

0.35 µm Process Family:

> XU035



0.35 Micron Modular Analog Mixed Signal Ultra High-Voltage Technology

DESCRIPTION

The XU035 series is X-FAB's 0.35-micron Modular 700V Ultra-High-Voltage (UHV) Technology. It is specifically engineered for AC LED driver and efficient AC/DC conversion applications. Based on a robust single poly, twin metal 0.35-micron process with a single 5V gate oxide, the platform features additional process modules such as a third UHV Metal, Zener Diode, Depletion MOS Startup Devices, MIM capacitors and high resistance polysilicon. A range of 20V and 40V medium voltage devices complete

of offering. With its low specific On-resistance UHV devices and the lowest mask count in the foundry industry, the XU035 platform is well suited for cost-effective consumer applications. Designers can rely on X-FAB's comprehensive design support including PDKs for all major design environments, precision spice models, analog and digital libraries, as well as 2kV ESD support.

KEY FEATURES OVERVIEW

- 700V UHV low-side extended drain NMOS/PMOS process
- 0.35 µm single 5V gate oxide CMOS technology optimized for high volume consumer applications on 8" float zone wafers
- Industry leading lowest mask count from as low as 13 masks
- Competitive 700V RDSon of 14 Ωmm²
- 20V and 40V medium voltage transistors
- Wide spectrum of analog passive devices, e.g. UHV resistors, MOS and MIM capacitors and protection diodes
- Optional third standard or UHV power metals
- Spectre and HSpice spice models
- 3.3V & 5V low power junction isolated standard cells library
- 2kV HBM ESD support
- Cadence, Mentor, Synopsys and Tanner PDK support
- Operating Conditions: Tj = -40°C ... +125°C

APPLICATIONS

- AC/DC Conversion Applications
- AC LED Lighting
- Mixed-signal embedded systems / systems-on-chip (SOC)
- Power management ICs

QUALITY ASSURANCE

X-FAB spends a lot of effort to improve the product quality and reliability and to provide competent 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, 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

PRIMITIVE DEVICES

- NMOS/PMOS transistors
- Bipolar transistors
- Diodes
- Capacitors
- Resistors
- HV DMOS transistors

XU035 PROCESS MODULES

| CORE Module | Remarks | Mask No. |
|-------------|-----------------|----------|
| MOSS | Core MOS module | 13 |

| FEOL Module | Remarks | Mask No. |
|-------------|---|----------|
| DEPL | Depletion NMOS module | 1 |
| HRPOLY | High resistance polysilicon 1 module | 1 |
| XRPOLY | Very high resistance polysilicon 1 module | 1 |
| ESD | UHVMOS ESD module | 1 |
| ZENER | Zener diode module | 1 |
| MOS400 | UHV 400V MOS devices | 0 |
| MOS700 | UHV 700V MOS devices | 0 |

| BEOL Module | Remarks | Mask No. |
|-------------|-----------------------|----------|
| MIM | MIM capacitor module | 1 |
| MIMA | MIM capacitor module | 1 |
| METAL3 | Metal 3 module | 2 |
| UHVMET | Ultra HV metal module | 2 |

