0.18 µm Process Family:

XH018

0.18 Micron Modular Analog Mixed HV Technology

MIXED-SIGNAL FOUNDRY EXPERTS

DESCRIPTION

The XH018 series is X-FAB's 0.18 micron Modular Mixed Signal HV CMOS Technology. Based upon the industrial standard single poly with up to six metal layers 0.18 micron drawn gate length N-well process, integrated with high-voltage, Non-Volatile-Memory and ultra-low noise modules, the platform is ideal for SOC applications in the automotive market, as well as emdedded high-voltage applications in the communications, consumer and industrial market.
Comprehensive design rules, precise SPICE models, analog and digital libraries, IPs and development kits support the process for major EDA vendors.

KEY FEATURES OVERVIEW

- 0.18-micron single poly, up to six-metal N-well CMOS basic process
- Modular concept
- Up to 175°C operating temperature, extending beyond AEC Q100 requirement
- Low Power core module
- Thick metal layers optional module
- Integrated digital, analog, HV and NVM in a single process
- Isolation well for all 1.8V, 3.3V and 40V MOS devices
- 10-45V sym./asy. HVMOS transistors
- 35-45V DMOS transistors
- Vertical NPN BJT
- ESD protected HV PNP for reverse polarity protection (e.g. for LIN pins)
- **Ultra-low-noise NMOS/PMOS (3.3V) and 1.8V NMOS transistors**
- **MOS 1/f noise characterized & included in model**
- Low Vt Transistors
- High-reliability NVM using SONOS technology
- Various types of memory compiler (e.g. RAM, ROM, NVRAM)
- Integrated high-ohmic poly resistor in core module (zero mask penalty)
- High capacitance single, double, triple MIM and fringe capacitors
- Characterized photo diodesUV to NIR sensible
- Schottky & protection diodes
- High density up to 125000 gates per mm^2
- Typical and worst-case models (MOS, BJT, RES, CAP)
- Assura verification deck
- Common-Timing-Engine in Cadence P&R encounter platform
- Cadence & Mentor Graphic PDK

APPLICATIONS

- High temperature mixed-signal embedded systems/ system-on-chip (SOC)
- Automotive
- Analog frontends for sensors
- High precision mixed signal circuits
- Embedded high-voltage applications
- Power management IC
- Communications, Consumer and Industrial markets

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, IATF 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

DIGITAL LIBRARIES

- Foundry-specific optimized libraries
- Low power, low leakage library for energy effecient and small size digital blocks
- Junction isolated library for low noise applications
- Multi-voltage library for multi-voltage and power cut-off applications
- Liberty™ synthesis models
- IEEE 1364 Verilog simulation models
- IEEE 1076.4 VHDL-VITAL simulation models

ANALOG LIBRARIES

- Operational Amplifiers
- Bias Cells
- Digital-to-Analog Converters
- Analog-to-Digital Converters
- RC Oscillators
- Power-On/Off-Reset
- Comperators
- Bandgaps
- Voltage Regulators
- Over-Temperature Detector

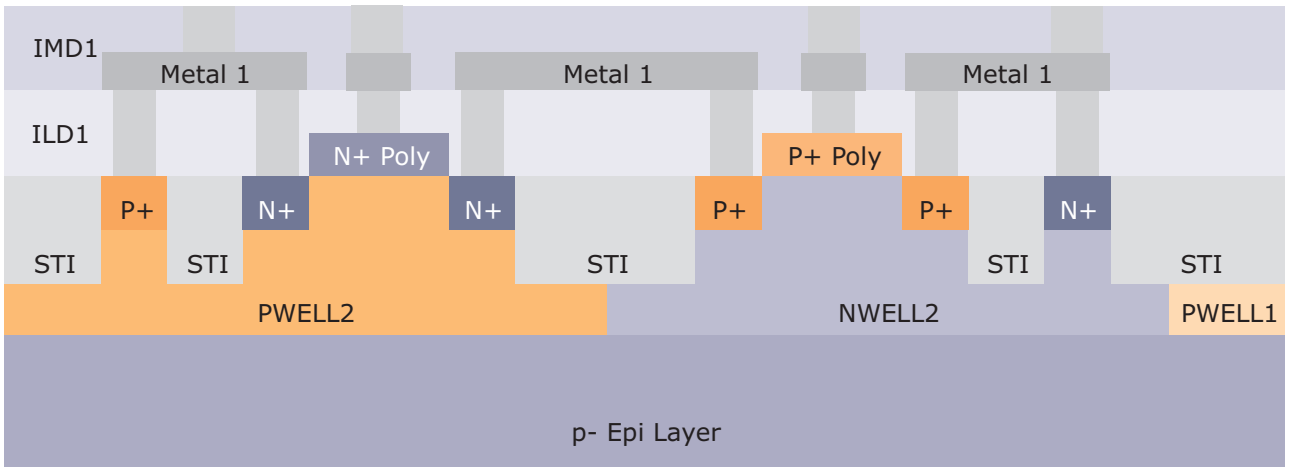
PRIMITIVE DEVICES

- (Isolated) 1.8V, 3.3V LP NMOS/PMOS
- 10V, 15V, 20V, 45V HVMOS, Sym./Asy.
- 35V, 40V, 45V lateral DMOS, isolated
- Depletion NMOS
- Bipolar transistors, ESD protected
- Sandwich, Fringe, MIM Capacitors
- Resistors
- Diffusion, Schottky, Protection, Photo Diodes

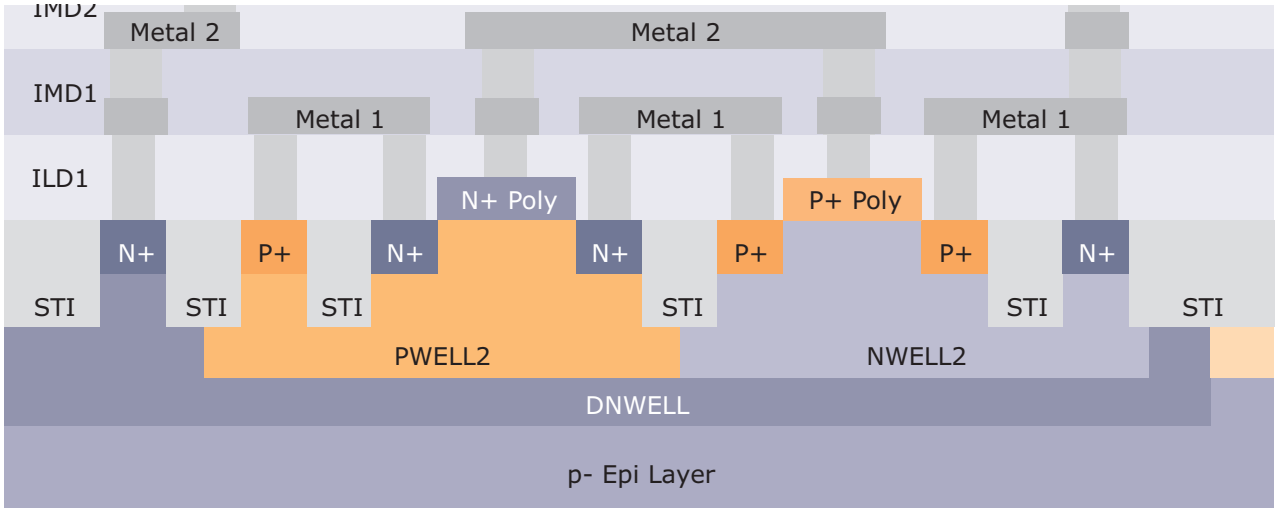
XH018 BASIC DESIGN RULES

Mask	width [µm]	Spacing [µm]
N-well	0.86	1.4
Active Area	0.22	0.28
Poly-silicon Gate	0.18	0.25
Poly-silicon Resistor	0.44	0.44
Contact	0.22	0.25
Metal 1	0.23	0.23
Via 1, 2, 3, 4	0.26	0.26
Metal 2, 3, 4, 5	0.28	0.28
Top Via	0.36	0.35
Top Metal	0.44	0.46
Thick Metal	3.0	2.5

