INNOVATIONS
FOR HIGH PERFORMANCE MICROELECTRONICS

SiGe BiCMOS Technologies with RF and Photonic Modules

Multi Project and Low Volume Wafer Production

About Us

Leibniz IHP is a German R&D institution, focused on wireless and broadband communication.

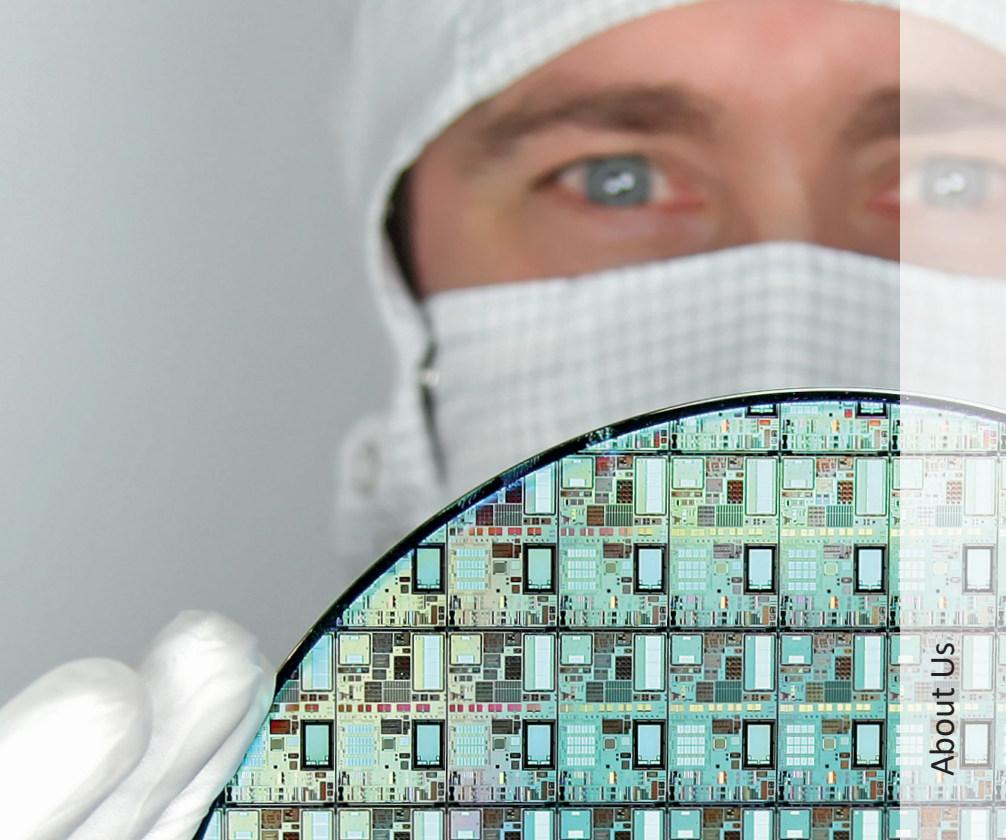
Core competencies are:

- Mixed signal process technology
- RF & digital circuit design
- Communication system design

IHP is running an 8″ pilot line housed in a 1,500 square meter class-3 cleanroom.

Several 0.25 µm and 0.13 µm SiGe:C BiCMOS technologies are available.

IHP Solutions GmbH is a 100% subsidiary of IHP. IHP Solutions was founded to focus on and grow the transfer of research results (technology transfer) of IHP research activities as well as the commercial partner for value added services along the value chain of IC manufacturing. In the context of IHP's service offerings IHP Solutions is responsible for commercial IC production.



