IBM

Foundry technologies
180-nm CMOS, RF CMOS and SiGe BiCMOS

Highlights

Standard Features

- ***Twin-well CMOS technology on nonepitaxial p- doped substrate***
- ***Low-resistance cobalt-silicide n+ and p+ doped polysilicon and diffusions***
- ***Two to six levels of global metal (copper and aluminum)***
- ***Wire-bond or C4 solder-bump terminals***

Optional Features

- ***Range of high-speed and high-voltage heterojunction bipolar transistors (HBTs) using IBM SiGe technology***
- ***Range of FET devices, including multiple V_t options and an isolated triple-well NFET***
- ***Vast array of passive analog RF devices, including:***
  - ***Low-tolerance resistors with high and low sheet resistivity***
  - ***High-density metal-insulator-metal (MIM) capacitors***
  - ***Linear varactors with wide tuning ranges***
  - ***High-quality factor (Q) copper and aluminum inductors and inductor models***
  - ***High-value, low-tolerance capacitors***
  - ***Electrically writable e-fuses***

IBM Microelectronics offers a comprehensive suite of foundry products and services for its industry-standard 180-nm CMOS-based technology family, which includes both high-speed analog radio frequency (RF) CMOS and leading-edge silicon germanium (SiGe) BiCMOS technologies. Customers can choose appropriate devices and design tools to match their application requirements.

Base technology

The IBM **CMOS 7SF** advanced process technology features 180-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 7SF uses low-resistance copper wiring at all metal levels, enabling high wiring density with minimal timing delays.

IBM 180-nm Technology Highlights

Category	Base Technology CMOS 7SF	Related Technologies CMOS 7RF	BiCMOS 7WL	BiCMOS 7HP
Process	Industry-standard 180-nm CMOS	CMOS 7SF with passive devices	CMOS 7RF with 60-GHz bipolar devices	CMOS 7SF with120-GHz bipolar devices
Wiring	Copper or aluminum	Copper and aluminum with analog metal	Copper and aluminum with analog metal	Copper with analog metal
Bipolar devices	N/A	N/A	3 HBTs, wireless focus	2 HBTs, high-speed optical/digital focus

Related technologies

IBM **CMOS 7RF** is ideal for cost-sensitive wireless applications, local area networks (LANs), and handsets. The FET structures, identical to those used in CMOS 7SF, support analog RF-compatible models. This technology offers a wide range of optional passive features to enable analog designs. The design kit and design tools match those available for BiCMOS 7WL (see below) to streamline migration of designs from CMOS 7RF to BiCMOS 7WL. This technology uses copper wiring at the first metal level and aluminum wiring at the remaining metal levels while maintaining identical ground rules with the corresponding levels in CMOS 7SF.

CMOS Specifications (common to 180-nm technology family)	
Lithography	180 nm
Voltage (V_{DD})	1.8 V
Additional power supply options	2.5 V / 3.3 V I/O
Standard NFET / PFET	
L_{min}	0.18 µm
L_{eff}	0.11 µm / 0.14 µm
V_t	0.43 V / -0.38 V
I_{Dsat}	600 mA / 260 mA
I_{off}	<80 pA/µm (at 25°C)
T_{ox}	3.5 nm
Thick-oxide NFET / PFET	
L_{min}	0.4 µm
L_{eff}	0.29 µm
V_t	0.64 V / -0.67 V
I_{Dsat}	550 mA / 235 mA
I_{off}	<1 pA/µm (at 25°C)
T_{ox}	7 nm

CMOS Specifications	CMOS 7SF	CMOS 7RF	BiCMOS 7WL	BiCMOS 7HP
Isolation	Shallow trench	Shallow trench	Shallow and deep trench	Shallow and deep trench
Levels of metal	2–6	3–8	3–7	4–7
Metallization	Copper	Copper, aluminum	Copper, aluminum	Copper
FET devices (nominal voltage)*				
Standard NFET / PFET (1.8V)	✓	✓	✓	✓
Zero V_t NFET (1.8V)	✓	–	–	–
Isolated NFET (1.8V)	–	✓	✓	✓
High V_t NFET / PFET (1.8V)	✓	–	–	✓
High Gain NFET / PFET (1.8V)	✓	✓	–	–
Thick-oxide NFET (3.3V)	✓	✓	✓	✓
Thick-oxide Isolated NFET (3.3V)	–	✓	✓	✓
Thick-oxide Zero V_t NFET (3.3V)	✓	–	–	–