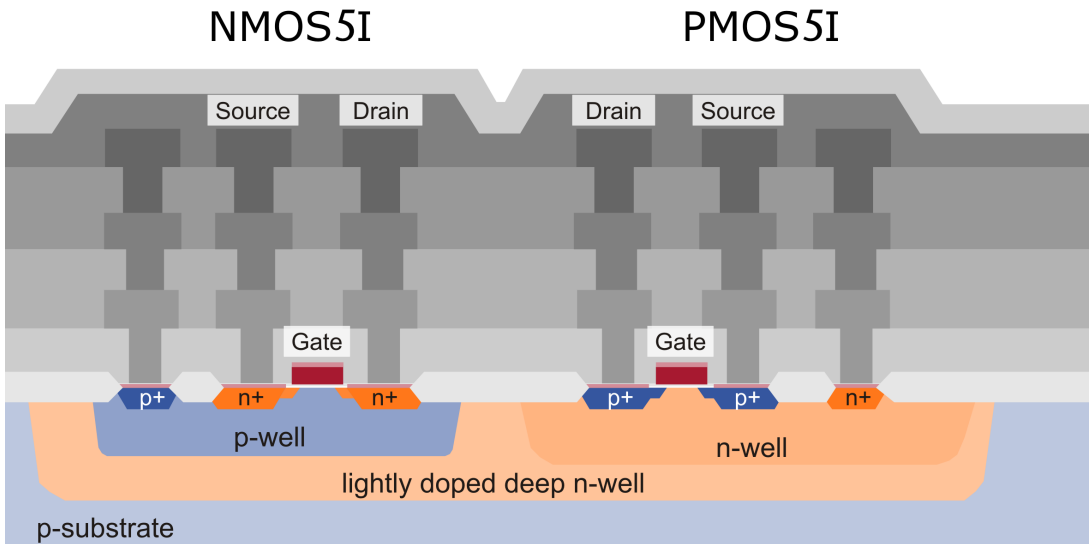
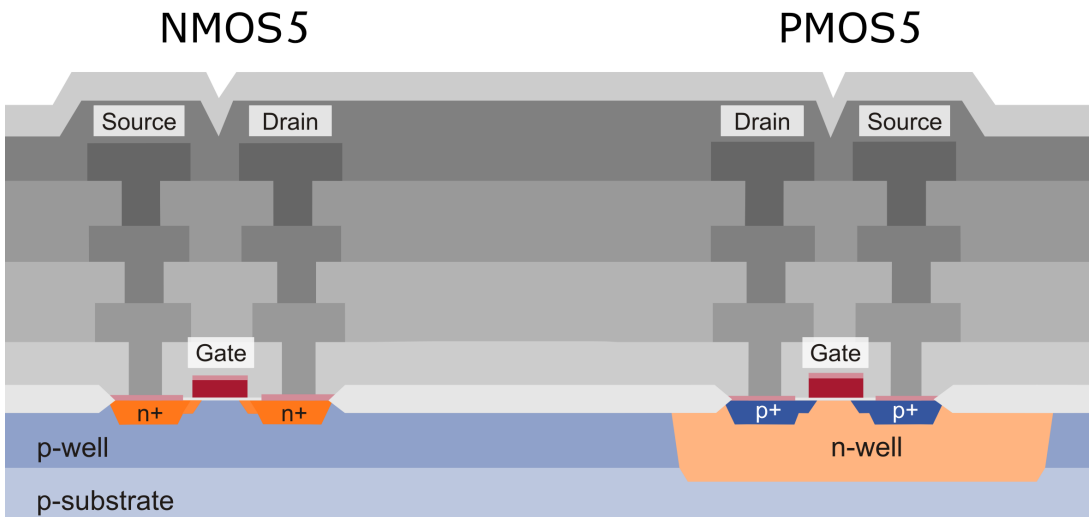
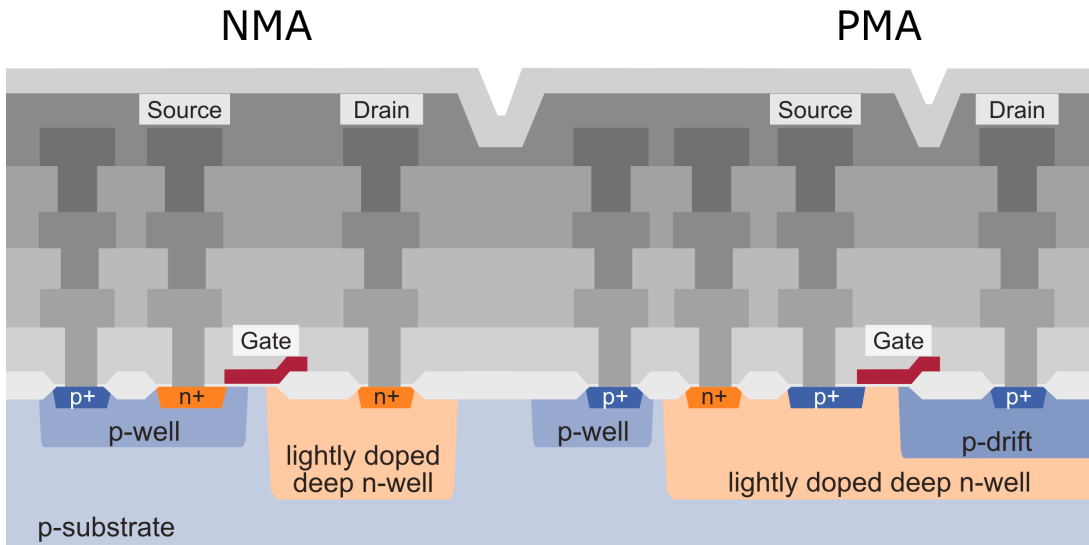
XU035 RESTRICTIONS FOR MODULE COMBINATIONS

