# 0.13 µm Process Family:

# XC013

## 0.13 Micron Modular CMOS Analog Mixed Signal Technology

X-FAB
MIXED-SIGNAL FOUNDRY EXPERTS

## DESCRIPTION

The XC013 series is X-FAB's 0.13 micrometer mixed-signal CMOS technology. This single poly 0.13 micrometer process with up to six metal layers is well-suited for highly integrated mixed-signal System-on-Chip applications addressing the communications, consumer or industrial market.

The modular process concept allows for a high flexibility in analog and mixed-signal designs. Comprehensive design rules, precise SPICE models, analog and digital libraries, IPs and development kits support the process on platforms supplied by the major EDA tool vendors.

## KEY FEATURES OVERVIEW

- 0.13-micron single poly, N-well CMOS basic process
- Easy shrink from 0.18µm
- Modular concept, 8" wafers
- Optional 3.3V module
- Isolation well for all 1.5V and3.3V MOS devices
- Up to six AL-based metal layers
- Metal-Insulator-Metal capacitors
- High resistive poly resistors
- One-Time programmable memory module for trimming and data storage
- Operating Conditions: Tj = -40°C ... +125°C
- Common-Timing-Engine in Cadence P&R encounter platform
- Cadence & Mentor Graphic PDK

## APPLICATIONS

- Mixed-signal embedded systems / systems-on-chip (SOC)
- Low power mixed-signal circuits
- High Precision mixed-signal circuits

## QUALITY ASSURANCE

X-FAB spends a lot of effort to improve the product quality and reliability and to provide comprehensive support to the customers. This is maintained by the direct and flexible customer interface, the reliable manufacturing process and complex test and evaluation conceptions, all of them guided by strict quality improvement procedures developed by X-FAB. This comprehensive, proprietary quality improvement system has been certified to fulfill the requirements of the ISO 9001, QS 9000, VDA 6, ISO TS 16949 and other standards.

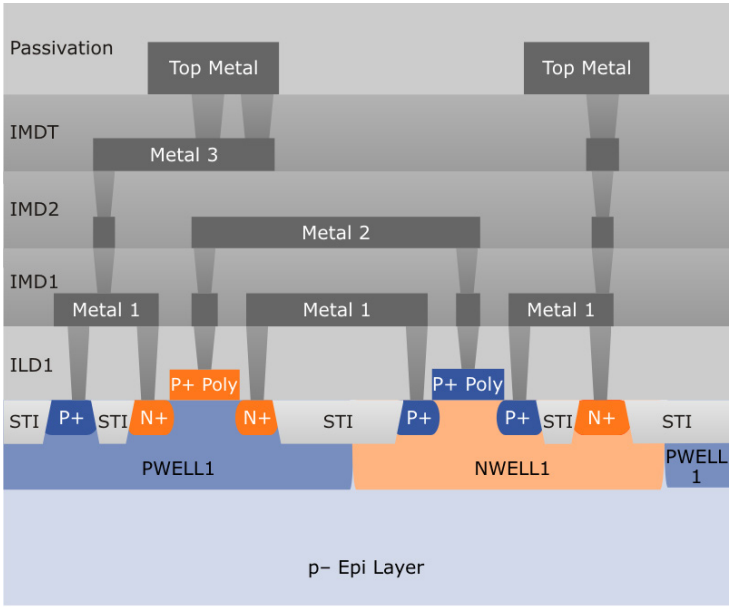
## DELIVERABLES

- PCM tested wafers
- Optional engineering services: Multi Project Wafer (MPW) and Multi Layer Mask Service (MLM)
- Optional design services: feasibility studies, Place & Route, synthesis, custom block development