About Us

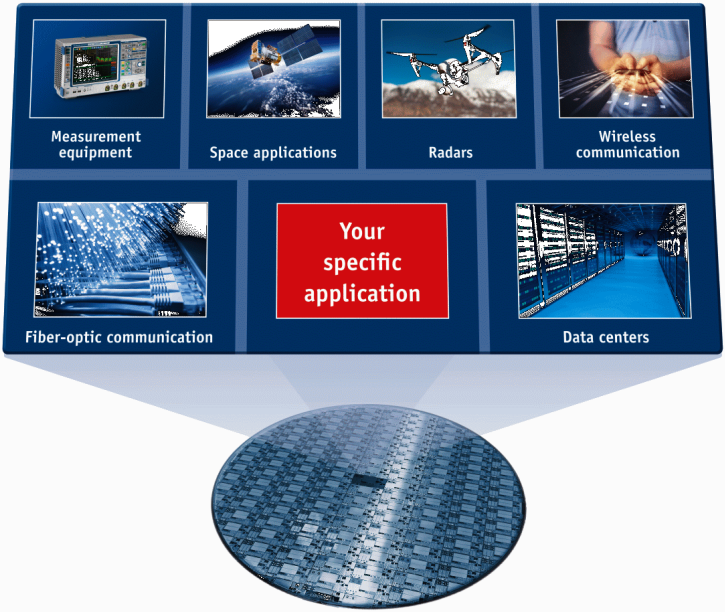
Low-Volume & MPW Service

IHP offers research partners and customers access to its powerful SiGe:C BiCMOS technologies and special integrated RF modules.

These technologies are especially suited for applications in the higher GHz bands (e.g. for wireless, broadband, radar).

They provide integrated HBTs with cut-off frequencies of up to 500 GHz including complementary devices.

- For products in fiber optics, aerospace, broadband and wireless communication, radar, data centers, measurement equipment, THz imaging, e-health
- 8" wafer fab for research and production in Germany
- Reliable service since 2001
- SiGe BiCMOS with state-of-the-art 500 GHz HBTs



Low-Volume & MPW Service

SiGe:C BiCMOS Technologies for MPW & Prototyping

SG25H3	A 0.25 µm technology with a set of npn-HBTs ranging from a higher RF performance (f_T/f_{max} = 110/180 GHz) to higher breakdown voltages up to 7 V.
SGB25V	A cost-effective technology with a set of npn-HBTs up to a breakdown voltage of 7 V.
SG13S	A high-performance 0.13 µm BiCMOS with npn-HBTs up to f_T/f_{max} = 250/340 GHz, with 3.3 V I/O CMOS and 1.2 V logic CMOS.
SG13G2	A 0.13 µm BiCMOS technology with higher bipolar performance of f_T/f_{max} = 300/500 GHz.
SG25H5_EPIC	A monolithic photonic BiCMOS technology combining 0.25 µm CMOS, high-performance npn HBT's (f_T/f_{max} = 220/290 GHz), and full photonic device set for C/O-band.

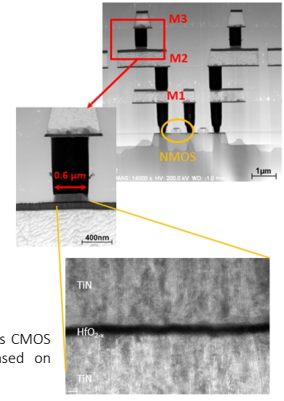
The backend for 0.13 µm process offers 5 thin and 2 thick metal layers (TM1: 2 µm TM2: 3 µm).

The schedule for MPW & Prototyping runs is located at www.ihp-microelectronics.com.

