

# Foundry technologies

## 130-nm CMOS and RF CMOS

### Highlights

#### Standard Features

- *Twin-well CMOS technology on nonepitaxial p- doped substrate*
- *Low-resistance cobalt-silicide n+ and p+ doped polysilicon and diffusion regions*
- *Up to three thick copper wiring levels*
- *Four to eight levels of global copper metal (CMOS 8SFG)*
- *Five to eight levels of copper metal with an Al-Cu-Al last metal sequence (CMOS 8RF)*
- *Wire-bond or C4 solder-bump terminals*

#### Optional Features

- *Range of FET devices to optimize power and performance, including an isolated triple-well NFET (CMOS 8RF)*
- *Vast array of passive analog RF devices, including:*
  - *Low-tolerance resistors with high and low sheet resistivity*
  - *High-quality factor (Q) copper and aluminum inductors and inductor models (CMOS 8RF)*
  - *High-value, low-tolerance capacitors*
  - *Electrically writable e-fuses*
- *IBM and third-party logic library design tools*

IBM Microelectronics offers a comprehensive suite of foundry products and services for its industry-standard 130-nm CMOS-based technology family, which includes a high-speed analog radio frequency (RF) CMOS technology. Customers can choose appropriate devices and design tools to match their application requirements.

#### Base technology

The IBM **CMOS 8SFG** advanced process technology features 130-nm lithography. The fine lines and high densities characterizing this state-of-the-art silicon process can support leading-edge microprocessors, communications and computer data-processing applications. CMOS 8SFG uses low-resistance copper wiring at all metal levels, enabling high wiring density with minimal timing delays. Up to three thick copper wiring metal options provide design flexibility.

#### Related technology

IBM **CMOS 8RF** offers several enhancements to CMOS 8SFG including FET structures that support high-frequency RF-compatible models, a broad range of optional passive devices and copper and aluminum wiring with a thick last metal. A high-quality analog design

### IBM 130-nm Technology Highlights

Category	Base Technology CMOS 8SFG	Related Technology CMOS 8RF
Process	Industry-standard 130-nm CMOS	CMOS 8SFG additional passive devices
Wiring	Copper	Copper and aluminum with analog metal

kit ensures close correlation between simulated and measured performance. In addition, the technology maintains compatible design rules with the corresponding levels in CMOS 8SFG.

CMOS 8RF is an ideal semiconductor technology for low-cost, high-performance wireless applications such as Bluetooth™ technologies, local area networks, handsets and global positioning systems.

#### For more information

For more information, contact IBM at [foundation@us.ibm.com](mailto:foundation@us.ibm.com)

<b>CMOS Specifications (common to 130-nm technology family)</b>	
Lithography	130 nm
Voltage ( $V_{DD}$ )	1.2 V or 1.5 V
Additional power supply options	2.5 V / 3.3 V I/O
<b>Standard NFET / PFET</b>	
$L_{min}$	0.24 $\mu$ m
$L_p$	0.22 $\mu$ m
$V_t$	0.355 V / -0.30 V
$I_{Dsat}$	530 mA / 210 mA
$I_{off}$	300 pA/ $\mu$ m / 250 pA/ $\mu$ m
$T_{ox}$	2.2 nm
<b>Thick-oxide NFET / PFET</b>	
$L_{min}$	0.24 $\mu$ m
$L_p$	0.22 $\mu$ m
$V_t$	0.41 V / -0.44 V
$I_{Dsat}$	660 mA / 260 mA
$I_{off}$	10 pA/ $\mu$ m / 10 pA/ $\mu$ m
$T_{ox}$	5.2 nm

Note: Specifications given for 1.2 V (nominal) at 25°C.

<b>CMOS Specifications</b>	<b>CMOS 8SFG</b>	<b>CMOS 8RF</b>
Isolation	Shallow trench	Shallow trench
Levels of metal	4–8	5–8
Metallization	Copper	Copper, Aluminum
<b>FET devices (max. voltage)*</b>		
Ultra-thin NFET / PFET (1.2V)	✓	–
Standard NFET / PFET (1.5V)	✓	✓
Zero- $V_t$ NFET (1.5V)	✓	✓
Isolated NFET (1.5V)	–	✓
Low- $V_t$ NFET / PFET (1.5V)	✓	–
High- $V_t$ NFET / PFET (1.5V)	✓	–
Low-power NFET / PFET (1.5V)	✓	✓
Thick-oxide NFET / PFET (2.5V)	✓	✓
Thick-oxide Zero $V_t$ NFET (2.5V)	✓	✓
Thick-oxide Isolated NFET (2.5V)	–	✓
Thick-oxide I/O NFET / PFET (3.3V)	✓	✓

\*FET devices can be used in a variety of design options that are defined in the respective technology design manuals.



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Passive Devices	CMOS 8SFG	CMOS 8RF
<b>Capacitors</b>		
MIM	1.35 fF/μm <sup>2</sup> ± 15%	1.35 fF/μm <sup>2</sup> ± 15%
Single MIM	–	2.0 fF/μm <sup>2</sup> ± 10%
Dual MIM	–	4.1 fF/μm <sup>2</sup> ± 10%
Thick-oxide MOS	5.85 fF/μm <sup>2</sup> ± 10%	5.85 fF/μm <sup>2</sup> ± 10%
Thin-oxide MOS	11.1 fF/μm <sup>2</sup> ± 10%	11.1 fF/μm <sup>2</sup> ± 10%
<b>Fuses</b>		
	Laser, e-fuse	e-fuse
<b>Inductors*</b>		
Analog metal spiral	–	Q = 10
Stacked dual-metal spiral	–	Q = 24
<b>Resistors</b>		
n+ diffusion	73 Ω/□ ± 11%	73 Ω/□ ± 15%
p+ polysilicon	340 Ω/□ ± 12%	340 Ω/□ ± 20%
p- polysilicon	–	1450 Ω/□ ± 25%
Tantalum nitride	–	60 Ω/□ ± 6%
<b>Varactors</b>		
Hyperabrupt junction	–	✓
MOS	✓	✓

\* All inductor measurements were taken at L = 1 nH and f = 2 GHz.

Design Tools	CMOS 8SFG	CMOS 8RF
<b>Models</b>		
BSIM3	✓	✓
Cadence Spectre	✓	–
Cadence SpectreRF	–	✓
IBM digital	✓	–
Synopsys HSPICE	✓	✓
<b>Verification tools</b>		
Avant! Hercules	✓	✓
Cadence Assura	–	✓
Mentor Graphics Calibre	✓	✓
<b>Libraries</b>		
Artisan	✓	✓
IBM	✓	–

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