## XC013 PROCESS FLOW

| CORE Module | Additional Modules | |
|---|---|---|
| Wafer Start | | |
| Active area | | |
| | Deep N-well | DNWELL |
| | 3.3V well | MOS3A |
| 1.5V wells | | |
| 1.5V Gate oxide | | |
| | 3.3V Gate oxide | MOS3A |
| Poly silicon gate | | |
| Source/drain implants | | |
| | HRPOLY implant | HRPOLY |
| Salicidation | | |
| | Contact | |
| | Metal 1 | |
| | Via 1 | METAL2 |
| | Metal 2 | |
| | Via 2 | METAL3 |
| | Metal 3 | |
| | Via 3 | METAL4 |
| | Metal 4 | |
| | Via 4 | METAL5 |
| | Metal 5 | |
| | Single MIM capacitor | MIM |
| | Top Via | METMID |
| | Top metal | |
| PAD | | |
| | | mask steps |

## XC013 DEVICES SCHEMATIC CROSS SECTION

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## XC013 CORE MODULE

| Module Name | Descriptions | Masks No. |
|---|---|---|
| MOSLP | 1.5V Low Power MOS module | 11 |

## XC013 ADDITIONAL MODULES

| Module Name | Descriptions | Masks No. |
|---|---|---|
| MOS3A | 3.3V CMOS module | 5 |
| HRPOLY | High resistance polysilicon module | 1 |
| ISOMOS | Triple well isolated CMOS module | 1 |
| MIM | Single MIM capacitor module | 1 |
| METAL1 | Metal 1 module | 2 |
| METAL2 | Metal 2 module | 2 |
| METAL3 | Metal 3 module | 2 |
| METAL4 | Metal 4 module | 2 |
| METAL5 | Metal 5 module | 2 |
| METMID | Top metal module | 2 |
| OTP | One-Time Programmable memory module | 0 |

## XC013 RESTRICTION FOR MODULE COMBINATIONS

| Module name | Use of the module also requires use of the following module(s) | Use of the module is not available with the use of the following module(s) |
|---|---|---|
| MOSLP | METAL1+ METAL2+METAL3+METMID | |
| MIM | METMID | |
| METAL3 | METAL1+METAL2 | |
| METAL4 | METAL3 | |
| METAL5 | METAL4 | |

## XC013 BASIC DESIGN RULES

| Mask | width [µm] | Spacing [µm] |
|---|---|---|
| N-well | 0.6 | 0.6 |
| Active Area | 0.15 | 0.21 |
| Poly-silicon Gate/Resistor | 0.13 | 0.18 |
| Contact | 0.16 | 0.18 |
| Metal 1 | 0.16 | 0.18 |
| Via 1...4 / Metal 2...5 | 0.19 / 0.20 | 0.22 / 0.21 |
| Via TP / Metal top | 0.36 / 0.44 | 0.35 / 0.46 |

## XC013 METAL OPTIONS

| Number of Metals | Available Metal Layer Combinations | Module Names |
|---|---|---|
| 4 | MET1 - MET2 - MET3 - METTP | MOSLP+METAL1+METAL2+METAL3+METMID |
| 5 | MET1 - MET2 - MET3 - MET4 - METTP | MOSLP+METAL1+METAL2+METAL3+METAL4+METMID |
| 6 | MET1 - MET2 - MET3 - MET4 - MET5 - METTP | MOSLP+METAL1+METAL2+METAL3+METAL4+METAL5+METMID |

## Active Devices

### XC013 MOS LOW VOLTAGE TRANSISTORS

| Device | Name | Available with module | \|VT\| [V] | IDS [µA/µm] | IOFF [pA/µm] | BVDS [V] | Max. VDS [V] | Max. VGS [V] |
|---|---|---|---|---|---|---|---|---|
| 1.5V native NMOS | nn | MOSLP | 0.24 | 270 | | | | |
| 1.5V LP NMOS | ne | MOSLP | 0.54 | 455 | < 30 | > 2.5 | 1.65 | 1.65 |
| 1.5V LP PMOS | pe, pe_5 | MOSLP | 0.59 | 190 | < 30 | > 2.5 | 1.65 | 1.65 |
| 3.3V native NMOS | nn3 | MOS3A | 0.1 | 358 | | | | |
| 3.3V NMOS | ne3 | MOS3A | 0.72 | 544 | < 10 | > 5.5 | 3.6 | 3.6 |
| 3.3V PMOS | pe3, pe3_5 | MOS3A | 0.65 | 330 | < 10 | > 5.5 | 3.6 | 3.6 |