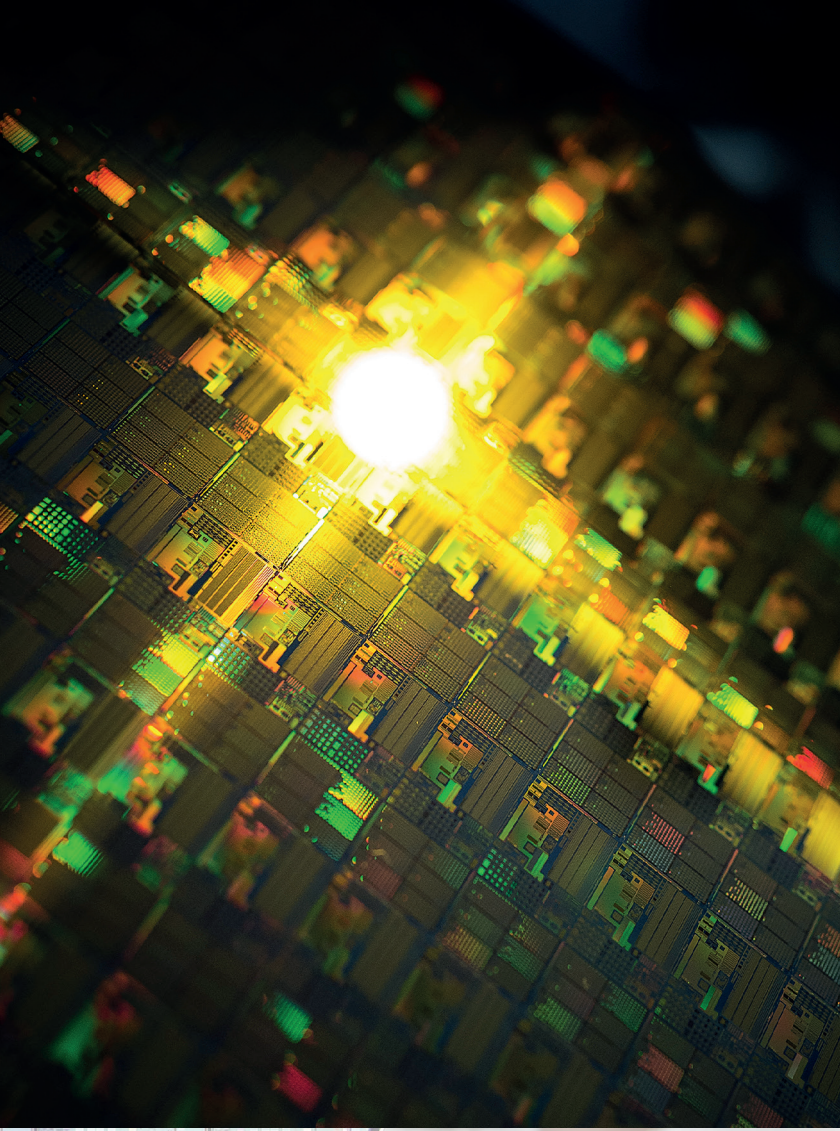
Cadence-based mixed signal Design Kit is available. For high frequency designs an analog Design Kit in ADS can be used. IHP's reusable blocks and IPs for wireless and broadband are offered to support your designs.

The Following Modules are Available

PIC	Additional photonic design layers together with BiCMOS BEOL layers on SOI wafers.
LBE	The Localized Backside Etching module is offered to remove silicon locally to improve passive performance (available in all technologies).
TSV	Module is an additional option in SG13S and SG13G2 technology which offers RF grounding by vias through silicon to improve RF performance.
MEMRES	A fully CMOS integrated memristive module based on resistive TiN / HfO_{2-x} / TiN switching devices in SG13S technology. Process Design Kit including layout and VerilogA simulation model is also available.



High resolution micrographs, illustrating IHP's CMOS integrated MEMRES mod-ule, which is based on resistive TiN / HfO_{2-x} / TiN switching devices



Available Modules

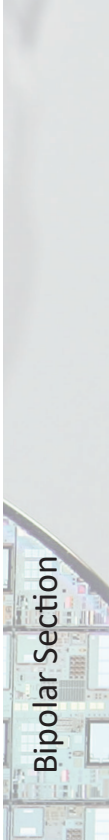
Key Specification

Feature	SG13S	SG13G2	SG25H3	SGB25V
Technology node (nm)	130	130	250	250
f_{max} NPN (GHz)	340	500	180	95
CMOS core supply (V)	1.2, 3.3	1.2, 3.3	2.5	2.5
C_{MIM} (fF/µm²)	1.5	1.5	1.0	1.0
Poly Res (Ω/□)	250	275	210—280	210—310
High Poly Res (Ω/□)	1300	1360	1600	2000
BEOL	7× Al	7× Al	5× Al	5× Al
Varactor (C_{max}/C_{min})	1.7	1.7	3	3
Q inductor	37*	37*	37*	37*

*1 nH (with LBE)

Bipolar Transistors

Feature	SG13S	SG13G2	SG25H3	SGB25V
NPN1 f_T / f_{max} (GHz)	250 / 340	300 / 500	110 / 180	75 / 95
NPN2 f_T / f_{max} (GHz)	45 / 165	120 / 330	45 / 140	45 / 90
NPN3 f_T / f_{max} (GHz)			25 / 80	25 / 70
NPN1 BV_{CEO} (V)	1.7	1.7	2.3	2.4
NPN2 BV_{CEO} (V)	3.7	2.5	5	4
NPN3 BV_{CEO} (V)			7	7
NPN1 BV_{CBO} (V)	5	4.8	6	7
NPN2 BV_{CBO} (V)	15	8.5	10.5	15
NPN3 BV_{CBO} (V)			21	20



