

# X-Band Power GaAs MESFET Investigation

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# X-Band Power GaAs MESFET Investigation

- ◆ EOS-AM/Landsat-7 Power MESFET (Metal Semiconductor Field Effect Transistor) exhibited unusual degradation in Gate-Drain breakdown voltage during life test.
- ◆ Combination of degradation mechanisms were suspected
- ◆ Extensive RF life tests (~15000 hours) conducted
- ◆ Overstress electrical tests conducted
- ◆ Reliability of devices successfully demonstrated for intended application. Devices did not have to be retrofitted.

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# X-Band Power GaAs MESFET Investigation

- ◆ Investigation centered on devices in final 2 stages
- ◆ MGFC36V7785 and MGFC40V7785
- ◆ Application information from Lockheed-Martin indicated device operation was within allowable boundaries for safe, long term operation

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- ◆ A variety of problems emerged, none of which were noted during Engineering Model phase:
- ◆ 36V and 40V devices displayed a BVgdo (gate-drain breakdown) slump after a high temperature marking operation
- ◆ 36V and 40V devices displayed a BVgdo slump after RF overdrive test
- ◆ 40V devices displayed BVgdo slump during RF life test

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- ◆ Investigation involved multiple life tests and burn-in's under different conditions
- ◆ Devices displayed shift that was dependent on bias and operating conditions
- ◆ Short term behaviour was attributed to shallow surface state trapping and detrapping. The surface states can be decreased via
  - ▶ thermal acceleration
  - ▶ electric field
  - ▶ electron-hole recombination
- ◆ 36V devices failed initial life test at  $V_{ds}=9.0\text{ V}$  @  $P_{out}=P_{-5.0db}$ , second sample passed at  $V_{ds}=8.5\text{ V}$  @  $P_{out}=P_{-2.5db}$  for 1000 hours

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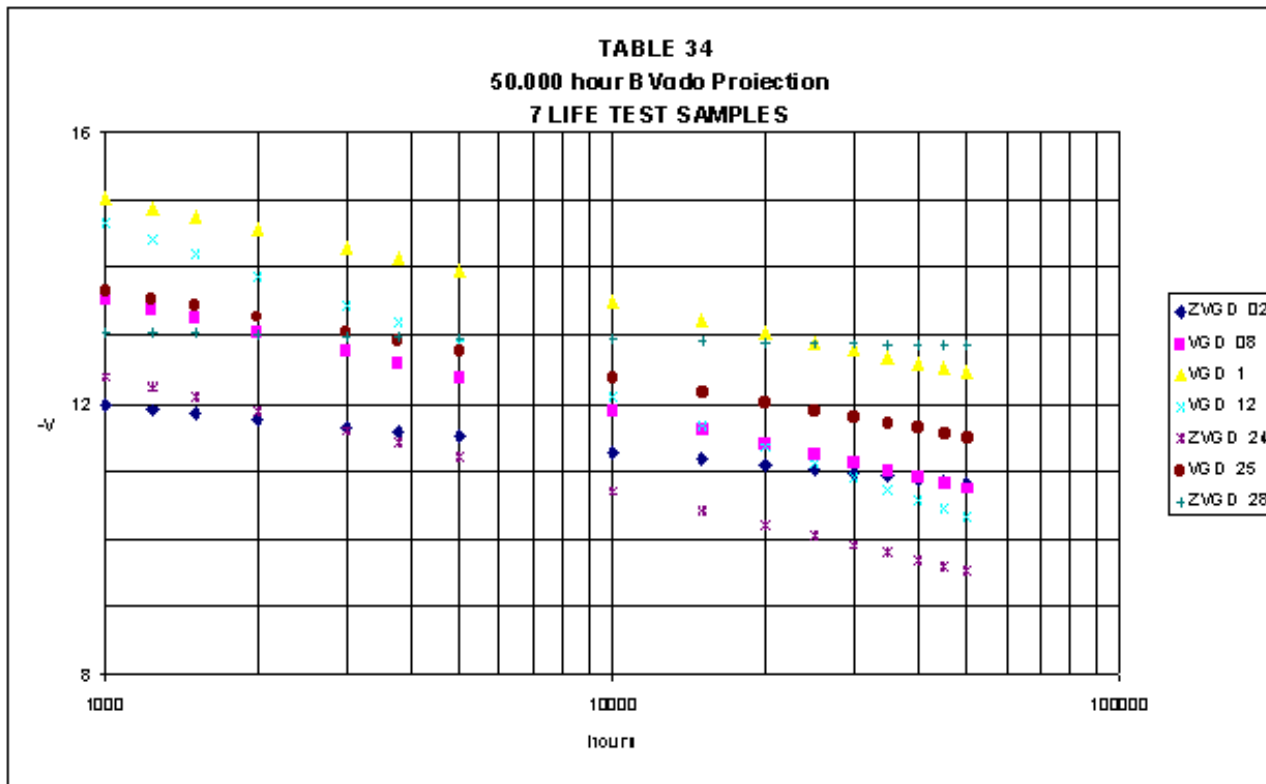
- ◆ 4 samples were tested at -15,-17,-19, -21,-23, -25 V reverse breakdown voltage dwelled for one minute at each voltage
- ◆ At -25V the maximum gate leakage recorded was -970mA. Bvgdo was -12.15 V (@Ig=1mA)
- ◆ Pout at +22.5dBm (linear) and +32.5dBm (compressed) were recorded after each round
- ◆ All 4 samples met Pout requirements > +29.3dBm and +38.3dBm with no degradation