| 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) |
|-------------|--|--|
| XRPOLY | HRPOLY | |
| MOS400 | UHVMET | |
| MIM | METAL3 | MIMA, UHVMET |
| MIMA | | MIM, METAL3 |
| METAL3 | | UHVMET |
| UHVMET | | METAL3 |

XU035 BASIC DESIGN RULES

| Mask | width [µm] | Spacing [µm] |
|----------------------------|------------|--------------|
| N-well | 1.6 | 1.0 |
| Active Area | 0.5 | 0.6 |
| Poly-silicon Gate/Resistor | 0.35 | 0.45 |
| Contact | 0.4 | 0.4 |
| Metal 1, Via 1, Via 2 | 0.5 | 0.45 |
| Metal 2/3 | 0.6 | 0.5 / 0.6 |
| UHV Metal | 3.0 | 2.5 |

XU035 SCHEMATIC CROSS SECTIONS



XU035 PROCESS FLOW

| Core Module | Additional Modules | |
|---|---------------------|--------------------------|
| Zero Layer | | |
| DW Implant | | |
| Active Area | | |
| N-well | | |
| P-well | | |
| | ESD Implant | ESD |
| P-Drift | | |
| | ND Implant | DEPL |
| | High Res. Poly | HRPOLY |
| Poly 1 | | |
| | Sub-surface Implant | ZENER |
| N-LDD Implant | | |
| P-LDD Implant | | |
| N+ implant | | |
| P+ Implant | | |
| | Very High Res. Poly | XRPOLY |
| Contact | | |
| | MIMA Capacitor | MIMA (Not with MATEL3) |
| Metal 1 | | |
| Via 1 | | |
| | MIM Capacitor | MIM (Not with UHVMET) |
| Metal 2 | | |
| | Via 2 | METAL3 (Not with UHVMET) |
| | Metal 3 | |
| | Via HV | |
| | Metal UHV | UHVMET (Not with MATEL3) |
| Passivation | | |
| Back side grinding (on customer request) | | |
| | | mask steps |

Active Devices

XU035 LOW VOLTAGE TRANSISTORS

| Device | Name | Available with module | VT [V] | IDS [μA/μm] | BVDS [V] | Max. VDS [V] | Max. VGS[V] |
|------------------|--------|-----------------------|---------|-------------|-----------|--------------|-------------|
| 5V NMOS | nmos5 | MOSS | 0.94 | 425 | > 7 | 5.5 | 5.5 |
| 5V PMOS | pmos5 | MOSS | 0.94 | 195 | > 7 | 5.5 | 5.5 |
| 5V isolated NMOS | nmos5i | MOSS | 0.88 | 435 | > 7 | 5.5 | 5.5 |
| 5V isolated PMOS | pmos5i | MOSS | 1.03 | 185 | > 7 | 5.5 | 5.5 |