CMOS Section

Feature		SG25H3*	SG13S**	
Core Supply Voltage (V)		2.5	3.3	1.2
nMOS	V_{TH} (V)	0.6	0.71	0.50
	I_{OUT}*** (µA/µm)	540	280	480
	I_{OFF} (pA/µm)	3	10	500
pMOS	V_{TH} (V)	−0.6	−0.61	−0.47
	I_{OUT} (µA/µm)	−230	−220	−200
	I_{OFF} (pA/µm)	−3	−10	−500

* Parameters for SGB25V are similar
** Parameters for SG13G2 are similar
*** @ VG = 2.5 V

Passive Section

Feature	SG25H3	SGB25V	SG13S	SG13G2
MIM Capacitor (fF/µm²)	1	1	1.5	1.5
N+ Poly Resistor (Ω/□)	210	205	-	-
P+ Poly Resistor (Ω/□)	280	310	250	260
High Poly Resistor (Ω/□)	1600	2000	1300	1360
Varactor C_{max}/C_{min}	3	3	1.7	1.7
Inductor Q @ 5 GHz	18 (1 nH)	18 (1 nH)	18 (1 nH)	18 (1 nH)
Inductor Q @10 GHz	20 (1 nH)	20 (1 nH)	20 (1 nH)	20 (1 nH)
Inductor Q @ 5 GHz	37 (1 nH)*	37 (1 nH)*	37 (1 nH)*	37 (1 nH)*

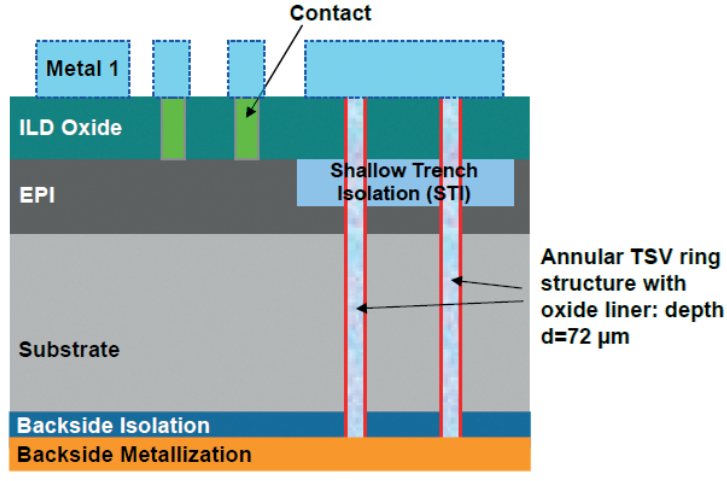
* with LBE

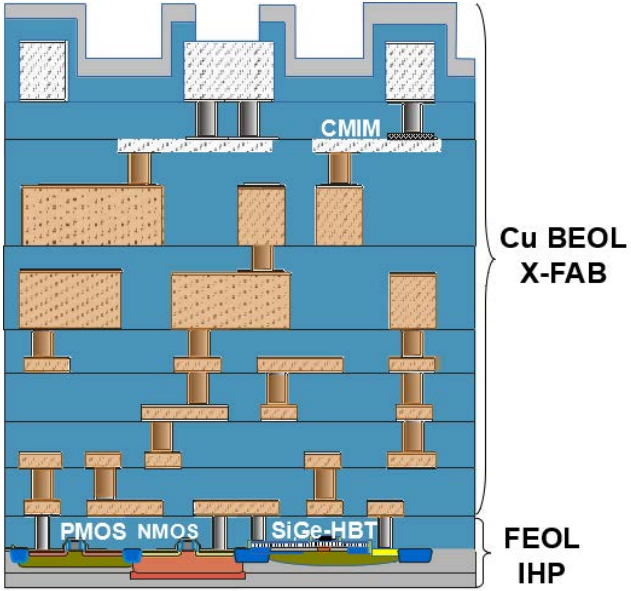
TSV-Module

Through-Silicon Via Module for RF Grounding available in SG13 technologies.

Single TSVs can provide low GND inductance ≈ 30 pH to improve RF circuit performance.

A backside metallization is provided as chip-to-package interface for die attach.