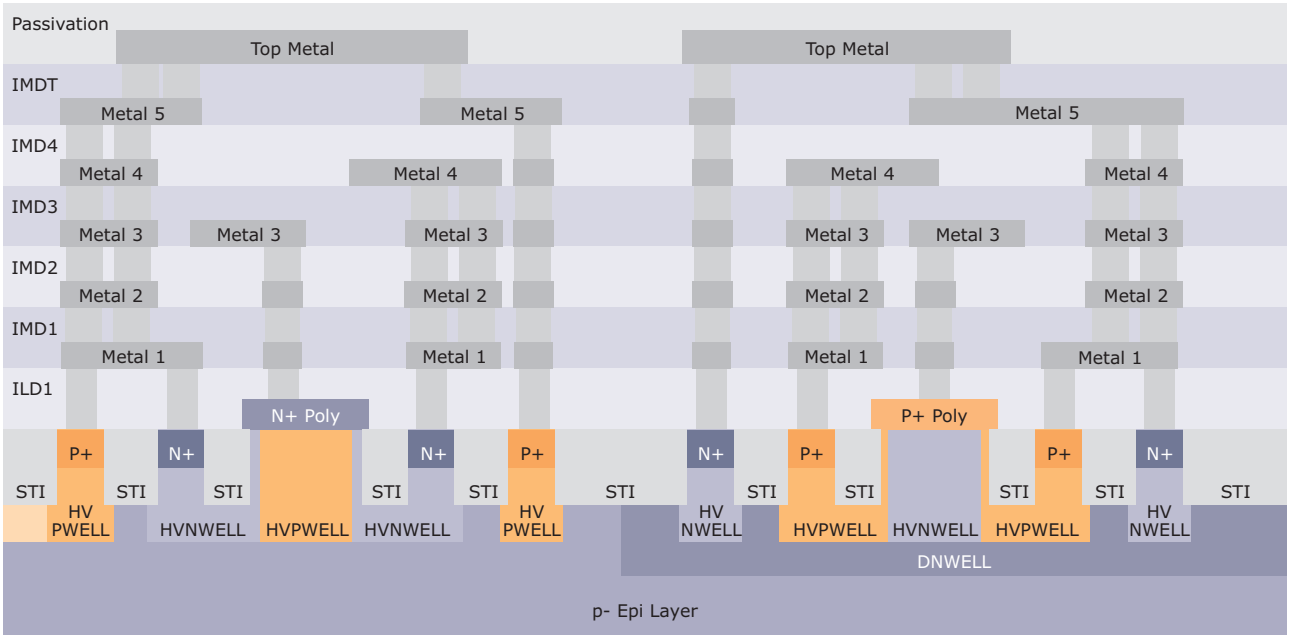
XH018 DEVICES SCHEMATIC CROSS SECTION



ne3 pe3



ne3i pe3i



nmma pmma

XH018 PROCESS FLOW

Core Modules	Additional Modules	
Wafer Start		
	HV gate oxide	HVMOS
	Deep HV N-well	HVPMOS/ BIPESD/ SCHOTTKY
Active area		
	Deep N-well	HVMOS/ ISOMOS/ ISOMOS2/ PHOTODIO
	HV wells	HVMOS
	Shallow HV N-well	NHVE
	Shallow HV P-well	PHVE
	DMOS drift implant	DMOS
	Depletion implant	DEPL
	HV depletion implant	HVDEPL
	Non volatile memory	NVM/ FLASH
3.3V wells		
	CPOD implant	CPOD
1.8V wells		
	1.8V low Vt wells	LVT
	1.8V medium Vt wells	SVT
Dual gate oxide		
Poly silicon gate		
Source/ Drain implants		
	MRPOLY implant	MRPOLY
Salicidation		
Contact		
Metal 1		
Via 1		
Metal 2		
	Single MIM capacitor	MIM23/ MIMH23
	Double MIM capacitor	DMIM/ DMIMH
	Triple MIM capacitor	TMIM/ TMIMH
	Via 2	MET3
	Metal 3	
	Single MIM capacitor	MIM34/ MIMH34
	Double MIM capacitor	DMIM/ DMIMH
	Triple MIM capacitor	TMIM/ TMIMH
	Via 3	MET4
	Metal 4	
	Triple MIM capacitor	TMIM/ TMIMH
	Via 4	MET5
	Metal 5	
	MIM capacitor	MIM/ MIMH
	Top Via	METMID
	Top Metal	
	Thick Via	METTHK
	Thick Metal	
	Planarized passivation	FLATPV
	Planarized passivation	SFALTPV
PAD		
	Polyimide	PIMIDE
		mask steps

XH018 CORE MODULE

Module Name	Descriptions	Masks No.
LPMOS	Low power 1.8V, 3.3V CMOS CORE module	19

XH018 ADDITIONAL MODULES

CPOD	POD capacitor module	1
CPODHV	HV POD module	2 *
MRPOLY	Medium resistance polysilicon module	1
ISOMOS	Triple well (DNWELL) isolated CMOS module	1
ISOMOS2	Triple well (DNWELLMV) isolated CMOS module	1
HIGHTEMP	High temperature module	0
LVT	1.8V low Vt module	2
SVT	1.8V medium Vt module	2
LNPMOS3	3.3V low noise PMOS module	1
ULN	Low noise CMOS module	1
DEPL	Depletion module	1
HVDEPL	High voltage depletion module	1
DMOS	DMOS module	1
HVMOS	High voltage module	5 *
HVNMOS	HVNMOS module	3 *
NHVE	High voltage extension module	1
HVPMOS	HVPMOS module	6 *
PHVE	High voltage extension module	1
SCHOTTKY	Schottky module	2 *
MIM	MIM capacitor module	1
MIM23	Metal2-Metal3 MIM capacitor module	1
MIM34	Metal3-Metal4 MIM capacitor module	1
DMIM	Double MIM capacitor module	1
TMIM	Triple MIM capacitor module	1
MIMH	Single high capacitance MIM capacitor module	1
MIMH23	Metal2-Metal3 high capacitance MIM capacitor module	1
MIMH34	Metal3-Metal4 high capacitance MIM capacitor module	1
DMIMH	Double high capacitance MIM capacitor module	1
TMIMH	Triple high capacitance MIM capacitor module	1
NVM	Non-volatile-memory module	2
FLASH	Flash memory module	0
ANODOP	UV diode module - anode	1
CATDOP	UV diode module - cathode	1
UVWINDOW	UV diode module - UV window	0

* These modules might have different mask count when in combination with other modules, as listed in the table “XH018 Additional Mask Count for Module Combination”.