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

Bipolar Specifications	BiCMOS 7WL		BiCMOS 7HP	
Subcollector	Implanted		Buried	
Emitter	Not self-aligned		Self-aligned	
Transistor	High-speed	High-breakdown	High-speed	High-breakdown
Gain (ß)	140	140	500	350
V_a	155 V	170 V	90 V	120 V
BV_{ceo} / BV_{cbo}	3.3 V / 11 V	4.2 V / 9 V	1.8 V / 6.4 V	4.25 V / 12.5 V
C_{eb} / C_{cb}	5.7 / 1.97 fF/µm^2	6.6 / 1.75 fF/µm^2	9.5 / 4.6 fF/µm^2	8.5 / 2.8 fF/µm^2
R_e	9 Ω	15 Ω	2.5 Ω	45 Ω
F_t (at V_{ce} = 1 V)	60 GHz	45 GHz	120 GHz	27 GHz
F_{max} (at V_{ce} = 1 V)	85 GHz	73 GHz	100 GHz	57 GHz
$A_{e\ min}$ (length × width)	0.72 µm × 0.24 µm	0.72 µm × 0.24 µm	0.64 µm × 0.2 µm	0.64 µm × 0.2 µm

The IBM **BiCMOS 7WL** technology is best suited to meet higher performance consumer needs for wireless LAN and handset applications. BiCMOS 7WL uses leading-edge SiGe technology with deep trench isolation and a partially self-aligned bipolar structure. An implanted subcollector, the use of copper wiring at the first metal level and aluminum wiring at the remaining metal levels and other innovative processing techniques reduce the product complexity and processing time compared to standard BiCMOS products. BiCMOS 7WL offers both high-speed and high-breakdown bipolar devices to support speed versus voltage design trade-offs (see Bipolar Specifications on previous page). Optional passive features include an unparalleled selection of capacitors, inductors, resistors and varactors. BiCMOS 7WL FET structures are identical to those used in CMOS 7SF. Device models are optimized for RF and high-speed analog applications.

Passive Devices	CMOS 7SF	CMOS 7RF	BiCMOS 7WL	BiCMOS 7HP
Capacitors				
Single MIM	1.35 fF/µm² ± 15%	2.0 fF/µm² ± 10%	2.0 fF/µm² ± 10%	1.0 fF/µm² ± 15%
Dual MIM		4.0 fF/µm² ± 10%	4.0 fF/µm² ± 10%	
Thick-oxide MOS	7.9 fF/µm² ± 10%	7.9 fF/µm² ± 10%	7.9 fF/µm² ± 10%	2.5 fF/µm² ± 15%
Fuses	Laser	E-fuses	E-fuses	
Inductors*				
Analog metal spiral		Q = 10	Q = 10	
Thick analog metal spiral		Q = 18	Q = 18	Q = 18
Dual-metal spiral parallel stacked		Q = 24	Q = 24	
Resistors				
p+ diffusion	105 Ω/❑ ± 15%	105 Ω/❑ ± 15%	105 Ω/❑ ± 15%	105 Ω/❑ ± 15%
n+ diffusion	72 Ω/❑ ± 10%	72 Ω/❑ ± 10%	72 Ω/❑ ± 10%	72 Ω/❑ ± 10%
p+ polysilicon	260 Ω/❑ ± 15%	270 Ω/❑ ± 15%	270 Ω/❑ ± 15%	260 Ω/❑ ± 15%
p- polysilicon		1600 Ω/❑ ± 20%	1600 Ω/❑ ± 20%	1600 Ω/❑ ± 25%
Tantalum nitride on M1		61 Ω/❑ ± 6%	61 Ω/❑ ± 6%	142 Ω/❑ ± 10%
n+ subcollector diffusion				8.1 Ω/❑ ± 15%
Varactors				
Collector-base junction	–	–	✓	✓
Hyperabrupt junction	–	✓	✓	–
MOS	✓	✓	✓	✓

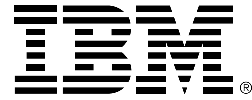
* All inductor measurements were taken at L = 1 nH and f = 2 GHz.

Design Tools	CMOS 7SF	CMOS 7RF	BiCMOS 7WL	BiCMOS 7HP
Models				
Agilent ADS	–	✓	✓	✓
BSIM3	✓	✓	✓	✓
Cadence Spectre	✓	–	–	–
Cadence SpectreRF	–	✓	✓	✓
IBM digital	✓	–	–	–
Synopsys HSPICE	✓	✓	✓	✓
Verification tools				
Avant! Hercules	✓	–	–	–
Cadence Assura	–	✓	✓	✓
Mentor Graphics Calibre	✓	✓	✓	–
Libraries				
Artisan	✓	✓	–	–
IBM	✓	✓	✓	✓

IBM **BiCMOS 7HP** incorporates a high-performance SiGe bipolar device optimized for high-speed or low-power applications. It is ideally suited to applications in the 40- to 100-GHz frequency space, such as fiber-optic communication transceivers and automotive proximity sensors. This technology has a fully self-aligned structure, a buried n+ doped subcollector and a base profile optimized for maximum operating frequencies. High-speed and high-breakdown BiCMOS 7HP transistors support speed versus voltage design trade-offs. BiCMOS 7HP design tools offer analog RF-compatible models for all the technology features. Like CMOS 7SF, BiCMOS 7HP uses copper wiring at all metal levels.

For more information

For more information, contact IBM at foundry@us.ibm.com



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