Active Devices (Continued)

| XU035 HIGH VOLTAGE TRANSISTORS | | | | | | | | | |
|--------------------------------|------|------------------------|------------|----------------------------|-------------------------------|--|---------------|----------------|---------------|
| Device | Name | Available w/ module | VT [V] | IDS [μ A/ μ m] | RON [k Ω · μ m] | RON*area [m Ω ·mm ²] | BVDSS [V] | Max. VDS[V] | Max VGS[V] |
| 20V drain NMOS | nma | MOSS | 0.86 | 345 | 7.6 | 32 | > 27 | 20 | 5.5 |
| 20V drain PMOS | pma | MOSS | 1.01 | 140 | 30 | 143 | > 30 | 20 | 5.5 |
| 20V d & s PMOS | pmma | MOSS | 1.12 | 45 | 65 | 480 | > 30 | 20 | 5.5 |
| 20V drain NDMOS | ndma | MOSS | 0.84 | 360 | 7.3 | 31 | > 27 | 20 | 5.5 |
| 40V drain PMOS | pmb | MOSS | 1.12 | 75 | 65 | 460 | > 50 | 40 | 5.5 |
| 40V NDMOS | ndmb | MOSS | 0.86 | 185 | 17.5 | 120 | > 50 | 40 | 5.5 |

| XU035 ULTRA HIGH VOLTAGE TRANSISTORS | | | | | | | | | |
|--------------------------------------|--------|------------------------|------------|----------------------------|-------------------------------|--|---------------|----------------|---------------|
| Device | Name | Available w/ module | VT [V] | IDS [μ A/ μ m] | RON [k Ω · μ m] | RON*A [Ω ·mm ²] | BVDSS [V] | Max. VDS[V] | Max VGS[V] |
| 400V NDMOS | ndrv | MOS400 +UHVMET | 0.79 | 108 | 100 | 5 | > 460 | 400 | 5.5 |
| 400V NDMOS ESD | ndre | MOS400 +ESD +UHVMET | 0.79 | 108 | 100 | 5 | > 460 | 400 | 5.5 |
| 700V NMOS | nuv | MOS700 +UHVMET | 0.79 | 61 | 190 | 15 | > 720 | 620 | 5.5 |
| 700V PMOS | puv | MOS700 +UHVMET | 1.07 | 14 | 710 | 64 | > 720 | 600 | 5.5 |
| 700V NMOS | nuvp* | MOS700 | 0.79 | 57 | 186 | 14.7 | > 750 | 650 | 5.5 |
| 700V NDMOS | nduv | MOS700 +UHVMET | 0.77 | 70 | 175 | 14 | > 720 | 620 | 5.5 |
| 700V NDMOS ESD | ndue | MOS700 +ESD +UHVMET | 0.77 | 70 | 170 | 13.6 | > 720 | 620 | 5.5 |
| 700V NDMOS | nduvp* | MOS700 | 0.77 | 65 | 165 | 13.2 | > 750 | 650 | 5.5 |
| 700V NDMOS ESD | nduep* | MOS700 +ESD | 0.77 | 67 | 165 | 13.2 | > 750 | 650 | 5.5 |
| 700V NMOS meander | nduvf | MOS700 | 0.74 | 51 | 240 | 19.3 | > 720 | 600 | 5.5 |
| 700V NDMOS mean- der ESD | nduef | MOS700 +ESD | 0.74 | 51 | 240 | 19.3 | > 720 | 620 | 5.5 |

* with drain pad inside

| XU035 DEPLETION TRANSISTORS | | | | | | | | | |
|-----------------------------|--------|--------------------------------|------------|----------------------------|-------------------------------|--|---------------|-----------------|-----------------|
| Device | Name | Available with module | VT [V] | IDS [μ A/ μ m] | RON [k Ω · μ m] | RON*A [Ω ·mm ²] | BVDSS [V] | Max. VDS [V] | Max. VGS [V] |
| 40V Depl NDMOS | ndmbd | DEPL | 0.86 | 210 | 15 | 0.105 | > 50 | 40 | 5.5 |
| 400V Depl NDMOS | ndrvd | DEPL +UHVMET +MOS400 | 1.04 | 111 | 97 | 4.9 | > 460 | 400 | 5.5 |
| 400V Depl NDMOS ESD | ndred | DEPL +ESD +UH- VMET +MOS400 | 1.02 | 110 | 97 | 4.9 | > 460 | 400 | 5.5 |
| 700V Depl NDMOS | nduvd | DEPL +UHVMET +MOS700 | 1.0 | 72 | 170 | 13.6 | > 720 | 620 | 5.5 |
| 700V Depl NDMOS | nduudp | DEPL +MOS700 | 1.0 | 67 | 165 | 13.2 | > 750 | 650 | 5.5 |
| 700V Depl NDMOS ESD | ndued | DEPL+ESD +UHV- MET +MOS700 | 0.96 | 72 | 170 | 13.6 | > 720 | 620 | 5.5 |
| 700V Depl NDMOS ESD | nduedp | DEPL+ESD +MOS700 | 0.96 | 68 | 165 | 13.2 | > 750 | 650 | 5.5 |