XH018 ADDITIONAL MODULES (CONT‘)

BIPESD	ESD module	3 *
ESDPNP	ESD module	5 *
FLATPV	Flat passivation module	0
SFLATPV	Sensor flat passivation	0
PHOTODIO	Photo diode module	0
MET3	3-metal module	2
MET4	4-metal module	2
MET5	5-metal module	2
METMID	Top metal module	2
METTHK	Thick metal module	2
PIMIDE	Polyimide module	1

XH018 ADDITIONAL MASK COUNT FOR MODULE COMBINATION

Module Name	When combines with modules	Combined additional mask count
CPODHV	HVMOS/ HVNMOS/ HVPMOS/ ESDPNP	0
HVMOS	ISOMOS/ ISOMOS2	5
HVNMOS	HVMOS	5
HVNMOS	HVPMOS	6
HVNMOS	HVPMOS+HVNE	6
HVPMOS	HVMOS	7
HVPMOS	HVNMOS+PHVE	7
BIPESD	HVMOS	7
ESDPNP	HVPMOS	6
SCHOTTKY	HVMOS	6
SCHOTTKY	HVNMOS	4
SCHOTTKY	HVPMOS	6

XH018 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)
LPMOS	MET3+METMID	
CPODHV	CPOD	
ISOMOS2	ISOMOS	
HVDEPL	NHVE	
HIGHTEMP		PHOTODIO
PHOTODIO	ISOMOS	HIGHTEMP
NVM	ISOMOS	FLATPV, SFLATPV
ANODOP	UVWINDOW	MET4, METTHK
CATDOP	UVWINDOW	MET4, METTHK
UVWINDOW *	MET3+METMID	MET4, METTHK

* Only allowed with (ANODOP or CATDOP)

XH018 RESTRICTION FOR MODULE COMBINATIONS (CONT')

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)
FLASH	NVM	FLATPV, SFLATPV
DMOS	HVMOS	
NHVE	HVNMOS	
PHVE	HVPMOS	
MIM23	MET3	MIM34, MIMH23, MIMH34, MIM, DMIM, TMIM, MIMH, DMIMH, TMIMH
MIM34	MET4	MIM23, MIMH23, MIMH34, MIM, DMIM, TMIM, MIMH, DMIMH, TMIMH
MIMH23	MET3	MIM23, MIM34, MIMH34, MIM, DMIM, TMIM, MIMH, DMIMH, TMIMH
MIMH34	MET4	MIM23, MIM34, MIMH23, MIM, DMIM, TMIM, MIMH, DMIMH, TMIMH
MIM	METMID	MIM23, MIM34, MIMH23, MIMH34, DMIM, TMIM, MIMH, DMIMH, TMIMH
DMIM	MET3	MIM23, MIM34, MIMH23, MIMH34, MIM, TMIM, MIMH, DMIMH, TMIMH
TMIM	MET4	MIM23, MIM34, MIMH23, MIMH34, MIM, DMIM, MIMH, DMIMH, TMIMH
MIMH	METMID	MIM23, MIM34, MIMH23, MIMH34, MIM, DMIM, TMIM, DMIMH, TMIMH
DMIMH	MET3	MIM23, MIM34, MIMH23, MIMH34, MIM, DMIM, TMIM, MIMH, TMIMH
TMIMH	MET4	MIM23, MIM34, MIMH23, MIMH34, MIM, DMIM, TMIM, MIMH, DMIMH
MET4	MET3	
MET5	MET4	METTHK
METTHK	METMID	MET5
FLATPV	METMID	METTHK, NVM, FLASH, OTP3, SFLATPV
SFLATPV	METMID	METTHK, NVM, FLASH, OTP3, FLATPV

XH018 METAL OPTIONS

Number of Metals	Available Metal Layer Combinations	Module Names
4	MET1 - MET2 - MET3 - METTP	LPMOS+MET3+METMID
5	MET1 - MET2 - MET3 - MET4 - METTP	LPMOS+MET3+MET4+METMID
5	MET1 - MET2 - MET3 - METTP - METTPL	LPMOS+MET3+METMID+METTHK
6	MET1 - MET2 - MET3 - MET4 - MET5 - METTP	LPMOS+MET3+MET4+MET5+METMID
6	MET1 - MET2 - MET3 - MET4 - METTP - METTPL	LPMOS+MET3+MET4+METMID+METTHK

Active Devices

XH018 LOW NOISE TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	IOFF [pA/µm]	BVDS [V]	Max. VDS [V]
1.8V low noise NMOS	nelna nelnai (1 nelnai_6 (2 nelnai_m_6 (2	ULN ULN+ISOMOS ULN+(ISOMOS2, ISOMOS+HVMOS) ULN+ISOMOS	0.61 0.6 0.6 0.6	460	< 3	> 3.6	1.98
3.3V low noise NMOS	ne3lna ne3lnai (1 ne3lnai_6 (2 ne3lnai_m_6 (2	ULN ULN+ISOMOS ULN+(ISOMOS2, ISOMOS+HVMOS) ULN+ISOMOS	0.74 0.72 0.72 0.72	580 590 590 590	< 3	> 5	3.6
3.3V low noise PMOS	pe3lna, pe3lna_5 (2	ULN	0.63	300	< 3	> 5	3.6
3.3V isolated low noise PMOS	pe3lnai (1, pe3lnai_5 (2, pe3lnai_m_5 (2	ULN+ISOMOS ULN+(ISOMOS2, ISOMOS+HVMOS) ULN+ISOMOS	0.63	300	< 3	> 5	3.6
3.3V low noise PMOS	pe3ln, pe3ln_5 (2	LNPMOS3	0.92	250	< 15	> 5	3.6
3.3V isolated low noise PMOS	pe3lni (1, pe3lni_5 (2, pe3lni_m_5 (2	LNPMOS3+ISOMOS LNPMOS3+(ISOMOS2, ISOMOS+HVMOS) LNPMOS3+ISOMOS	0.92	250	< 15	> 5	1.98

(1 The ISOMOS2 or HVMOS module is needed, if isolated MOS transistors are placed in DNWELL instead of DNWELLMV.
(2 These devices are variants of the corresponding basic device with underlying wells. Parameters of these devices are identical to the corresponding basic device.

XH018 MOS CORE TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	IOFF [pA/µm]	BVDS [V]	Max. VDS [V]	Max. VGS [V]
1.8V LP NMOS	ne	LPMOS	0.58	475	< 3	> 3.6	1.98	1.98
1.8V LP PMOS	pe, pe_5 (2	LPMOS	0.65	170	< 3	> 3.6	1.98	1.98
3.3V native Vt NMOS	nn3	LPMOS	0.18	650	-	> 4	3.6	3.6
3.3V LP NMOS	ne3	LPMOS	0.69	605	< 3	> 5	3.6	3.6
3.3V LP PMOS	pe3, pe3_5 (2	LPMOS	0.63	305	< 3	> 5	3.6	3.6

(2 These devices are variants of the corresponding basic device with underlying wells. Parameters of these devices are identical to the corresponding basic device.

XH018 MEDIUM & LOW VT TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	IOFF [pA/µm]	BVDS [V]	Max. VDS [V]	Max. VGS [V]
1.8V SVT NMOS	nesvt,	SVT	0.47	550	< 40	> 3.6	1.98	1.98
1.8V SVT PMOS	pesvt, pesvt_5 (2	SVT	0.48	255	< 40	> 3.6	1.98	1.98
1.8V LVT NMOS	nel	LVT	0.35	610	< 5k	> 3.6	1.98	1.98
1.8V LVT PMOS	pel, pel_5 (2	LVT	0.36	300	< 10k	> 3.6	1.98	1.98

(2 These devices are variants of the corresponding basic device with underlying wells. Parameters of these devices are identical to the corresponding basic device.