### XC013 ISOMOS TRANSISTORS

| Device | Name | Available with module | \|VT\| [V] | IDS [µA/µm] | IOFF [pA/µm] | \|BVDS\| [V] | max. VDS [V] |
|---|---|---|---|---|---|---|---|
| Iso. 1.5V LP NMOS | nei, nei_6 | ISOMOS | 0.54 | 465 | < 30 | > 2.5 | 1.65 |
| Iso. 1.5V LP PMOS | pei, pei_5 | ISOMOS | 0.59 | 190 | < 30 | > 2.5 | 1.65 |
| Iso3.3V NMOS | ne3i, ne3i_6 | MOS3A+ISOMOS | 0.72 | 544 | < 10 | > 5.5 | 3.6 |
| Iso. 3.3V PMOS | pe3i, pe3i_5 | MOS3A+ISOMOS | 0.65 | 330 | < 10 | > 5.5 | 3.6 |

### XC013 BIPOLAR TRANSISTORS

| Device | Name | Available | BETA | VA [V] | BVCEO [V] | VBE [mV] | max. VCE [V] |
|---|---|---|---|---|---|---|---|
| 3.3V vPNP | qpva3/b3/c3 * | MOS3A | 4.8/4.6/4.5 | > 100 | | 705/665/630 | 3.6 |
| 3.3V vNPN | qnva3 | MOS3A+ISOMOS | 9.1 | 76 | > 13 | 710 | 3.6 |

* devices with emitter area = 2x2µm² / 5x5µm² / 10x10µm²

## Passive Devices

### XC013 MIM CAPACITORS

| Device | Name | Available | Area Cap [fF/µm²] | Voltage Coeff. [ppm/V] | Temp. Coeff. [$10^{-6}$/K] | \|BV\| [V] | max. VTB [V] |
|---|---|---|---|---|---|---|---|
| M3/MTP MIM<br>M4/MTP MIM<br>M5/MTP MIM | cmm4t,<br>cmm5t,<br>cmm6t | MIM | 1 | 14.12 | 38.9 | > 20 | 3.6 |

### XC013 POLY RESISTORS

| Device | Name | Available with module | RS [Ω/□] | Temp. Coeff. [$10^{-3}$/K] | Max VTB [V] |
|---|---|---|---|---|---|
| N+ Poly | rnp1, rnp1_3* | MOSLP | 184 | -0.14 | 3.6 |
| P+ Poly | rpp1, rpp1_3* | MOSLP | 260 | 0.005 | 3.6 |
| P+ Poly silicided | rpp1s, rpp1s_3* | MOSLP | 6.6 | 2.97 | 3.6 |
| P- Poly | rpp1k1, rpp1k1_3* | HRPOLY | 990 | -0.89 | 3.6 |

* These devices are variants of the corresponding basic device with an underlying well, but not crossing a well boundary. The models realise an improved description of bulk voltage dependency. Parameters of these devices are identical to the corresponding basic device.

## Passive Devices *(Continued)*

### XC013 DIFFUSION RESISTORS

| Device | Name | Available with module | RS [Ω/□] | Thickness/junc. depth [µm] | Temp. Coeff. [$10^{-3}$/K] | Max VTB [V] |
|---|---|---|---|---|---|---|
| 1.5V N+ diffusion | rdn | MOSLP | 77 | 0.23 | 1.47 | 1.65 |
| 1.5V N+ diffusion silicided | rdns | MOSLP | 6 | | 3.07 | 1.65 |
| 1.5V P+ diffusion | rdp | MOSLP | 81 | 0.225 | 1.47 | 1.65 |
| 1.5V P+ diffusion silicided | rdps | MOSLP | 6 | | 2.95 | 1.65 |
| 1.5V N-well | rnw | MOSLP | 985 | 1.7 | 3.06 | 1.65 |
| 3.3V N+ diffusion | rdn3 | MOS3A | 73 | | 1.44 | 3.6 |
| 3.3V N+ diffusion silicided | rdn3s | MOS3A | 6 | | 3.11 | 3.6 |
| 3.3V P+ diffusion | rdp3 | MOS3A | 83 | | 1.45 | 3.6 |
| 3.3V P+ diffusion silicided | rdp3s | MOS3A | 6 | | 3.11 | 3.6 |
| 3.3V N-well | rnw3 | MOS3A | 1140 | 2.5 | 3.6 | 3.6 |
| DN-well | rdnw | ISOMOS | 1600 | 3.5 | 5.9 | 3.6 |

