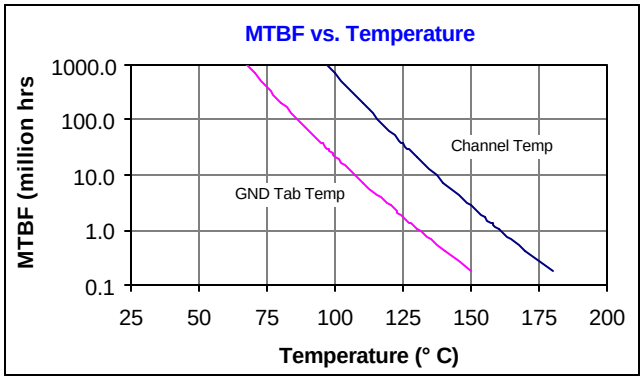
AG101 Temperature Effects on Reliability

The AG101 is a GaAs MESFET MMIC amplifier based on GaAs processes and technology that have been incorporated into WJ's products for more than 15 years. Extensive life testing and field history of our GaAs products have demonstrated excellent robustness and reliability. In general, WJ GaAs MMIC products are capable of operating reliably at channel temperatures of +175° C based on accelerated lifetest measurements of small-signal linear parameters like gain and input/output match. Biased lifetests at 250° C channel temperature for 1000 hours routinely show no I_{DS} failures for a sample size of 10 devices.

Long-term aging behavior of two-tone third-order output intercept (3OIP) performance, a non-linear characteristic, has not been as extensively studied as the small-signal linear parameters. As a result, WJ Communications opted to take a conservative position in specifying the maximum operating temperature of the AG101. Currently, the maximum recommended operating temperature is +85° C (referenced to the GND lead of the device) which insures that the maximum channel temperature at worst case power conditions will never be above a very safe +115° C. Since releasing the product in 2001, WJ Communications has continued to study the aging characteristics of the AG101's performance. As shown in the AM1 and AG101 Qualification Report, we have reported no failures with over 7,300 device hours under an Accelerated Biased Humidity (HAST, +130°C, 85% RH, 33 psia) test. In addition, WJ has not had any failures on over 77,000 device hours with a High Temperature Operating Lifetime (HTOL) test under a biased condition at +125° C ground tab. The results of these tests confirmed that the AG101 temperature failure mode is similar to that found in other WJ GaAs devices, and has an activation energy of about 1.5 eV [1].

The channel temperature can be calculated using the temperature rise due to power dissipation of the device, e.g. ground tab temperature (80.3° C) x voltage (4.5 V) x current consumption (75 mA max) x thermal resistance (88° C/W) = 110° C. The calculation is conservative because as the temperature of the channel increases in the device, the current consumption of the device typically decreases. A 10% reduction is typical with a temperature increase from 25° C to 85° C at the ground lead temperature. Using the activation energy of 1.5 eV, the following MTBF estimates have been calculated from the Arrhenius function [1]:

Channel Temperature (°C)	GND Lead Temperature (°C)	MTBF (million hours)
110	80.3	203.32
120	90.3	63.96
130	100.3	21.31
140	110.3	7.49
150	120.3	2.76
155	125.3	1.71
160	130.3	1.07
170	140.3	0.43
180	150.3	0.18



As can be seen from the MTBF numbers above, the predicted failure rate is still above 1 million hours, even at operating temperatures up to +130° C (corresponding to channel temperatures of +160° C). Also note that these MTBF estimates are a lower bound as the accelerated testing never resulted in 50% failures.

[1] Please refer to the application note "MTBF Analysis for AH1" for further information.

Specifications and information are subject to change without notice