



Space & Electronics Group

InP 101 - “*View from the Top*”

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Acknowledgements

- TRW's Indium Phosphide technology development is a combination of resources from TRW, DARPA, Air Force, Navy, Army.
- We would like to thank Max Yoder of ONR, and Tim Kemerley of AFRL for their strong support.
- Finally we would like to acknowledge the great people we are fortunate to work with at TRW.

Outline

- Why we call InP a “disruptive” technology
- InP Applications
- Importance of reliability
- Summary

“Disruptive Technology”

- Definition - From author Clayton Christensen’s book, “The Innovator’s Dilemma”.

Characteristics:

- **Disruptive Innovations are technologically straightforward.**
- **Disruptive technologies are developed in relative obscurity, often for small markets**
- **Established firms FOCUS on their “sustaining technologies”.**
- **New companies were formed based on disruptive technologies.**
- **Established firms belatedly jump in, but are too late.**

GaAs HBT - A Disruptive Technology

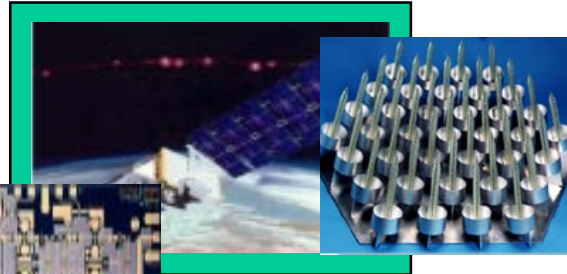
- GaAs HBT technology was developed in the 1980s.
- Developed for military and space applications, in relative obscurity..
- Commercial cellular power amp suppliers focused on constantly improving GaAs MESFET technology. Fiber optic companies focused on OC-48, WDM, and silicon technology.
- New companies were established based on GaAs HBT.
- Established companies belatedly jump on the bandwagon.

InP HBT - A Disruptive Technology

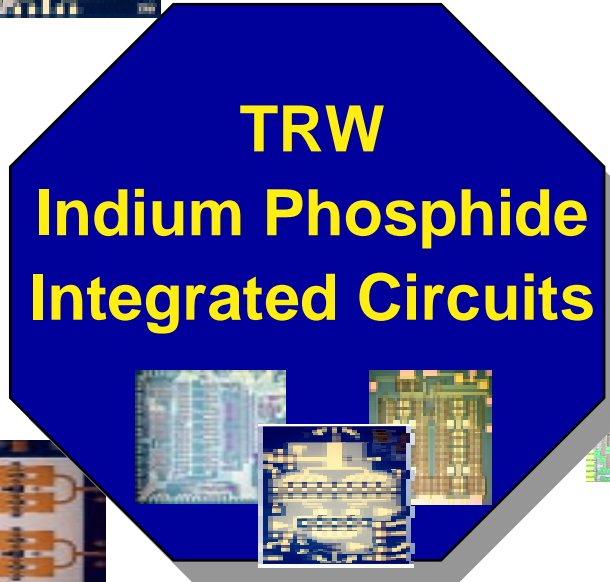
- InP HBT technology was in development since 1989.
- Developed for military and space applications, in relative obscurity.
- Commercial suppliers focused on constantly improving GaAs HBT, and silicon germanium technology.
- New companies will be established based on InP HBT.
- Established companies will belatedly jump on the bandwagon.