Active Devices *(Continued)*

XH018 ISOMOS TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	IOFF [pA/µm]	|BVDS| [V]	max. VDS [V]
Iso. 1.8V SVT PMOS	nesvti [1], nesvti_6 [2], nesvti_m_6 [2]	SVT+ISOMOS SVT+(ISOMOS2, ISOMOS+HVMOS) SVT+ISOMOS	0.46	550	< 40	> 3.6	1.98
Iso. 1.8V SVT PMOS	pesvti [1], pesvti_6 [2], pesvti_m_6 [2]	SVT+ISOMOS SVT+(ISOMOS2, ISOMOS+HVMOS) SVT+ISOMOS	0.48	255	< 40	> 3.6	1.98
Iso. 1.8V LP NMOS	nei [1], nei_m_6 [2] nei_6 [2]	ISOMOS ISOMOS2, ISOMOS+HVMOS	0.58	475	< 3	> 3.6	1.98
Iso. 1.8V LP PMOS	pei [1], pei_m_5 [2] pei_5 [2]	ISOMOS ISOMOS2, ISOMOS+HVMOS	0.65	170	< 3	> 3.6	1.98
Iso. 1.8V LVT NMOS	neli [1], neli_m_6 [2] neli_6 [2]	LVT+ISOMOS LVT+(ISOMOS2, ISOMOS+HVMOS)	0.35	610	< 5k	> 3.6	1.98
Iso. 1.8V LVT PMOS	peli [1], peli_m_5 [2] peli_5 [2]	LVT+ISOMOS LVT+(ISOMOS2, ISOMOS+HVMOS)	0.36	300	< 10k	> 3.6	1.98
Iso. 3.3V LP NMOS	ne3i [1], ne3i_m_6 [2] ne3i_6 [2]	ISOMOS ISOMOS2, ISOMOS+HVMOS	0.665	615	< 3	> 5.0	3.6
Iso. 3.3V LP PMOS	pe3i [1], pe3i_m_5 [2] pe3i_5 [2]	ISOMOS ISOMOS2, ISOMOS+HVMOS	0.63	305	< 3	> 5.0	3.6

[1] The ISOMOS2 or HVMOS module is needed, if isolated MOS transistors are placed in DNWELL instead of DNWELLMV.
[2] These devices are variants of the corresponding basic device with underlying wells. Parameters of these devices are identical to the corresponding basic device.

XH018 MEDIUM VOLTAGE TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	RON [kΩ.µm]	RON*A [mΩ.mm²]	BVDSS [V]	Max. |VDS| [V]	Max. VGS [V]
6V NMOS	nma nma_bjt*	HVNMOS	1.23	140	3.6		> 8.5	6	18
6V PMOS	pma pma_bjt*	HVPMOS	1.20	55	13		> 8.5	6	18
10V HV NMOS	nmma nmma_bjt*	HVMOS	1.45	52	13	60.5	> 15	10	10
10V Asy. HV NMOS	nmc nmc_bjt*	NHVE	1.40	80	13		> 21	10	18
15V HV PMOS	pmma pmma_bjt*	HVMOS	1.50	19.5	43	202	> 20	15	15
15V Sym. HV NMOS	nmmc nmmc_bjt*	NHVE	1.32	41	22	99	> 21	15	18
15V Sym. HV NMOS	nmmd nmmd_bjt*	NHVE	1.70	46	20	112	> 21	15	18
20V Sym. HV PMOS	pmmc pmmc_bjt*	PHVE	1.40	21	54	228	> 24	20	18
20V Asy. HV PMOS	pmc pmc_bjt*	PHVE	1.15	47	34		> 24	20	18
5V ESD PMOS	pmb**	HVMOS	-	-	-	-	-	-	-

* These devices are variants of the corresponding basic devices with parasitic substrate PNP and underlying wells. Parameters of these devices are identical to the corresponding basic devices.
** This device is only allowed to be used for ESD protection. Pleasae refer to ESD documentation on “My X-FAB“.

Active Devices *(Continued)*

XH018 DEPLETION TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	BVDSS [V]	Max. |VDS| [V]	Max. VGS [V]
3.3V Depl NMOS	nd3	DEPL	0.20	730	> 5	3.6	3.6
Iso. 3.3V Depl NMOS	nd3i (1 nd3i_6 (2 nd3i_m_6 (2	DEPL+ (ISOMOS, HVMOS) DEPL+HVMOS DEPL+ISOMOS	0.24	740	> 5	3.6	3.6

(1 The ISOMOS2 or HVMOS module is needed, if isolated MOS transistors are placed in DNWELL instead of DNWELLMV.
(2 These devices are variants of the corresponding basic device with underlying wells. Parameters of these devices are identical to the corresponding basic device.

XH018 HIGH VOLTAGE DEPLETION TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	RON [kΩ.µm]	RON*A [mΩ.mm²]	BVDSS [V]	Max. |VDS| [V]	Max. VGS [V]
32V Asy. HV Depl NMOS	nhvd nhvd_bjt*	HVDEPL	1.15	7.5	37	167	> 50	32	18
32V Sym. HV Depl NMOS	nhhvd nhhvd_bjt*	HVDEPL	1	3	53	514	> 50	32	18

* These devices are variants of the corresponding basic devices with parasitic substrate PNP and underlying wells. Parameters of these devices are identical to the corresponding basic devices.

XH018 HIGH VOLTAGE TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	RON [kΩ.µm]	RON*A [mΩ.mm²]	BVDSS [V]	Max. |VDS| [V]	Max. VGS [V]
45V Sym. HV NMOS	nhhv nhhv_bjt*	NHVE	1.87	62	60	686	> 50.5	45	18
45V Sym. HV PMOS	phhv phhv_bjt*	PHVE	1.5	39	101	900	> 51	45	18
45V Asy. HV NMOS	nhv nhv_bjt*	NHVE	1.63	130	33	214	> 50.5	45	18
45V Asy. HV PMOS	phv phv_bjt*	PHVE	1.38	102	56	280	> 51	45	18

* These devices are variants of the corresponding basic devices with parasitic substrate PNP and underlying wells. Parameters of these devices are identical to the corresponding basic devices.

XH018 DMOS TRANSISTORS

Device	Name	Available with module	|VT| [V]	IDS [µA/µm]	RON [kΩ.µm]	RON*A [mΩ.mm²]	BVDSS [V]	Max. |VDS| [V]	Max. VGS [V]
Iso. 40V nLDMOS*	nedi** nedi_bjt*	DMOS	1.63	110	15	60	> 45.5	40	18
35V pLDMOS	ped2 ped2_bjt*	DMOS	2.0	42	42	185	> 40.5	35	18
Iso. 45V nLDMOS	nedia** nedia_bjt*	DMOS	1.65	82	19	114	> 55	45	18
45V pLDMOS	ped ped_bjt*	DMOS	1.95	41	48	215	> 50.5	45	18

** 'nedi' has been superseded by 'nedia'. 'nedia' is a more robust device with higher on-state drain-source breakdown voltage than 'nedi'
* Parameters of these devices are identical to the corresponding basic devices.

Active Devices *(Continued)*

XH018 BIPOLAR TRANSISTORS

Device	Name	Available	BETA	VA [V]	BVCEO [V]	VBE [mV]	max. VCE [V]	|VEB| [V]
1.8V vPNP	qpva qpvb qpvc	LPMOS	2.5 2.6 2.8	250 150 100		710 669 636	1.98	1.5
3.3V vPNP	qpva3 qpvb3 qpvc3	LPMOS	2.3 2.5 2.7	250 150 100		709 669 635	3.6	1.5
ESD HV PNP	qpvhscr*	BIPESD	31		> 51	574	45	45
ESD HV PNP	qpvascr*	HVMOS+DMOS	-	-	-	-	-	-
ESD HV PNP	qpvhbscr*	ESDPNP	13.5		> 51	570	45	25
3.3V vNPN	qnva	DEPL+HVMOS	> 21	16	> 10	710	3.6	2.5
3.3V vNPN	qnvb	DEPL+ (ISOMOS, HVMOS)	85	8.5	> 4.5	700	3.6	2.5
3.3V vNPN	qnvc	ISOMOS	18.5	79	> 10	695	3.6	2.5

* These devices are only allowed to be used for ESD protection. Pleasae refer to ESD documentation on “My X-FAB“.