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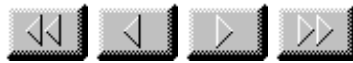
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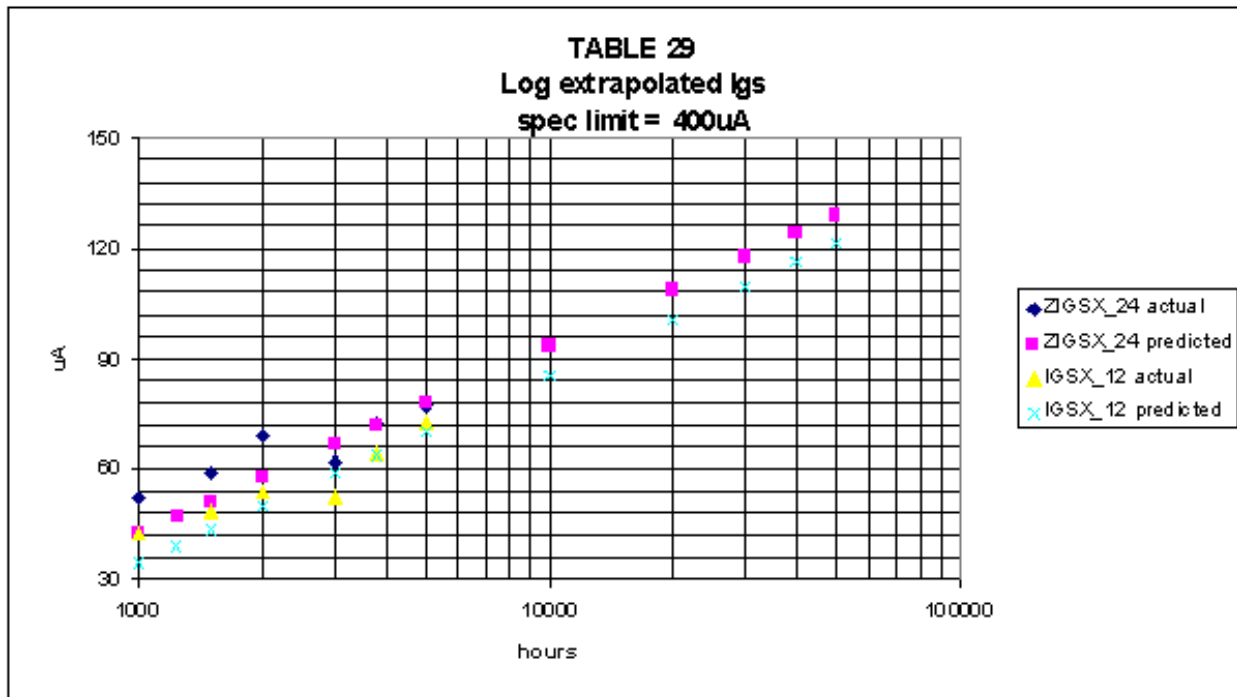
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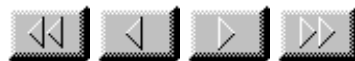


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- ◆ Investigation by MELCO and LMMS was thorough. The 36V devices were deemed acceptable.
- ◆ The 40V devices were questionable. MELCO believed that BVgdo slump had annealed out after  $\sim 1000$  hours
  - ▶ Would the degradation continue and lead to ultimate device failure due to g-d overstress?
- ◆ NASA analyzed 2000 hour life test data on another sample set of 12 40Vs running at  $V_{ds}=8.0$  V @  $P_{out}=P_{-3.0\text{db}}$
- ◆ Two additional conditions were imposed.