### XC013 METAL RESISTORS

| Device | Name | Available with module | RS [Ω/ □] | Thickness/junc. depth [µm] | Max J/W [mA/µm] | Temp. Coeff. [$10^{-3}$/K] | Max VTB [V] |
|---|---|---|---|---|---|---|---|
| Metal 1 | rm1 | MOSLP | 0.23 | 0.295 | 0.18 | 2.91 | 3.6 |
| Metal 2 | rm2 | METAL2 | 0.095 | 0.475 | 0.8 | 3.05 | 3.6 |
| Metal 3 | rm3 | METAL3 | 0.095 | 0.475 | 0.8 | 3.43 | 3.6 |
| Metal 4 | rm4 | METAL4 | 0.095 | 0.475 | 0.8 | 3.43 | 3.6 |
| Metal 5 | rm5 | METAL5 | 0.095 | 0.475 | 0.8 | 3.43 | 3.6 |
| Top Metal | rmtp | METMID | 0.035 | 3.04 | 1.6 | 4 | 3.6 |

### XC013 DIFFUSION DIODES

| Device | Name | Available with module | Area Cap [fF/µm²] | \|BV\| [V] | Leakage Current [fA/µm²] | Max VCC [V] |
|---|---|---|---|---|---|---|
| N+ diif. /Psub | dnat | MOSLP | 0.137 | > 5.5 | $2.5 \times 10^{-2}$ | 1.65 |
| 1.5V N+ diff. / PW | dn | MOSLP | 0.922 | > 5.5 | 1.5 | 1.65 |
| 1.5V P+ diff. /NW | dp | MOSLP | 1.205 | > 5.5 | $6.8 \times 10^{-4}$ | 1.65 |
| 1.5V NW /Psub | dnw | MOSLP | 0.126 | > 9 | $2.0 \times 10^{-3}$ | 3.6 |
| 3.3V N+ diff. /PW | dn3 | MOS3A | 1.013 | > 5.5 | $9.3 \times 10^{-2}$ | 3.6 |
| 3.3V P+ diff. /NW | dp3 | MOS3A | 1.052 | > 5.5 | $3.53 \times 10^{-5}$ | 3.6 |
| 3.3V NW /Psub | dnw3 | MOS3A | 0.127 | > 9 | $3.71 \times 10^{-4}$ | 3.6 |
| 1.5V P+ diff. /DNW | dpdnw | ISOMOS | 0.577 | > 5.5 | $5.7 \times 10^{-5}$ | 1.65 |
| PW /DNW | dpw | ISOMOS | 0.268 | > 9 | $7.16 \times 10^{-5}$ | 3.6 |
| 3.3V PW /DNW | dpw3 | MOS3A+ISOMOS | 0.284 | > 9 | $9.16 \times 10^{-5}$ | 3.6 |
| DNW /Psub | ddnw | ISOMOS | 0.111 | > 9 | $2.0 \times 10^{-3}$ | 3.6 |