Passive Devices

XH018 POLY RESISTORS

Device	Name	Available with module	RS [Ω/□]	Temp. Coeff. [10^{-3}/K]	Max VTB [V]
N+ Poly	rnp1, rnp1_3*	LPMOS	320	-1.38	45
P+ Poly	rpp1, rpp1_3*	LPMOS	280	-0.11	45
P+ Poly silicided	rpp1s, rpp1s_3*	LPMOS	7.5	2.92	45
High-Ohmic N+ Poly1	rnp1h, rnp1h_3*	LPMOS	6300	-4	45
Lightly dope P+ Poly1	rpp1k, rpp1k_3*	MRPOLY	960	-0.85	45

* These devices are variants of the corresponding basic device with an underlying well, but not crossing a well boundry. The models realize an improved description of bulk voltage dependency.

XH018 DIFFUSION RESISTORS

Device	Name	Available with module	RS [Ω/□]	Temp. Coeff. [10^{-3}/K]	Max VTB [V]
1.8V N+ diffusion	rdn rdn_esd*	LPMOS HVMOS	65	1.42	1.98
1.8V P+ diffusion	rdp rdp_io*	LPMOS HVMOS	130	1.3	1.98
1.8V N-well	rnw, rnw_scr*	LPMOS	970	2.90	5.5
3.3V N+ diffusion	rdn3	LPMOS	61	1.42	3.6
3.3V P+ diffusion	rdp3	LPMOS	125	1.3	3.6
3.3V N-well	rnw3, rnw3_scr*	LPMOS	970	2.90	5.5
5V Deep N-well	rdnwmv	ISOMOS, HVMOS	1500	5.6	5.5

* These devices are only allowed to be used for ESD protection. Pleasae refer to ESD documentation on “My X-FAB“.

Passive Devices *(Continued)*

XH018 METAL RESISTORS

Device	Name	Available with module	RS [Ω/ □]	Thickness [µm]	Max J/W [mA/µm]	Temp. Coeff. [10^{-3}/K]	Max VTB [V]
Metal 1	rm1	LPMOS	0.077	0.555	0.5*	3.4	45
Metal 2	rm2	LPMOS	0.074	0.565	0.5*	3.4	45
Metal 3	rm3	MET3	0.074	0.565	0.5*	3.4	45
Metal 4	rm4	MET4	0.074	0.565	0.5*	3.4	45
Metal 5	rm5	MET5	0.074	0.565	0.5*	3.4	45
Top Metal	rmtp	METMID	0.031	0.98	1.6**	3.2	45
Thick Metal	rmtpl	METTHK	0.0101	3.11	6**	3.8	45

* value quoted at Tj = -40°C ... +175°C; value for Tj = -40°C ... +125°C is 1.0 mA/µm
** value quoted for both Tj = -40°C ... +175°C and Tj = -40°C ... +125°C

XH018 VARACTORS

Device	Name	Available with module	Tuning range [%]	Capacitance @-V [fF/µm²]	Capacitance @+V [fF/µm²]	Max VBpsub [V]
1.8V N-type varactor	mosvc	LPMOS	70	2.6	8.1	5.5
3.3V N-type varactor	mosvc3	LPMOS	70	1.7	5	5.5
3.3V P-type varactor	mosvc3i	ISOMOS2, ISOMOS+HVMOS	70	5	1.6	45
3.3V P-type varactor	mosvc3i_m	ISOMOS	70	5	1.6	10
1.8V P-type varactor	mosvci	ISOMOS2, ISOMOS+HVMOS	75	8.1	2	45
1.8V P-type varactor	mosvci_m	ISOMOS	75	8.1	2	10

XH018 SANDWICH CAPACITORS

Device	Name	Available with module	Area Cap [fF/µm²]	Max. VTB [V]
Poly1/M1/M2/M3	csandwt3	MET3	0.155	45
Poly1/M1/M2/M3/M4	csandwt4	MET4	0.2	45
Poly1/M1/M2/M3/M4/M5	csandwt5	MET5	0.25	45

XH018 POD CAPACITOR

Device	Name	Available with module	Area Cap. [fF/µm²]	V Coeff. [1/V]	|BV| [V]	max. VTB [V]
1.8V POD capacitor	cpod	CPOD	7.7	90k	> 3	1.98
3.3V POD capacitor	cpod3	CPOD	4.3	26k	> 5	3.6
HV POD capacitor	cpodhv	CPODHV, CPOD+(HVMOS, HVN-MOS, HVPMOS, ESDPNP)	1	1.7k	> 30	18

Passive Devices *(Continued)*

XH018 FRINGE CAPACITORS

Device	Name	Available with module	Cell Cap [fF]	BV [V]	Max. VTB [V]
Poly1/M1/M2 fringe	csf2p	LPMOS	25.2	> 15	45
Poly1/M1/M2/M3 fringe	csf3p	MET3	36.8	> 15	45
10V M1/M2/M3 fringe	csf3	MET3	32.9	> 35	45
45V M1/M2/M3 fringe	csf3a	MET3	23.9	> 70	45
10V M1/M2/M3/M4 fringe	csf4	MET4	45	> 35	45
45V M1/M2/M3/M4 fringe	csf4a	MET4	32.9	> 70	45
10V M1/M2/M3/M4/M5 fringe	csf5	MET5	57.1	> 35	45
45V M1/M2/M3/M4/M5 fringe	csf5a	MET5	41.8	> 70	45
10V M1/M2/M3/MTP fringe	csft4	MET3+METMID	36.5	> 35	45
45V M1/M2/M3/MTP fringe	csft4a	MET3+METMID	28.7	> 70	45
10V M1/M2/M3/M4/MTP fringe	csft5	MET4+METMID	49.1	> 35	45
45V M1/M2/M3/M4/MTP fringe	csft5a	MET4+METMID	37.7	> 70	45
10V M1/M2/M3/M4/M5/MTP fringe	csft6	MET5+METMID	61.5	> 35	45
45V M1/M2/M3/M4/M5/MTP fringe	csft6a	MET5+METMID	46.6	> 70	45

XH018 MIM CAPACITOR

Device	Name	Available with module	Area Cap [fF/µm²]	V Coeff. [1/V]	|BV| [V]	max. VTB [V]
Single MIM, M2/M3	cmm3	MIM23	1.00	-15	> 20	45
Single MIM, M3/M4	cmm4	MIM34	1.00	-15	> 20	45
Single MIM, M3/MTP Single MIM, M4/MTP Single MIM, M5/MTP	cmm4t cmm5t cmm6t	MET3+METMID+MIM MET4+METMID+MIM MET5+METMID+MIM	1.00	-15	> 20	45
Double MIM, M2/M3/MTP Double MIM, M2/M3/M4	cdmm4t cdmm4	MET3+METMID+DMIM MET4+DMIM	2.00	3	> 20	45
Triple MIM, M2/M3/M4/MTP Triple MIM, M2/M3/M4/M5	ctmm5t ctmm5	MET4+ METMID+ TMIM MET5+TMIM	3.00	15	> 20	45
High cap. MIM, M2/M3	cmmh3	MIMH23	2.35	-120	> 10	45
High cap. MIM, M3/M4	cmmh4	MIMH34	2.35	-120	> 10	45
High cap. MIM, M3/MTP High cap. MIM, M4/MTP High cap. MIM, M5/MTP	cmmh4t cmmh5t cmmh6t	MET3+METMID+MIMH MET4+METMID+MIMH MET5+METMID+MIMH	2.35	-120	> 10	45
High cap. DMIM, M2/M3/MTP High cap. DMIM, M2/M3/M4	cdmmh4t cdmmh4	MET3+METMID+DMIMH MET4+DMIMH	4.70	-20	> 10	45
High cap. TMIM M2/M3/M4/MTP High cap. TMIM M2/M3/M4/M5	ctmmh5t ctmmh5	MET4+METMID+TMIMH MET5+TMIMH	7.05	-120	> 10	45

