RH

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Page	**Subjects (major changes since last revision)**

1 Theory

Excessive RF power applied to the input of a bipolar transistor has the capability to degrade the transistor performance. The RF power translates into a voltage swing at the base of the bipolar transistor according to the input impedance of the device. If the RF voltage amplitude is high enough, the base emitter diode is driven into reverse operation for a certain part of each RF swing. Such an electrical overstress can result in a permanent current gain (hFE) degradation, which in turn leads to a shift of the operation point adjusted by the passive biasing circuitry and in the end to a changed RF performance.

Whether a certain amount of RF source power degrades the transistor or not, depends on the conditions of the stress and the transistor itself.

1) Stress conditions
    a. Fraction of the RF power emitted by the source which effectively reaches the input. That is, how well is the transistor matched to the excessive RF input power. Large signal matching generally is different from small signal matching.
    b. Valueof the base-emitter reverse voltage VEB which effectively results from the given RF input power. It depends on the input impedance of the transistor and the class of operation. And the input impedance depends on frequency and device state (on or off).
    c. Duration of the effective stress. Depends also on the duty cycle.
    d. Failure criterion respectively what hFE degradation is regarded as a failure. If hFE is degraded by 20% normally the impact on the RF performance is regarded as significant.

All of these factors have to be specified in a statement of maximum RF input power in the maximum ratings section in the datasheet, otherwise the statement is worthless.

2) Transistor process technology

    Not all bipolar transistors are equally susceptible to RF input power. Modern RF transistors tend to have highly doped base regions. This leads to relatively low base-emitter breakdown voltages BVEB. Actually this is not a sharp avalanche breakdow any more as in older technologies, but a gradually increasing tunnel current through the reverse-biased base-emitter diode. The maximum allowed base emitter reverse voltage, which must not be exceeded, is stated in the maximum ratings of the datasheet.

2 BFR740L3RH Stress Test Results

In the following example, the BFR740L3RH has been exposed to a CW RF source power of +10 dBm at 1.9 GHz for 1000 hrs. A circuitry has been used where the device is matched at small signal with input return loss RLin of 7 dB at 1.9 GHz. The DC operation point was 8mA at 3V. The device was always switched on during the test.

After 1000 hrs the typical hFE degradation was 12%, see Fig 1, none of the 16 DUTs violated the 20% failure criterion.

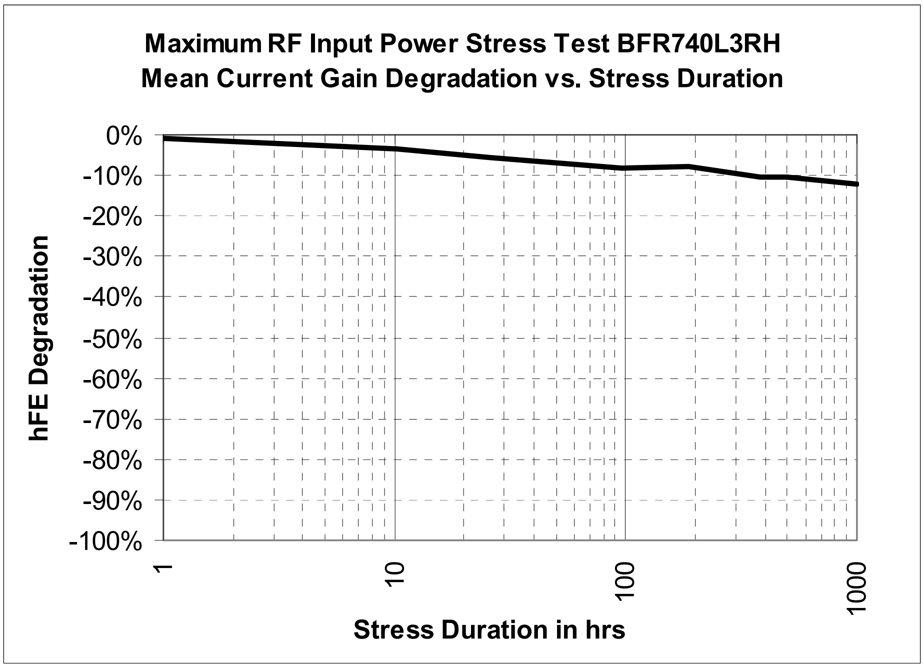

Figure 1 Percentual mean hFE degradation during RF input power stress test

For the more stringent 5% failure criterion and for source powers different from +10 dBm the time to failure can bee seen in Fig. 2 (estimated values in dashed lines). The hFE degradation is a gradual decrease with increasing stress duration. Then it is followed by an abrupt hFE gedradation after certain stress duration exceeds. If 5% hFE degradation is regarded as failure criterion, then the gradual decrease already leads to failures. If one regards an hFE degradation of 20% as the failure criterion, then normally the abrupt hFE breakdown leads to the failure.

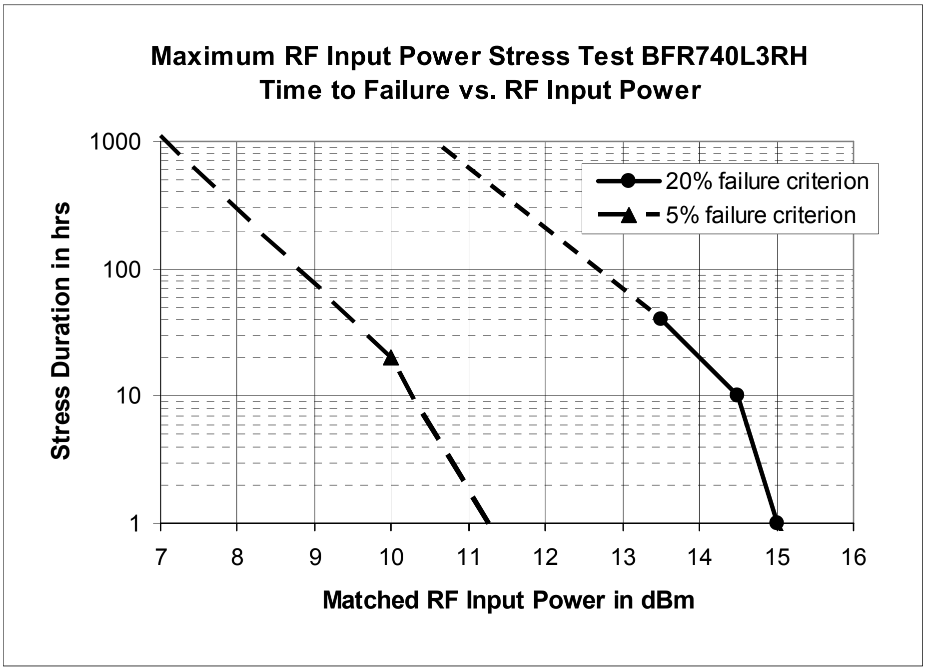

Figure 2 Time to failure vs. matched RF input source power with failure criterion as parameter

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