Active Devices (Continued)

XU035 BIPOLAR TRANSISTORS

| Device | Name | Available | BETA | VA [V] | BVCEO [V] | VBE [mV] | Max. VCE [V] |
|-----------------------|----------------------|-----------|------|--------|-----------|----------|--------------|
| Vertical PNP | qp1, qp2, qp3, qp4 * | MOSS | 10 | 260 | | 685 | 5 |
| Isolated vertical PNP | qnvc | MOSS | 65 | 82 | > 7 | 647 | 5.5 |

* Vertical PNP bipolar transistor with emitter size 8 μ m² / 155 μ m² / 12.5 μ m² / 100 μ m² respectively

Passive Devices

XU035 DIFFUSION & METAL RESISTORS

| Device | Name | Available with module | RS [Ω/\square] | Thickness/junc. depth [μ m] | Temp. Co-eff. [$10^{-3}/K$] | Max VTB [V] |
|-----------------------------|------------------|-----------------------|-------------------------|----------------------------------|-------------------------------|---------------|
| P+ diff in Nwell | rdp, rdp_io* | MOSS | 140 | 0.21 | 1.6 | 6 |
| P+ diff in Nwell /LDD Nwell | rdplw, rdplw_io* | MOSS | 140 | 0.21 | 1.6 | 6 |
| N+ diff in Pwell | rdn, rdn_io* | MOSS | 85 | 0.17 | 1.6 | 6 |
| N+ diff in Pwell /LDD Nwell | rdnlw, rdnlw_io* | MOSS | 85 | 0.17 | 1.6 | 6 |
| N-well | rw | MOSS | 1140 | 1.7 | 3.9 | 6 |
| Metal 1 | rm1 | MOSS | 0.090 | 0.58 | 3.4 | 100 |
| Metal 2 | rm2t | MOSS | 0.045 | 1.0 | 3.4 | 100 |
| Metal 2 | rm2 | UHV MET, METAL3 | 0.090 | 0.58 | 3.4 | 100 |
| Metal 3 | rm3t | METAL3 | 0.045 | 1.0 | 3.4 | 100 |
| UHV metal | rmhv | UHV MET | 0.030 | 1.3 | 3.4 | 650 |

* This device should be used only as an ESD protection resistor in IO-cells

XU035 POLY RESISTORS

| Device | Name | Available with module | RS [Ω/\square] | Temp. Coeff. [$10^{-3}/K$] | Max VTB [V] |
|-----------------------------|------|-----------------------|-------------------------|------------------------------|---------------|
| N+ HRES polysilicon 1 | rnp1 | HRPOLY | 950 | -2.8 | 100 |
| P+ HRES polysilicon 1 | rpp1 | HRPOLY | 425 | -0.51 | 100 |
| Polysilicon 1 | rp1 | MOSS | 43 | 0.8 | 100 |
| Very high value polysilicon | rhp1 | XRPOLY | 11,000 | -5.33 | 100 |

XU035 CAPACITORS

| Device | Name | Available with module | Area Cap [fF/ μ m ²] | BV [V] | Perimeter Cap. [fF/ μ m] | Max. VTB [V] |
|--------------------------|-----------------------|-----------------------|--------------------------------------|---------|------------------------------|----------------|
| Poly/M1/M2 | csw | MOSS | 120 (fF) | | | 100 |
| Poly/M1/M2/M3 finger | csandwtf | METAL3 | 275 (fF) | | | 100 |
| Poly - N-depletion MOS | cpd5 | DEPL | 2.1 | > 10 | 0.18 | 5.5 (max. VGB) |
| Isolated Poly1/NDepl MOS | cpd5i, cpd5ih, cpd5iu | DEPL | 2.1 | > 10 | 0.18 | 5.5 (max. VGB) |
| Metal2/Metal3 MIM | cmm, cmm2 | MIM | 1.25 | > 20 | 0.111 | 100 |
| Metal1/Metal2 MIM | cmma, cmma2 | MIMA | 1.25 | > 20 | 0.111 | 100 |