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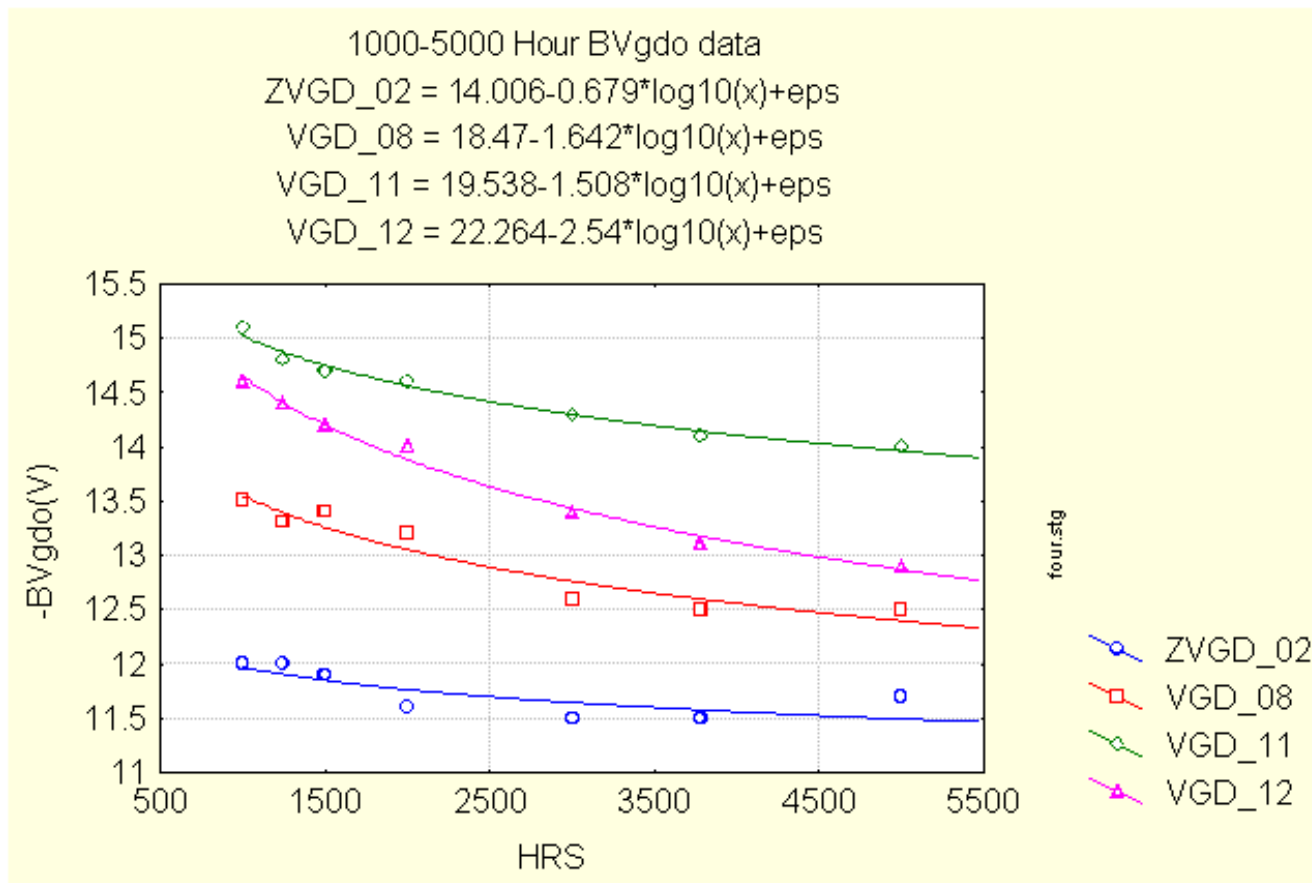
- ◆ Extend the 2000 hour test to 5000 hours for 8 samples.
  - ▶ This would bound the question of whether the slump had annealed or if another mechanism would lead to failure
- ◆ Take 4 samples tested to 2000 hours and subject them to high reverse breakdown to determine the robustness of the degraded devices. Testing was conducted in Japan, witnessed by NASA and LMMS