SG13S/G2 FEOL

XR013 Cu BEOL

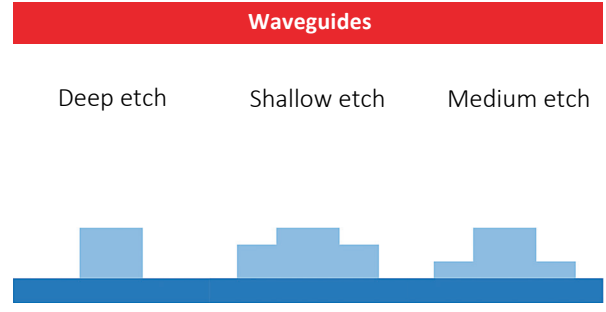
Joint foundry offer
via
IHP Solutions

- More than 2 times higher current handling of thin metal lines
- More than 3 times higher current handling of small vias
- 40% higher area density of MIM capacitor

Photonic Integrated Circuit Module

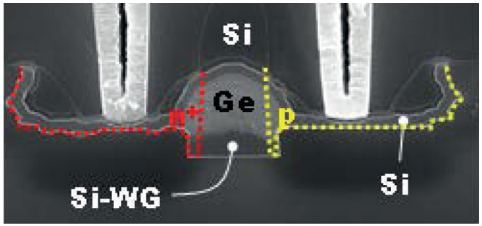
Main features

- 220 nm Si on 2 µm SiO_2
- 3 etch depths
- 4 doping levels (p, n, p+, n+)
- 3 + 2 thick Al backend metal layers
- Germanium photo diodes (f_{3dB} > 60 GHz)
- HBT's (f_T/f_{max} = 220/290 GHz)
- Optional localized backside etching
- Complements BiCMOS in SG25H5_EPIC



	Deep etch	Shallow etch	Medium etch
Loss	3.0 dB/cm	0.9 dB/cm	2.5 dB/cm
Core width	450 nm	700 nm	500 nm
Features		Grating etch	p, n, p+, n+ possible

Photodiode



- f_{3dB} > 60 GHz@−2 V
- R > 0.8 A/W
- I_{dark} = 200 nA@−2 V, 20°C
- Ipkiss3 building block
- GDSII cell

Phase-shifter

Typical values

- 7 mm in length
- V_{π} L = 3.0 Vcm, V_{bias} = −2 V
- C = 1.8 pF

Design Kit

The design kits support a Cadence mixed signal platform.

Analog/Mixed-Signal Flow:

- Verification
  - Cadence Assura and PVS DRC/LVS/QRC
  - Calibre DRC/LVS
  - POLYTEDA PowerDRC/LVS
- Selected PDKs offer Cadence VPS for EMIR Analysis
- Sonnet support for all design kits
- Empire support for all design kits
- ADS support via Golden Gate/RFIC dynamic link to Cadence available
- Standalone ADS Kit including Momentum substrate layer file
- EMX stack for SG13 technology with aluminium backend

Digital Design Flow:

- Digital CMOS libraries and IO cells for 0.25 µm CMOS and 0.13 µm CMOS are available: Behavorial Models (Verilog), Timing Files (LIB) and Abstracts (LEF)
- Simulation: ModelSim (Mentor Graphics), Incisive Enterprise Simulator IES (Cadence)
- Logic Synthesis: Design Compiler (Synopsys), RTL Compiler (Cadence)
- Formal Verification: Formality (Synopsys)
- Scan Insertion and Test Pattern Generation: DFT Compiler/TetraMax (Synopsys)
- Place & Route: Encounter Digital Implementation System (Cadence)
- OA views of digital libraries are available for mixed-signal flow
- Power Analysis: PrimeTime with PrimePower Option (Synopsys)
- Static Timing Analysis: PrimeTime (Synopsys)

Models	SG25H3	SGB25V	SG25H5 EPIC	SG13S	SG13G2
PSP	x	x	x	x	x
MOSVAR				x	x
HSIM		x		x	x
VBIC/HICUM	x	x	x	x	x

EM simulations	SG25H3	SGB25V	SG25H5 EPIC	SG13S	SG13G2
Keysight momentum	x	x		x	x
Sonnet	x	x		x	x

Design platforms	SG25H3	SGB25V	SG25H5 EPIC	SG13S	SG13G2
Cadence Virtuoso & Virtuoso XL	x	x	x	x	x
Cadence Spectre & Spectre RF	x	x	x	x	x
Cadence Assura DRC/LVS/QRC	x	x	x	x	x
Cadence VPS & Voltus FI	x	x		x	x
Keysight ADS	x	x	x	x	x
Mentor Calibre DRC/LVS				x	x
Polyteda Power DRC/LVS			x	x	x
TexEDA RFIC Studio	x	x	x	x	x
NI AWR Design Environment	x			x	x
IPKISS3			x		

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Leibniz Association

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