XH018 SCHOTTKY DIODE

Device	Name	Available with module	Vforward [V]	ILeakage [nA]	|BV| [V]	Max. VTB [V]
18V Schottky	dsb	SCHOTTKY	0.45	< 5	> 20.5	45

Passive Devices *(Continued)*

XH018 PROTECTION DIODES

Device	Name	Available with module	Leakage Current [pA]	|BV|[V]	BV Temp. Coef. [mV/K]	Max Vcc [V]
20V N-type Protection	dnp20	NHVE	300	> 23	10	30
20V P-type Protection	dpp20	HVMOS	100	> 22	18	30

XH018 PHOTO DIODES

Device	Name	Available with module	Area dark Current [aA/µm²]	Sensitivity [A/W]	Max Vcc [V]
PD for visible & infrared light detection	dphoa	PHOTODIO	0.1	0.35 / 0.42 / 0.31*	10
PD for infrared light detection	dphob	PHOTODIO	1.9	0.03 / 0.24 / 0.25*	10
PD for UV light detection	dphoc	CATDOP+ UVWINDOW	0.7	0.11 / 0.23/ 0.39/ 0.26**	10
PD for UV light detection	dphod	ANODOP+ UVWINDOW	0.2	0.11 / 0.21 / 0.07 / 0.01**	5

* optical responsivity @500nm / @650nm / @850nm
** optical responsivity @300nm / @405nm / @650nm / @850nm

XH018 DIFFUSION DIODE

Device	Name	Available with module	Area Cap [fF/µm²]	|BV| [V]	Leakage Current [fA/µm²]	Max VCC [V]
Polysilicon	dpol	LPMOS	-	-	-	-
1.8V N+ diff. /PW1	dn	LPMOS	1.11	> 6	0.042	1.98
1.8V P+ diff. /NW1	dp	LPMOS	1.02	> 6	0.002	1.98
1.8V NW1 /Psub	dnw	LPMOS	0.1	> 9	0.0001	5.5
3.3V N+ diff. /PW2	dn3	LPMOS	0.87	> 6	0.006	3.6
3.3V P+ diff. /NW2	dp3	LPMOS	1.00	> 6	0.0007	3.6
3.3V NW2 /Psub	dnw3	LPMOS	0.1	> 9	0.0001	5.5
MV DNW /P+ diff.	ddnwmv	ISOMOS, HVMOS	0.07	> 15	0.0001	10
P+ diff. /MV DNW	dpdnwmv	ISOMOS, HVMOS	0.56	> 10	0.01	5.5
Iso. PW /MV DNW	dipdnwmv	ISOMOS, HVMOS	0.34	> 15	0.003	8
DNW /Psub	ddnw	HVMOS	0.06	> 80	0.0002	45
Iso. P+ diff. /DNW	dpdnw	HVMOS	0.56	> 10	0.003	5.5
Iso. PW /DNW	dipdnw	HVMOS, ISOMOS	0.36	> 15	0.0003	8
N+ diff. /HV PW	dnhpw	HVMOS	0.77	> 9	0.01	5.5
P+ diff. /HV NW	dphnw	HVMOS	0.62	> 9	0.01	5.5
HV PW /DNW	dhpw	HVMOS	0.25	> 20	0.002	15
HV NW /Psub	dhnw	HVMOS	0.1	> 47	0.0001	15
NDF /Psub	dndf	NHVE	0.08	> 50.5	0.0001	45
PDF /HV NW	dpdwhn	PHVE	0.21	> 50	0.006	45
HV NW /Psub	dwhn	HVPMOS	0.07	> 50	0.0001	45
P+ diff. /HV NW	dpwhn	HVPMOS	0.21	> 22	0.0014	20
N+ diff. /Psub	dnn3	LPMOS	0.07		0.033	

Non-Volatile-Memory

XH018 POLY FUSE

Device	Name	Available with module	Unprog. Res. [Ω]	Prog. Res. [kΩ]	Prog. Max VCC [V]	Unprog. Max VCC [V]
Poly fuse	pfuse	LPMOS	35	> 100	3.6	0.1

XH018 NVM

Parameter	NVRAM Compiler	Flash
Available with module	NVM+MIM	NVM+FLASH+MIM
Memory Size	1k to 16k bits	8k x32
Operating voltage	1.6 to 2.0V 3.0 to 3.6V	1.6 to 2.0V 3.0 to 3.6V
Operating temperature	-40 to +175°C	-40 to +175°C read -40 to +125°C NV write/erase
Endurance	100k cycles for EEPROM @25°C 10k cycles for EEPROM @150°C unlimited SRAM	1k cycles @125°C
Data retention	Min. 10 years @ 125°C Min 3 year @150°C Min 1 years @175°C	Min. 10 years @125°C Min. 3 years @150°C Min. 1 years @175°C

I/O LIBRARIES

XH018 I/O CELLS LIBRARY

Device	Library Feature	V_{CORE}*	V_{IO}*	ESD Level	Application benefits
IO_CELLS_3V	Standard, 3.3V/1.8V multi supply voltage	1.8V	3.3V	4kV HBM	Pad limited
IO_CELLS_F3V	Standard, 3.3V/1.8V multi supply voltage	1.8V	3.3V	2kV HBM	Core limited
IO_CELLS_C1V8	Standard, V_{CORE}=V_{IO} single supply voltage	1.8V	1.8V	4kV HBM	Pad limited
IO_CELLS_FC1V8	Standard, V_{CORE}=V_{IO} single supply voltage	1.8V	1.8V	2kV HBM	Core limited
IO_CELLS_C3V	Standard, V_{CORE}=V_{IO} single supply voltage	3.3V	3.3V	4kV HBM	Pad limited
IO_CELLS_FC3V	Standard, V_{CORE}=V_{IO} single supply voltage	3.3V	3.3V	2kV HBM	Core limited
IO_CELLS_JI3V	Junction isolated, 1.8V/3.3V multi supply voltage	1.8V	3.3V	4kV HBM	Pad limited

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

XH018 HV CELLS LIBRARY

Device	Library Feature	Voltage Range	ESD Level	Application benefits
HV_CELLS	Special LV I/O, operating voltage specific HV ESD protection cells	LV, 12V-58V	2kV-8kV HBM	Customized I/O Design

STANDARD CELLS LIBRARIES

XH018 STD CELLS LIBRARY

Device	Library feature	Voltage range	Application benefits
D_CELLS	Standard Speed & Low Power	1.8V	standard speed, low power cells available, P&R compatible with D_CELLS_LL, D_CELLS_MV
D_CELLS_LL	Low Leakage & Low Power	1.8V	low leakage (0.21um channel length), low power cells (X0) available, P&R compatible with D_CELLS
D_CELLS_HD	Standard Speed & Low Power, High Density routing pitch	1.8V / 1.2V	standard speed, high density routing pitch, low power cells available, P&R compatible with D_CELLS_HDMV
D_CELL_3V	Standard Speed & Low Power, High Density routing pitch	3.3V / 2.2V	3.3V, 2.2V supply, standard speed, low power cells available, high density routing pitch
D_CELLS_JI	Junction Isolated, Standard Speed & Low Power	1.8V	standard speed, low power cells (X0) available, noise protection
D_CELLS_JILL	Junction Isolated, Low Leakage & Low Power	1.8V / 1.2V	low leakage (0.21um channel length), low power cells available, noise protection, voltage shifting, P&R compatible with D_CELLS_JI, D_CELLS_JIMV
D_CELLS_JIHD	Junction Isolated, Standard Speed & Low Power, High Density routing pitch	1.8V / 1.2V	standard speed, high density routing pitch, low power cells available, noise protection, voltage shifting, P&R compatible with D_CELLS_JIHDMV
D_CELLS_JI3V	Junction Isolated, Standard Speed & Low Power, High Density routing pitch	3.3V / 2.2V	3.3V, 2.2V supply, standard speed, low power cells (X0) available, high density routing pitch, noise protection
D_CELLSL_JI3V	Junction Isolated, Low Power	3.3V / 2.2V	low power consumption, noise protection, voltage shifting, P&R compatible with D_CELLSL_JIM3V
D_CELLS_MV	Multi Supply Voltage, Power Shut Off	1.8V/ 1.2V ... 3.3V	standard speed & power, multivoltage
D_CELLS_HDMV	Multi Supply Voltage, Power Shut Off, High Density routing pitch	1.8V/ 1.2V ... 3.3V	standard speed & power, multivoltage, high density routing pitch
D_CELLS_JIHDMV	Junction Isolated, Multi Supply Voltage, Power Shut Off, High Density routing pitch	1.8V/ 1.2V ... 3.3V	standard speed & power, multivoltage, noise protection, voltage shifting,
D_CELLS_JIMV	Junction Isolated, Multi Supply Voltage, Power Shut Off	1.8V/ 1.2V ... 3.3V	standard speed & power, multivoltage, 1.8V, junction isolated
D_CELLSL_JIM3V	Multi Supply Voltage, Power Shut Off, Junction Isolated	3.3V/ 1.8V ... 3.3V	standard speed & power, multivoltage, 3.3V, junction isolated

