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RELIABILITY EVALUATION OF GAASFETS,(U)
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UNCLASSIFIED TI-08-80-32 RADC-TR-80-390 NL

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The reliability of the A devices might be improved by placing the gate in the center of the source-drain gap and recessing the gate. The catastrophic failure rate of TI devices could probably be improved by greater attention to cleanliness in processing. There are no recommendations for the B and C devices. It is recommended that all of these GaAs power FETs be operated at a drain bias of 8 V or less and that they be thermally screened to identify poorly mounted devices. Our measurements indicated that 5% to 20% had excessive thermal resistance due to poor mounting. This problem should be addressed by the manufacturers.

It is not easy to recommend a specific device type as the most reliable, since all have extremely long extrapolated MLs at room temperature. The A devices would have the lowest and most predictable failure rate due to their extremely low ; however, the effect of their increased susceptibility to failure following stress has not been evaluated. More data are needed on the B devices before an accurate room temperature ML can be derived. The high temperature data taken indicate a relatively low ML. The C devices have a high ML with few catastrophic failures. However, their output power is relatively low and they operate at a higher temperature than other devices, although this latter seems to do them no harm. The TI production devices have the lowest gradual degradation rate and highest output power, while the TI laboratory devices have a higher gradual degradation rate (still low) and the highest gain combined with very high output power (the TI devices had higher output power than specified). However, the TI devices are more likely to fail catastrophically than other devices, an undesirable property even when the ML is long. If the highest and most predictable reliability is most important, the C devices should be chosen; if high reliability combined with excellent performance is needed, then TI devices would be best.

SECTION VIII
SUMMARY

The devices chosen for this reliability study were the TI MSX 802, a TI laboratory device, and devices from three other manufacturers A, B and C. All are hermetically packaged GaAs power FETs with 0.5 W output power. The device physical characteristics were obtained from measurements and conversations with the manufacturers, and significant differences between device types are apparent.

Four devices from each manufacturer were electrically characterized, with small signal S-parameters, gain, 3 dB bandwidth, phase linearity, third-order intermodulation, and noise figure being measured. Remeasurement of these parameters after the devices had been operated for 1000 hours with 8 V drain bias and 20 dBm input power at 8 GHz indicated no significant change in any of these parameters. Similar results were obtained under pulsed operation.

The devices underwent a number of electrical stress tests, and most of the differences between the device types could be associated with differences in device physical characteristics. The failures could usually be explained in terms of failures described in the literature. There were no significant differences when the devices were stressed to failure under pulsed operation.

A number of military standard environmental characterization tests were performed measuring susceptibility to mechanical and thermal stress. None of the devices failed these tests.

The environmental stress tests (elevated temperature with dc bias and rf input power) were performed at several temperatures. Extrapolated median life was in the neighborhood of 10^{12} hours with a room temperature heat sink for all of the device types except type B, which had about 3×10^{9} hours ML. There was not enough data for any device type to make results as statistically

like; however, order of magnitude estimates should be reliable. Several failure mechanisms were discovered but causes of most of the failures, both catastrophic and gradual 1 dB output power decrease, could not be identified with certainty. In spite of this, GaAs power FETs appear to have an extremely long median life under normal operation and should be quite reliable in system use, provided they are not subjected to excessive voltages.

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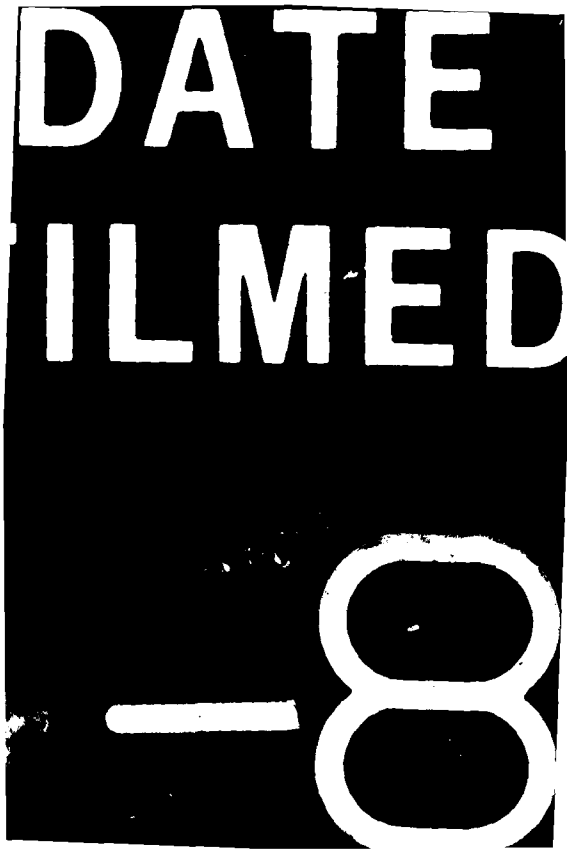
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