Application Note

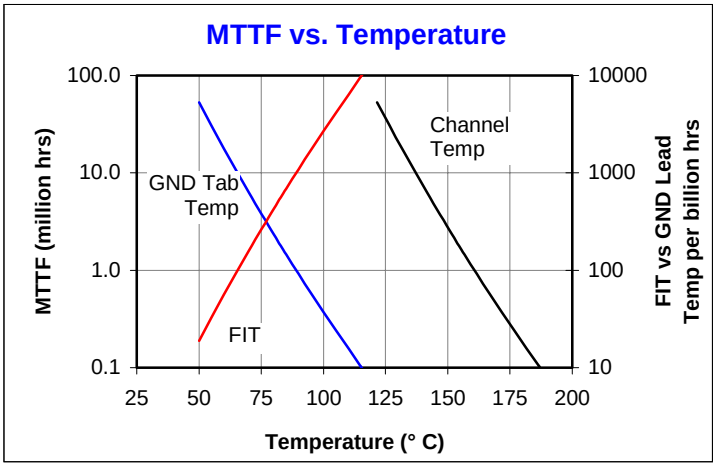
FP31QF Temperature Effects on Reliability

Product Information

The FP31QF is a 0.5 µm gate length AlGaAs/GaAs 2-Watt HFET based on GaAs processes and technology that have been incorporated into WJ's product 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.

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 will never be above a safe **+156.7° C**, when operated at the recommended bias of 9 V @ 450 mA. The maximum recommended operating temperature insures a MTTF (mean time to failure) rating of 1.46 million hours. The channel temperature can be calculated using a conservative approach by calculating the temperature rise due to power dissipation of the device, e.g. ground tab temperature (85° C) + voltage (9 V) x current consumption (450 mA) x thermal resistance (17.7° C/W) = 156.7° C. Using the activation energy of 1.5 eV, the following MTTF estimates have been calculated from the Arrhenius function [1]:

GND Lead Temp. (°C)	Channel Temp. (°C)	MTTF (million hours)	FIT per billion hours
50	121.7	52.9	18.9
60	131.7	17.8	56.2
70	141.7	6.31	158
80	151.7	2.35	425
85	156.7	1.46	686
90	161.7	0.91	1093
95	166.7	0.58	1724
100	171.7	0.37	2671
105	176.7	0.24	4158
110	181.7	0.16	6365



As can be seen from the MTTF values above, the predicted failure rate is still above 1 million hours, even at operating temperatures up to +88° C (corresponding to channel temperatures of +160° C). Also note that these MTTF estimates are a lower bound as the accelerated testing never resulted in 50% failures.

[1] $MTTF = A^* e^{(Ea/kT)}$ Where: $A = 3.71 \times 10^{-12}$ (hrs) (Pre-exponential Factor)
$Ea = 1.5$ (eV) (Activation Energy)
$k = 8.617 \times 10^{-5}$ (eV/ºC) (Boltzmann's Constant)