Indium Phosphide Applications

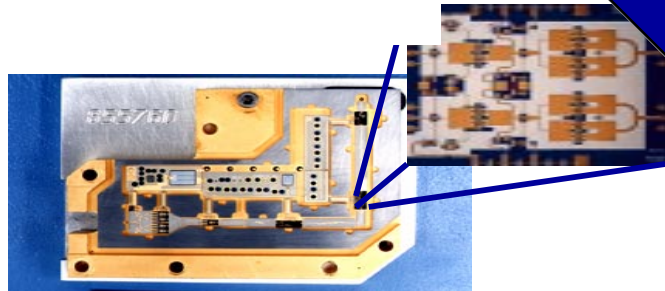
Satellite Payload Electronics



Cell Phone Chips



Base Station Electronics

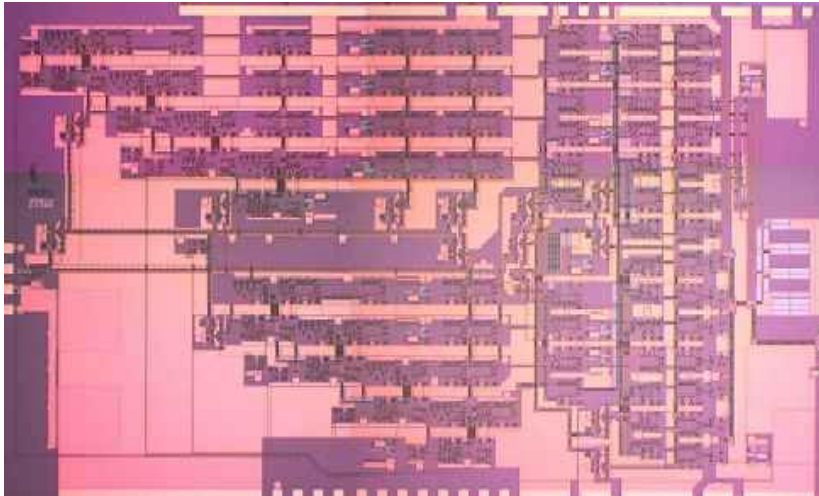


mmW Chips and Modules

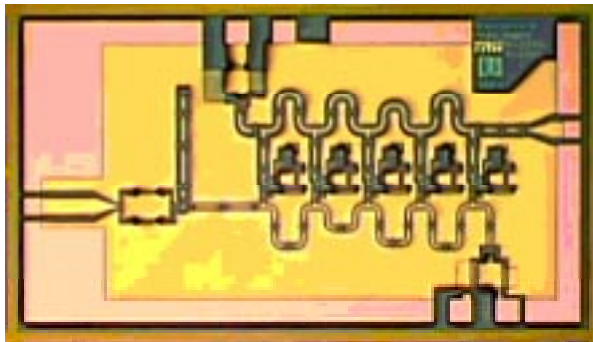


Fiber Optic Chips

Fiber Optics Applications



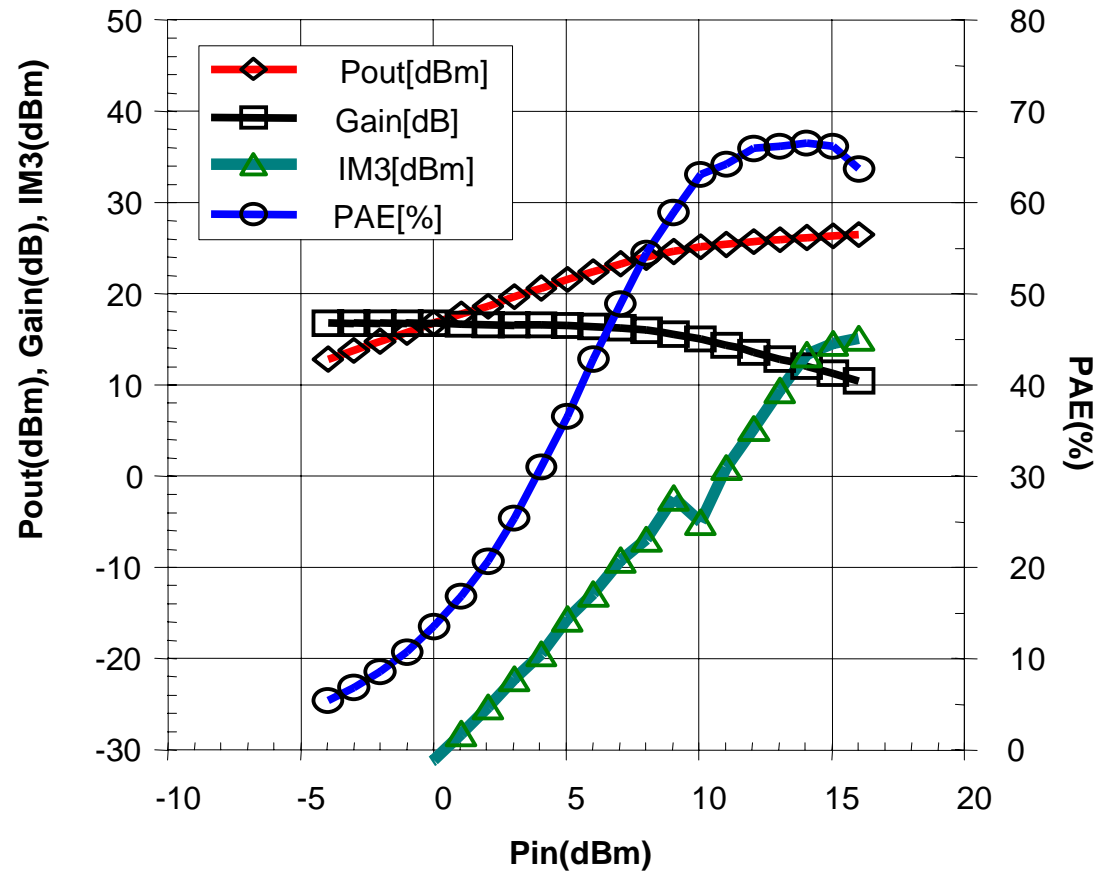
- World's First Multi-GHz Direct Digital Synthesizer
- Over 3,000 InP HBTs
- 40-60% yield.
- Sufficient for MUX, DMUX, CDR