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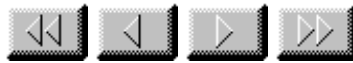
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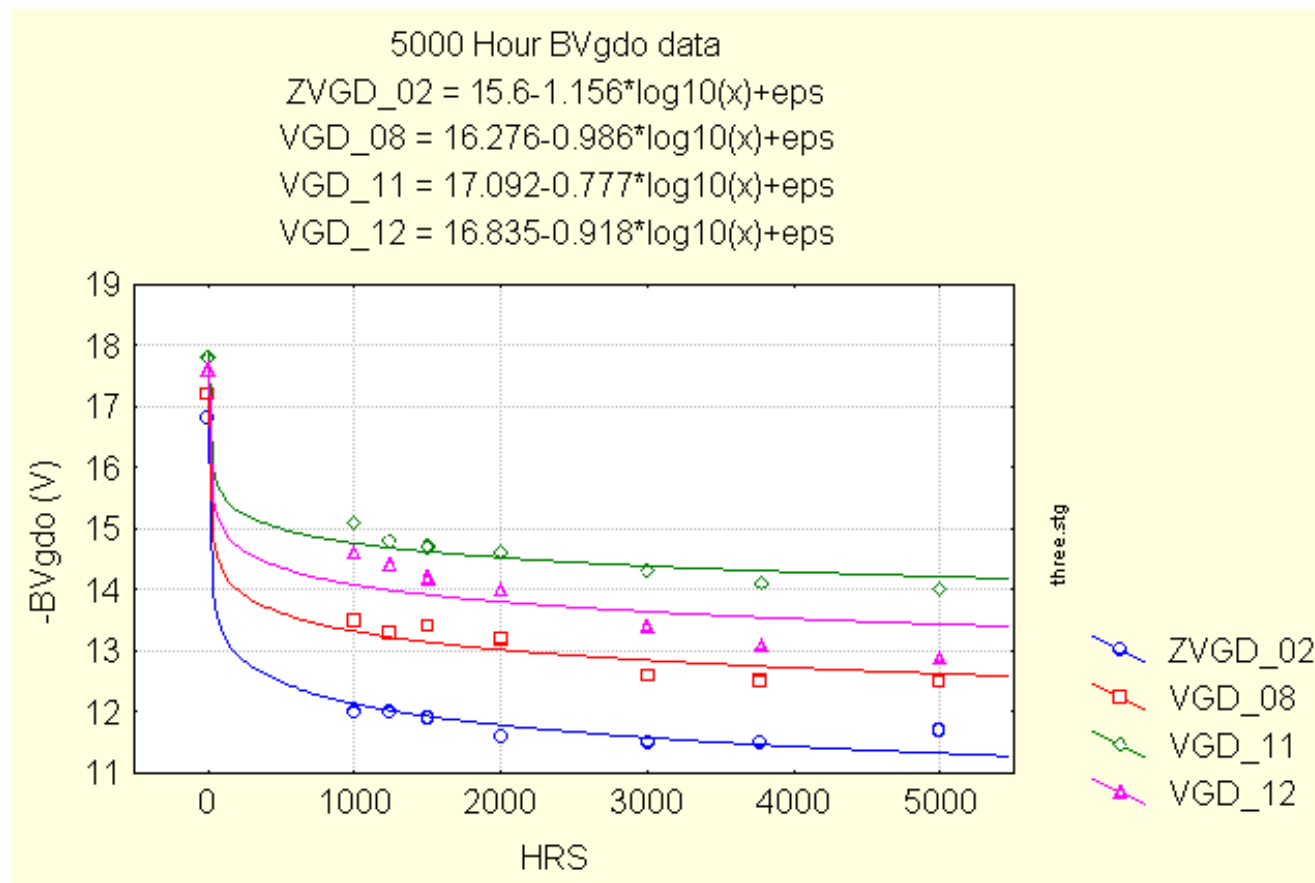
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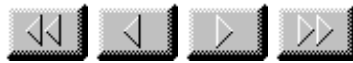
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