ANALOG LIBRARIES

XH018 3.3V A_CELLS ANALOG LIBRARY

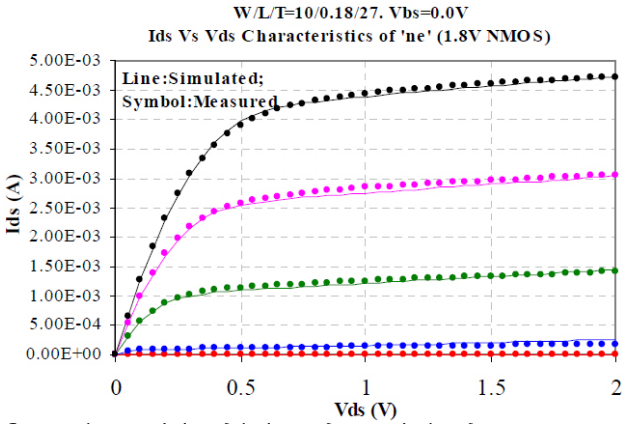
Library	Cell Name	Operating conditions	Required module
Bias Cells	abiac01_3v3 abiac02_3v3 abiac03_3v3	VDD: 2.7V to 3.6V; T: -40...125°C	LPMOS, MET3
Bias Cells	acsoc01_3v3 acsoc02_3v3	VDD: 2.7V to 3.6V; T: -40...125°C	LPMOS, MET3
Bandgap	abgpc01_3v3 abgpc02_3v3 abgpc04_3v3	VDD: 2.4V to 3.6V; T: -40...125°C	LPMOS, MET3
Bandgap	abgpc03_3v3_ji	VDD: 2.1V to 3.6V; T: -40...150°C	LPMOS, ISOMOS, HVMOS, DEPL, MIM-MET3, METMID
Operational Amplifier	aopac01_3v3 aopac02_3v3 aopac03_3v3 aopac04_3v3	VDD: 2.7V to 3.6V; T: -40...85°C	LPMOS, MET3
Comparators	acmpc01_3v3 acmpc02_3v3 acmpc03_3v3	VDD: 2.7V to 3.6V; T: -40...85°C	LPMOS, MET3
RC Oscillators	arcoc01_3v3 arcoc02_3v3 arcoc03_3v3 arcoc04_3v3	VDD: 2.7V to 3.6V; T: -40...125°C	LPMOS, MET3
RC Oscillators	arcoc01_3v3_ji	VDDA: 2.2V to 3.6V; VDD: 1.62V to 1.98V; T: -40...125°C	LPMOS, ISOMOS, MET3, METMID, MIM
RC Oscillators	arcoc03_3v3_ji	VDDA: 3.0V to 3.6V; VDD: 1.5V to 1.98V; T: -40...150°C	LPMOS, ISOMOS, MET3, METMID, MIM
Crystal Oscillators	axtoc01_3v3_ji axtoc02_3v3_ji	VDD: 2.4V to 3.6V; T: -40...85°C	LPMOS, MET3, METMID
ADC	aadcc01_3v3 aadcc01_3v3_ji	VDDA: 2.7V to 3.6V; T: -40...85°C	LPMOS, MET3, METMID, MIM LPMOS, ISOMOS, MET3, METMID, MIM
DAC	adacc01_3v3 adacc01_3v3_ji	VDDA: 2.7V to 3.6V; T: -40...85°C	LPMOS, MET3 LPMOS, ISOMOS, MET3
Power-On-Reset	aporc02_3v3 aporc03_3v3	VDD: 2.7V to 3.6V; T: -40...85°C	LPMOS, MET3
Voltage Regulators	aregc01_3v3	T: -40...85°C	LPMOS, MET3, METMID
Over-Temperature Detector	atmpc01_3v3	VDD: 2.7V to 3.6V; T: -40...140°C	LPMOS, MET3

ANALOG LIBRARIES *(Continued)*

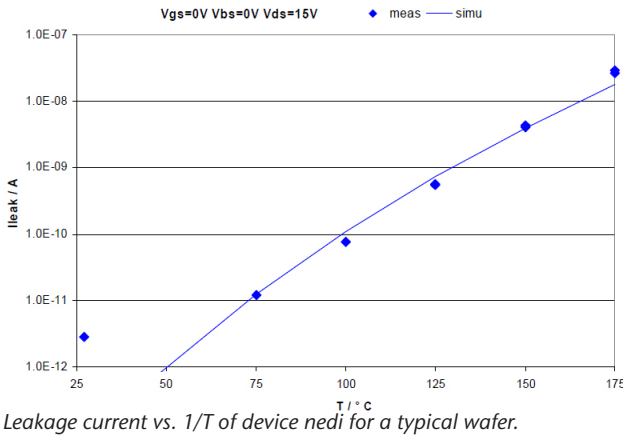
XH018 1.8V A_CELLS ANALOG LIBRARY

Library	Cell Name	Operating conditions	Required module
ADC	aadcc01_1v8 aadcc02_1v8 aadcc03_1v8	VDD: 1.62V to 1.98V; VREF: 1.62V to 1.98V; T: -40...125°C	LPMOS, ISOMOS, MET3, METMID, MIM LPMOS, MET3, METMID, MIM LPMOS, ISOMOS, MET3, METMID, MIM
Bandgap	abgpc01_1v8 abgpc02_1v8 abgpc04_1v8 abgpc05_1v8	VDD: (1.2) 1.62V to 1.98V; T: -40...125 (150)°C	LPMOS, MET3 LPMOS, MET3, DEPL, HVMOS/ISOMOS LPMOS, MET3 LPMOS, MET3, DEPL, HVMOS
Bias Cells	abiac06_1v8 abiac08_1v8 abiac09_1v8 abiac10_1v8 abiac11_1v8 abiac12_1v8	VDD: 1.2V to 1.98V; T: -40...150°C	LPMOS, MET3
Current Sources	acsoc04_1v8 acsoc05_1v8 acsoc06_1v8 acsoc07_1v8 acsoc08_1v8 acsoc09_1v8	VDD: (1.2) 1.5V to 1.98V; T: -40...150°C	LPMOS, MET3
Comparators	acmpc06_1v8 acmpc07_1v8 acmpc09_1v8 acmpc10_1v8 acmpc11_1v8 acmpc12_1v8	VDD: (1.2) 1.62V to 1.98V; T: -40...125 (150)°C	LPMOS, MET3
Crystal Oscillators	axtoc01_1v8 axtoc02_1v8	VDD: 1.5V to 1.98V; T: -40...85°C	LPMOS, MET3, METMID
DAC	adacc02_1v8	VDD: 1.62V to 1.98V; VREF: 1.62V to 1.98V; T: -40...125°C	LPMOS, MET3
Operational Amplifiers	aopac01_1v8 aopac03_1v8 aopac04_1v8 aopac05_1v8 aopac07_1v8 aopac08_1v8 aopac09_1v8 aopac10_1v8 aopac11_1v8 aopac12_1v8 aopac13_1v8	VDD: (1.2) 1.62V to 1.98V; T: -40...125 (150)°C	LPMOS, MET3
PLL	apllc03_1v8	VDD :1.62V to 1.98V; T: -40...150°C	LPMOS, MET3, METMID, MIM
Power-On/Off-Resets	aporc01_1v8 aporc02_1v8 aporc03_1v8	T: -40...125°C	LPMOS, MET3
RC Oscillators	arcoc01_1v8 arcoc02_1v8 arcoc03_1v8 arcoc04_1v8 arcoc05_1v8 arcoc06_1v8 arcoc07_1v8 arcoc08_1v8 arcoc09_1v8 arcoc10_1v8 arcoc11_1v8 arcoc12_1v8 arcoc21_1v8 arcoc22_1v8 arcoc23_1v8 arcoc24_1v8 arcoc15_1v8_ji arcoc16_1v8_ji	VDD: (1.2) 1.62V to 1.98V; T: -40...125 (150)°C	LPMOS, MET3 LPMOS, MET3, ISOMOS

