4H-SiC HIGH TEMPERATURE SENSING & ELECTRONICS
SENSORS, SIGNAL PROCESSING AND ACTUATORS
OPERABLE UP TO 600 °C

General Description
• Mixed-signal circuits operating at temperatures beyond 250 °C
• Combination of sensing function with on-chip amplification and Smart-Power IC for actuation

Features
• Wide range of applications:
  – Temperature
  – UV emission
  – Particles and radiation
  – Magnetic field
  – Chemical compounds
  – Pressure
• Operating temperatures up to 600 °C
• Amplification circuits and logic
• Actuators like HV switches

Advantages
• Higher thermal stability than Si
• Robust to harsh environments
• Compact single chip solution

Benefits
• Less effort for sensor maintainance (stability)
• Cost reduction by monolithic integration
• Best-in-class high temperature performance of semiconductor-based sensors

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Sensor Functions

Temperature
- Temperature-sensitive diodes operating in constant current forward bias mode (CCFB)
  - High sensitivity (dV/dT): up to 4.5 mV/K
  - High linearity up to 500 °C

Fast particles and radiation
- Soft x-ray detection
- Neutron detection

Pressure
- Piezo resistivity
- Capacitance 3.9 mV/bar at 300 °C

Magnetic fields
- Hall effect based Magnetic FETs

Chemical Compounds
- ISFET mode for detection of distinct elements and compounds

Signal Processing

Analog electronic circuits
- Amplifier
- Comparators
- Current mirrors

Electronic sensing and actuation circuits
- ADCs
- pre-Amps

Digital electronic circuits
- Inverters, Flip-flops
- State-machines
- Technology Details
  - High-temperature CMOS
  - $\mu_{\text{H莫斯}}/\mu_{\text{Hmos}} = 3.8 @ 300 ^\circ C$

Actuation

- High voltage devices
  - LDMOS transistors based on pin or RESURF
  - High-side capability by well-isolation
- Excellent Power-FOM at 600 V compared to silicon
- On-state resistance
  \(< 10 \Omega \text{ cm}^2 @ 650V\)

UV emission
- Tunable responsivity
- Maximum at 260 nm: 110 mA/W
- Near-constant responsivity from 270-300 nm
- Typical maximal external quantum efficiency of 55%
- Sensor arrays

- Mounted 4H-SiC UV-sensor