## STANDARD CELLS LIBRARIES

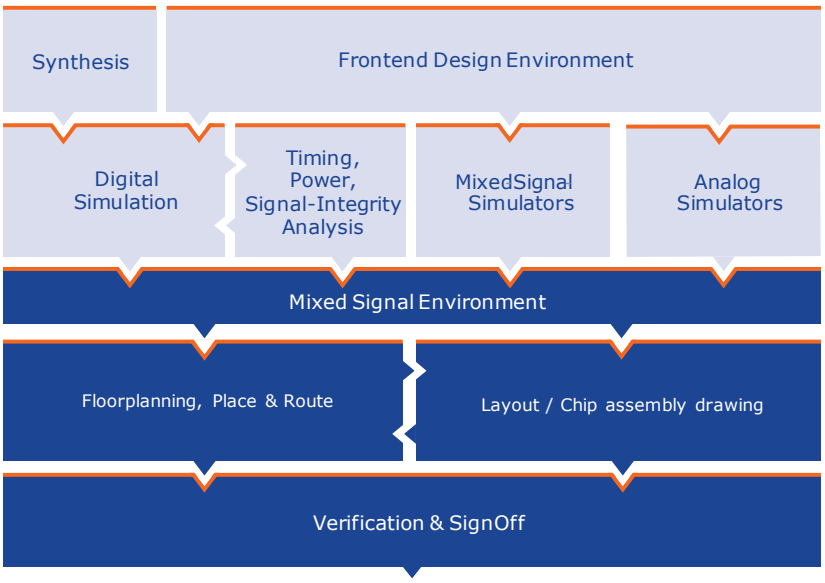
| XC013 STD CELLS LIBRARY | | | |
|---|---|---|---|
| **Device** | **Library feature** | **Voltage range** | **Application benefits** |
| D_CELLS_JI | Junction Isolated, Standard Speed & Low Power | 1.5V | standard speed, low power cells (X0) available, noise protection, voltage shifting |

## I/O LIBRARIES

| XC013 I/O CELLS LIBRARY | | | | | |
|---|---|---|---|---|---|
| **Device** | **Library Feature** | **$V_{CORE}$ *** | **$V_{IO}$ *** | **ESD Level** | **Application benefits** |
| IO_CELLS_3V | Standard, 1.5V/3.3VV multi supply voltage | 1.5V | 3.3V | 2kV HBM | Pad limited |
| IO_CELLS_F3V | Standard, 1.5V/3.3V multi supply voltage | 1.5V | 3.3V | 2kV HBM | Core limited |
| IO_CELLS_C1V5 | Standard, $V_{CORE}$=$V_{IO}$ single supply voltage | 1.5V | 1.5V | 2kV HBM | Pad limited |
| IO_CELLS_FC1V5 | Standard, $V_{CORE}$=$V_{IO}$ single supply voltage | 1.5V | 1.5V | 2kV HBM | Core limited |
| IO_CELLS_C3V | Standard, $V_{CORE}$=$V_{IO}$ single supply voltage | 3.3V/2.2V | 3.3V/2.2V | 2kV HBM | Pad limited |
| IO_CELLS_FC3V | Standard, $V_{CORE}$=$V_{IO}$ single supply voltage | 3.3V/2.2V | 3.3V/2.2V | 2kV HBM | Core limited |

* Please refer to the library databook for details about available PVT ranges

## XC013 SUPPORTED EDA TOOLS




*Note: Diagram shows overview of reference flow at X-FAB. Detailed information of suported EDA tools for major vendors like Cadence, Mentor and Synopsys can be found on X-FAB's online technical information center X-TIC.*

## X-FAB'S IC DEVELOPMENT KIT "THEKIT"

The X-FAB IC Development Kit is a complete solution for easy access to X-FAB technologies. TheKit is the best interface between standard CAE tools and X-FAB's processes and libraries. TheKit is available in two versions, the Master Kit and the Master Kit Plus. Both versions contain documentation, a set of software programs and utilities, digital and I/O libraries which contain full front-end and back-end information for the development of digital, analog and mixed signal circuits. Tutorials and application notes are included as well. The Master Kit Plus additionally provides a set of general purpose analog functions mentioned in section "Analog Library Cells" and is subject to a particular license.

## CONTACT

Marketing & Sales Headquarters
X-FAB Semiconductor Foundries AG
Haarbergstr. 67, 99097 Erfurt, Germany
Tel.: 49-361-427 6160
Fax: 49-361-427 6161
Email: info@xfab.com
Web: http://www.xfab.com

Technology & Design Support
hotline@xfab.com
Silicon Foundry Services
sifo@xfab.com

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