Passive Devices (Continued)

| XU035 DIFFUSION DIODES | | | | | | |
|------------------------|--------|-----------------------|--------|---------------------------------------|-----------------------|-------------|
| Device | Name | Available with module | BV [V] | Area junc. cap. [fF/μm ²] | Sidewall Cap. [fF/μm] | Max VCC [V] |
| N+ diff /Pwell | dn | MOSS | > 8 | 0.76 | 0.29 | 6 |
| P+ diff /Nwell | dp | MOSS | > 8 | 1.03 | 0.23 | 6 |
| P+ diff /LDD Nwell | dplw | MOSS | > 8 | 0.33 | 0.21 | 6 |
| Nwell /Psub | dw | MOSS | > 8 | 0.05 | 0.65 | 6 |
| Nwell /Psub | dwh | MOSS | > 15 | 0.04 | 0.32 | 10 |
| Pwell /LDD Nwell | dwplw | MOSS | > 14 | 0.27 | 0.31 | 10 |
| Pwell / LDD Nwell | dwplwh | MOSS | > 25 | 0.27 | 0.31 | 20 |
| LDD Nwell /Psub | dlw | MOSS | > 14 | 0.03 | 0.41 | 10 |
| LDD Nwell /Psub | dlwh | MOSS | > 50 | 0.03 | 0.41 | 40 |
| LDD Nwell /Psub | dlwu | MOSS | > 750 | 0.03 | 0.41 | 650 |

| XU035 ZENER DIODE | | | | | | |
|-------------------|--------------------|-----------------------|--------|-------------------|--------------|------------------------------------|
| Device | Name | Available with module | Rz [Ω] | Temp Coeff [mV/K] | Vreverse [V] | Max Ireverse [mA/μm ²] |
| 5.8V Zener | dzeg, dzegh, dzegu | ZENER | 600 | 2 | 5.8 | 0.1 |

| XU035 SCHOTTKY DIODES | | | | | | |
|-----------------------|------|-----------------------|--------------|----------------------|---------|--------------|
| Device | Name | Available with module | Vforward [V] | Leakage Current [nA] | BV [V] | Max. VCC [V] |
| Schottky | dsd | MOSS | 0.21 | 17 | > 22 | 18 |

LOGIC & I/O LIBRARY

| XU035 LOGIC LIBRARY | | | |
|---------------------|------------------------------|---------------|------------------------------------|
| Device | Library feature | Voltage range | Application benefits |
| D_CELLSL_J15V | Low power, junction isolated | 5V | Min. power consumption, min. noise |

| XU035 I/O LIBRARY | | | | | |
|-------------------|---|---------------------|-------------------|-----------|----------------------|
| Device | Library Feature | V _{CORE} * | V _{IO} * | ESD Level | Application benefits |
| IO_CELLS_5V | Standard, V _{CORE} ≤ V _{IO} multi supply voltage | 5.0V | 5.0V | 4kV HBM | Pad limited |
| | | 3.3V | 5.0V | | |
| | | 3.3V | 3.3V | | |
| IO_CELLS_F5V | Standard, V _{CORE} ≤ V _{IO} multi supply voltage | 5.0V | 5.0V | 2kV HBM | Core limited |
| | | 3.3V | 5.0V | | |
| | | 3.3V | 3.3V | | |

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

LOGIC & I/O LIBRARY (Continued)

| XH035 HV CELLS | | | | |
|----------------|--|---------------|-------------|-----------------------|
| Device | Library Feature | Voltage Range | ESD Level | Application benefits |
| HV_CELLS | Special LV I/O, operating voltage specific HV ESD protection cells | LV, 12V-40V | 3kV-8kV HBM | Customized I/O Design |