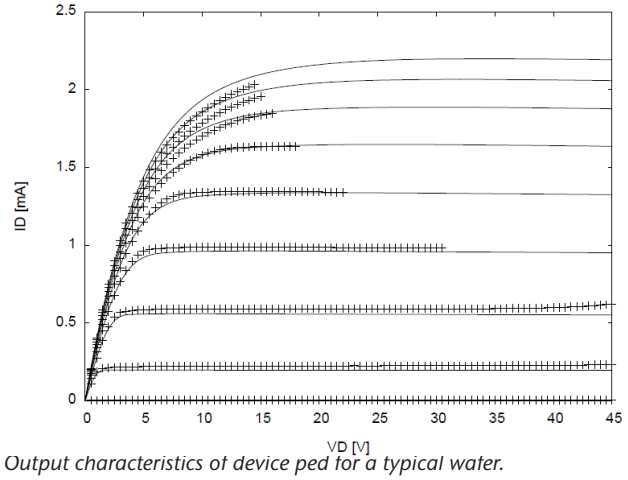
EXAMPLES FOR MEASURED AND MODELED PARAMETER CHARACTERISTICS



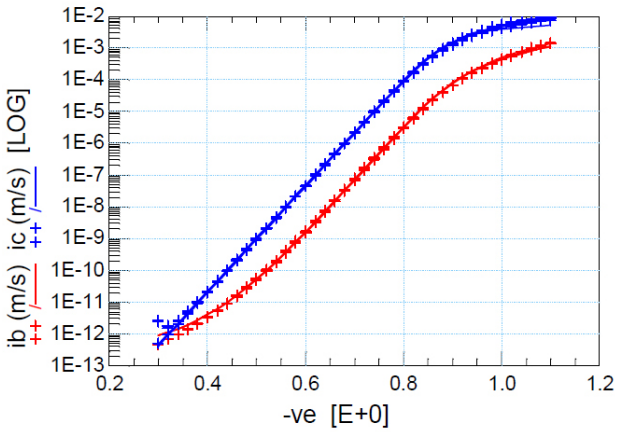
Output characteristics of device ne for a typical wafer,
W/L = 10/0.18, VGS = 0.4, 0.75, 1.10, 1.45, 1.80V, VBS = 0V
symbol = measured, solid line = BSIM3V3 model



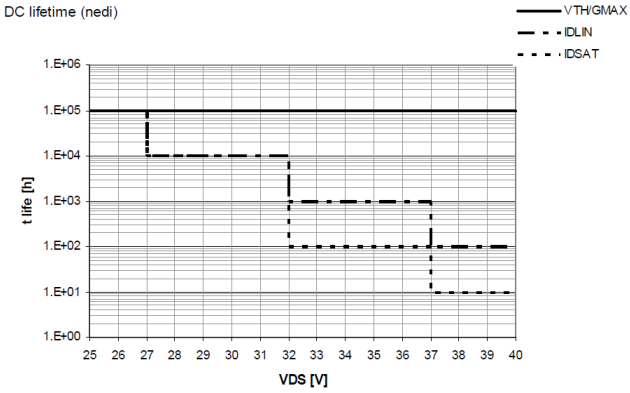
Leakage current vs. 1/T of device nedi for a typical wafer.
W/L = 100/0.65, VGS = VBS = 0V,
symbol = measured, solid line = BSIM3V3 subcircuit model



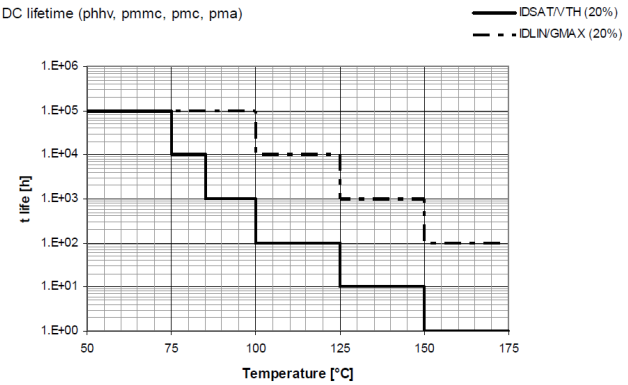
Output characteristics of device ped for a typical wafer.
W/L = 20/5, VGS = 2, 4, 6, 8, 10, 12, 14, 16, 18V,
VS = VB = 0V, symbol = measured, line = HiSIM_HV



Gummel plot of 3.3V vertical HV NPN transistor qnva
for a typical wafer, Emitter length 3.0 µm, VCB = 1, 2, 3V,
symbols = measured values, solid line = VBIC model

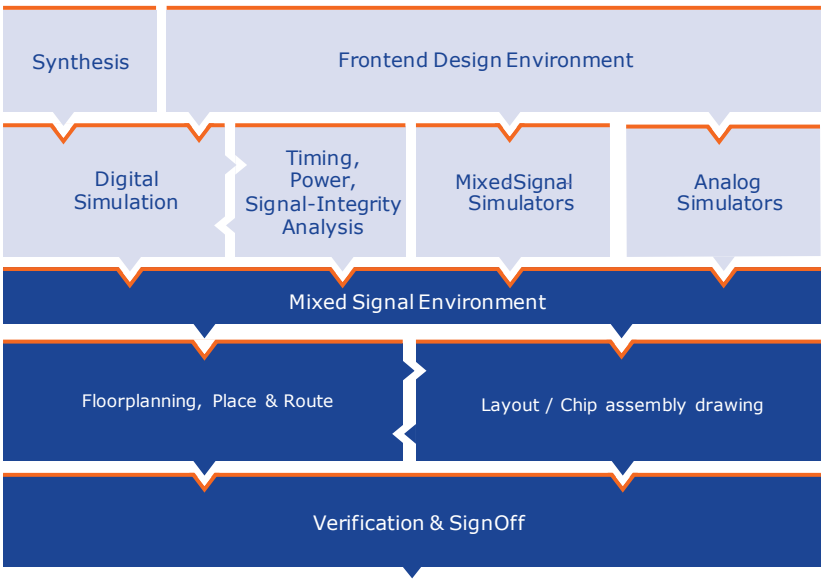


Hot Carrier Injection plot for device nedi for a typical wafer.



Negative Bias Temperature Instability plot for device phhv
for a typical wafer.

XH018 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 EDA 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.

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