- Integrated Pin Diode + TIA

Cellular Power Amplifiers

- Linear Efficiency > 60%
- Compact
- Easy Design
 - Low Vbe
 - Less Temp Change



Importance of Reliability

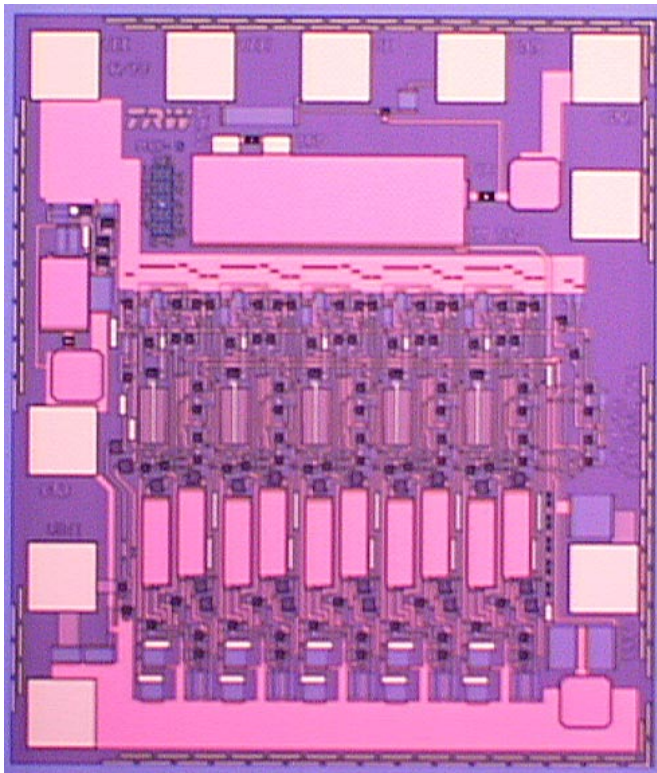
- Reliability is critical for both military and commercial markets
- Poor reliability is unacceptable for any commercial application.