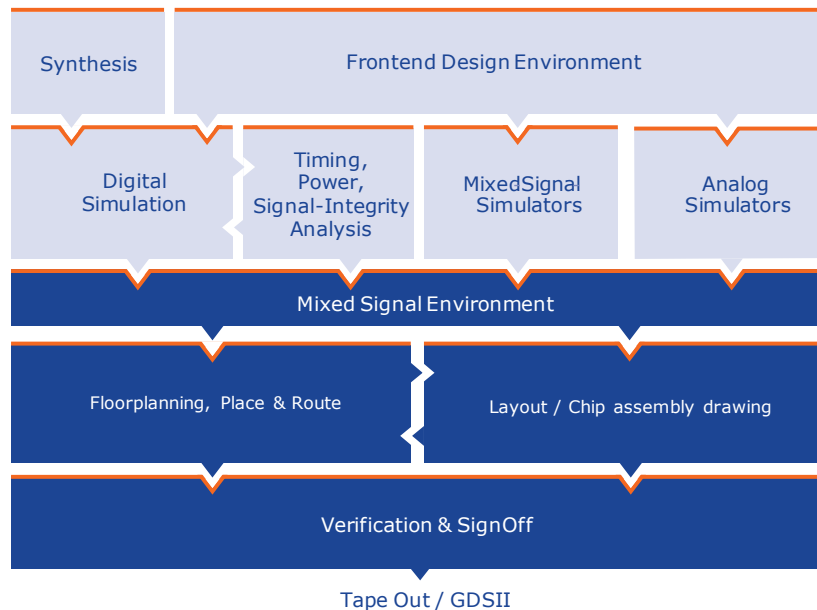
ANALOG LIBRARIES

| XU035 GENERAL ANALOG LIBRARY | | | |
|------------------------------|-----------|-----------------------------------|---------------------------|
| Library | Cell Name | Operating conditions | Required module |
| Operational Amplifiers | aopac01ji | VDD: 3.5V to 5.5V; T: -40...125°C | MOSS, METAL3, MIM, HRPOLY |
| Operational Amplifiers | aopac02ji | VDD: 3.5V to 5.5V; T: -40...125°C | MOSS, METAL3, MIM |
| Bandgap | abgpc01ji | VDD: 2.5V to 5.5V; T: -40...125°C | MOSS, METAL3, MIM, HRPOLY |
| Bias Cell | acsoc01ji | VDD: 3.5V to 5.5V; T: -40...125°C | MOSS, METAL3, MIM, HRPOLY |

| XU035 APPLICATION SPECIFIC ANALOG LIBRARY | | | |
|---|-------------------|---|----------------------------|
| Library | Cell Name | Operating conditions | Required module |
| XSMPS Supply Regulation | xpshvbc01_5V | UHV power supply cell | MOSS, HRPOLY, DEPL, UHVMET |
| | xpslstc01_5V | Linear regulator 5V | MOSS, HRPOLY |
| | xpsporc01_5V | Power on Reset with hysteresis | MOSS, HRPOLY, DEPL |
| XSMPS Reference and Current formers | abgpc01(/2/3)_1v8 | Bandgap voltage reference: 2.25V, 2.5V, 2.55V | MOSS, HRPOLY |
| | xpsbgbc01_5V | Multi-voltage reference buffer | MOSS, HRPOLY |
| | xpscsc01_5V | General purpose current source | MOSS, HRPOLY |
| XSMPS Oscillators and other core cells | xpspwm01_5V | 40kHz saw oscillator | MOSS, HRPOLY |
| | xpscscmp01_5V | Comparator | MOSS |
| | xpsswdc01_5V | Output Buffer | MOSS |
| XSMPS Protection | xpsopac01_5V | Error Amplifier | MOSS |
| | xpscsmc01_5V | Current sense | MOSS, HRPOLY |
| | xpsolpc01_5V | Over-load protection | MOSS, HRPOLY |
| | xpstmpc01_5V | Over-temperature detector | MOSS, HRPOLY |

Operating conditions: VDD: 4.5V to 5.5V; T: -40...125°C.

XU035 SUPPORTED EDA TOOLS



Note: Diagram shows overview of reference flow at X-FAB. Detailed information of supported 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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