InP HBT Reliability Circuit



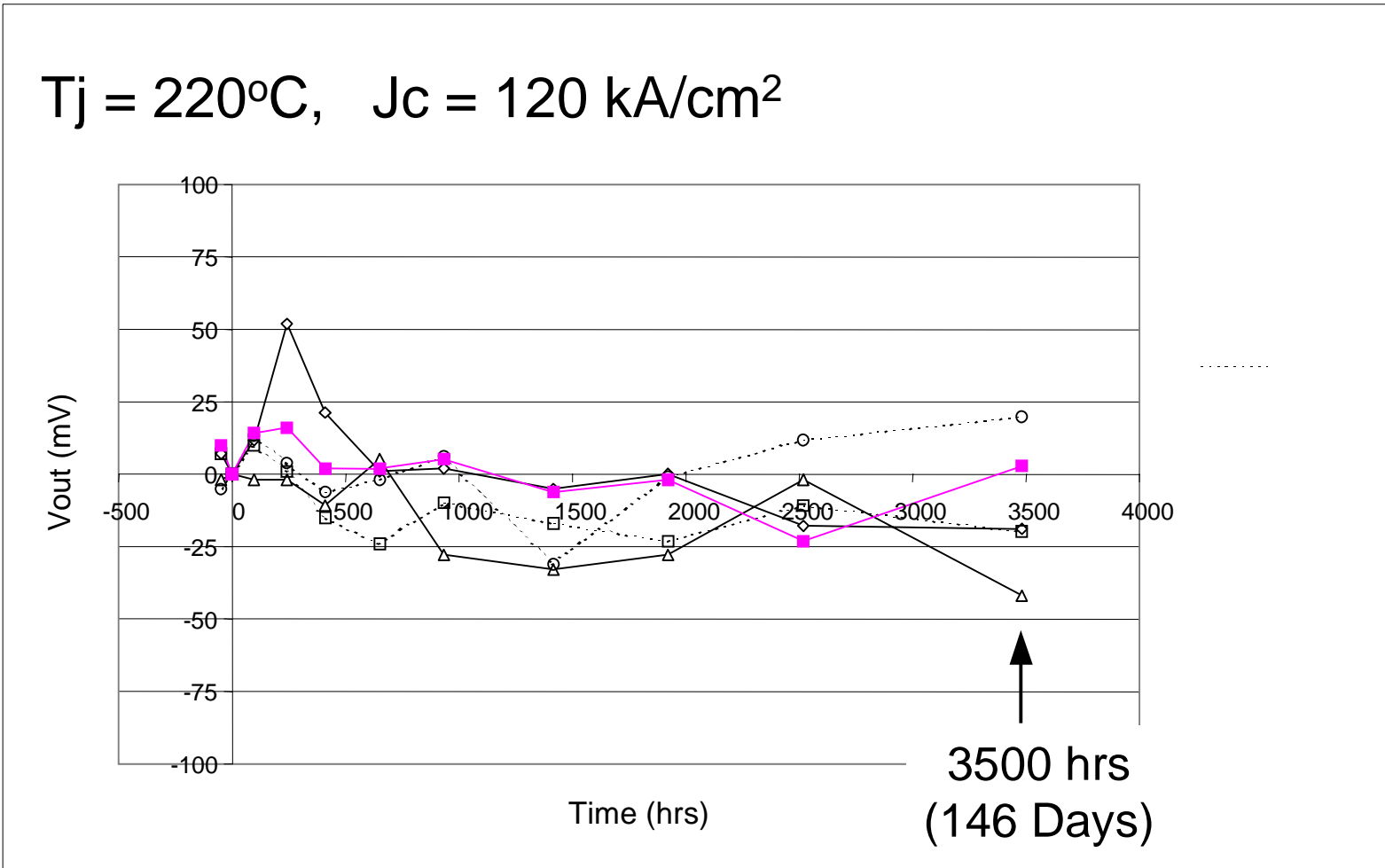
Reliability Standard Evaluation Circuit InP Logarithmic Amplifier (ILOG)

Chip Photo



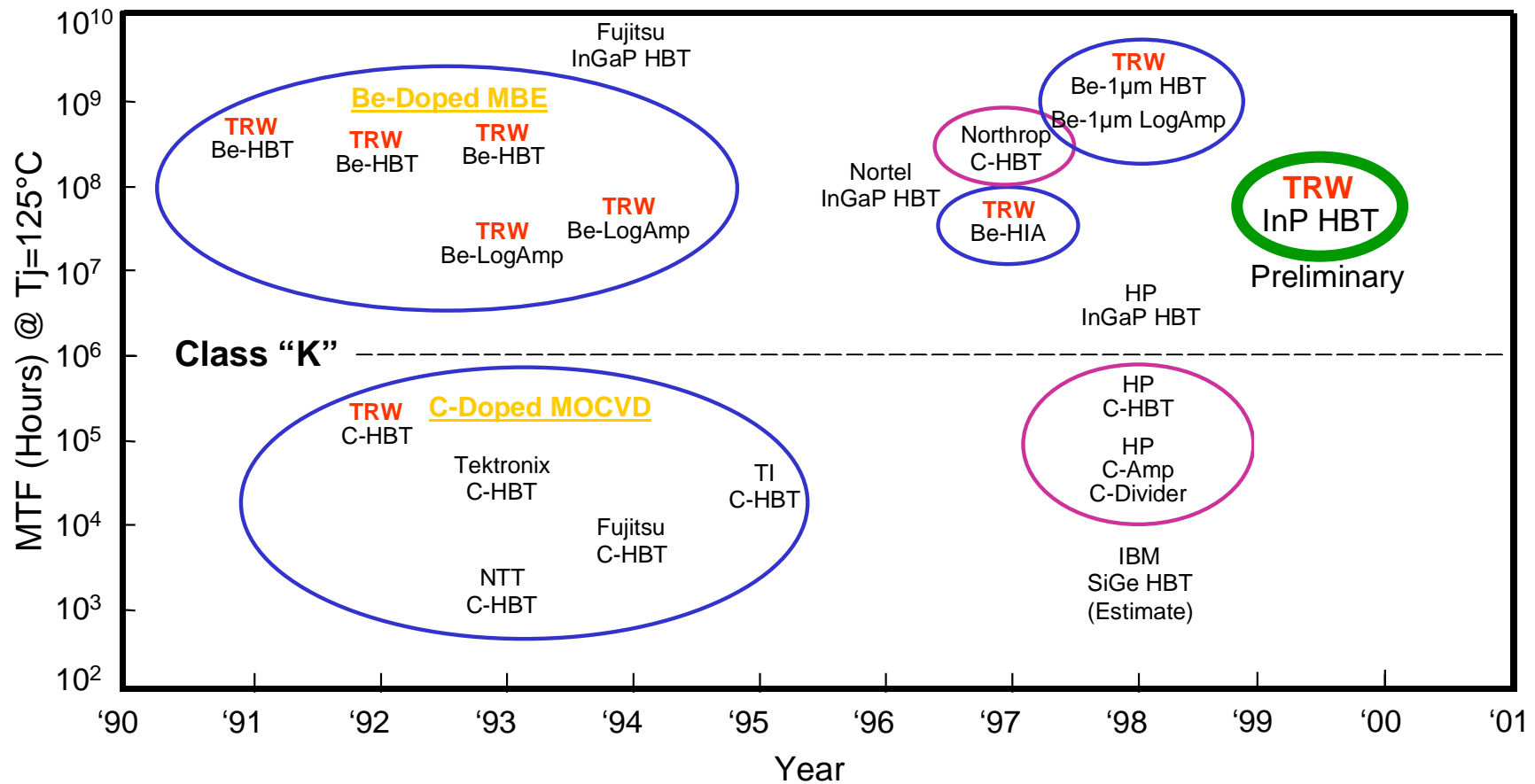
- 5 stages of amplification and 6 stages of detection
- 99 InP DHBTs
- Schottky diodes
- MIM capacitors
- Thin film resistors
- Some FIC lines at maximum current density
- Airbridges
- Backside vias

InP HBT Life Test (Preliminary)



No failures yet. MTTF (@125°C) = 4×10^7 hrs (4578 years)

GaAs and InP Reliability Comparison



Summary

- Indium Phosphide has significant advantages for defense and commercial applications.
- Need to nurture development 5 - 15 years.
- Money cannot always make up for time in technology development.
- Technology development is never ending. There will always be new “disruptive technologies”.