



# 1.5 Micron CMOS Process Family

February 1996

## Features

- LO<sub>V</sub>MOS Processes (2.7~3.6 Volts Low Voltage Option)
- 1.2 Volts Very Low Voltage Option
- 5.5 Volts Maximum Operating Voltage
- Double Poly / Double Metal
- 3 μm Poly and Metal I Pitch
- ProToDuction™ Option for prototypes

## Description

The 1.5μm process provides flexibility, speed and packing density needed in mixed signal designs. The aggressive design rules make it comparable to most 1.2 μm processes. A 3 volts and a 1.2 volts options are also available for low voltage applications, they offer low and matched threshold voltages for improved dynamic range.

## Technology Outline

- Drain Engineered Structure to Ensure Reliability against Hot-Carrier Injection
- Planarization with SOG Sandwich Structure
- Nitride Passivation for Reliability against Moisture
- Latchup Free Process on Non-Epi Material Achieved with Optimized I/O Protection

## Process Parameters

| Process Parameters              | 1.5μm       | Units |
|---------------------------------|-------------|-------|
| Metal I pitch (width/space)     | 1.5 / 1.5   | μm    |
| Metal II pitch (width/space)    | 2.0 / 1.8   | μm    |
| Poly pitch (width/space)        | 1.5 / 1.5   | μm    |
| Contact                         | 1.5 x 1.5   | μm    |
| Via                             | 1.8 x 1.8   | μm    |
| Gate geometry                   | 1.5         | μm    |
| P-well junction depth           | 3.0         | μm    |
| N+ junction depth (5V& 3V/1.2V) | 0.28 / 0.20 | μm    |
| P+ junction depth               | 0.28        | μm    |
| Gate oxide thickness            | 270         | Å     |
| Inter poly oxide thick.         | 480         | Å     |

## MOSFET Electrical Parameters

|  | 1.5 MICRON - 1.2 volts      |                             |  | 1.5 MICRON - 3 volts        |                             |  | 1.5 MICRON - 5 volts        |                             |  | Units             | Conditions                                   |                        |
|--|-----------------------------|-----------------------------|--|-----------------------------|-----------------------------|--|-----------------------------|-----------------------------|--|-------------------|--|------------------------|
|  | N Channel<br>min. typ. max. | P Channel<br>min. typ. max. |  | N Channel<br>min. typ. max. | P Channel<br>min. typ. max. |  | N Channel<br>min. typ. max. | P Channel<br>min. typ. max. |  |                   |  |                        |
| V <sub>t</sub> (50x1.5μm)  | 0.30 0.40 0.50              | 0.30 0.40 0.50              |  | 0.35 0.50 0.65              | 0.35 0.50 0.65              |  | 0.55 0.70 0.85              | 0.55 0.70 0.85              |  | V                 | Saturation                                   |                        |
| I <sub>ds</sub> (50x1.5μm)   | 13                          | 5.5                         |  | 14                          | 6                           |  | 9.8 12.0                    | 3.9 5.0                     |  | mA                | V <sub>ds</sub> =V <sub>gs</sub> =5V         |                        |
| Gain β (50x1.5μm)  | 2.92                        | 1.05                        |  | 3.50                        | 1.05                        |  | 2.90                        | 0.80                        |  | mA/V <sup>2</sup> | Linear (1.2V&3.0V)<br>Saturation (5V)        |                        |
| Body Factor (50x50μm)  | 0.50                        | 0.77                        |  | 0.52                        | 0.75                        |  | 0.45                        | 0.81                        |  | √V                |  |                        |
| B <sub>vdss</sub> (50x1.5μm)   | 5 10                        | 5 9                         |  | 7 12                        | 7 12                        |  | 10 12                       | 10 12                       |  | V                 | I <sub>ds</sub> =20nA                        |                        |
| Subthreshold Slope   | 85                          | 105                         |  | 87                          | 106                         |  | 93                          | 101                         |  | mV/dec.           | V <sub>ds</sub> =0.1V                        |                        |
| Substrate Current  | 1.1                         | NA                          |  | 0.26                        | NA                          |  | 0.21                        | NA                          |  | μA/μm             | V <sub>ds</sub> =5.5V, V <sub>gs</sub> =2.3V |                        |
| Field Threshold  | 10 15                       | 10 14                       |  | 10 15                       | 10 14                       |  | 10 17                       | 10 20                       |  | V                 | I <sub>ds</sub> = 1μA/square                 |                        |
| L Effective  | 1.27                        | 1.12                        |  | 1.09                        | 1.05                        |  | 1.2                         | 1.2                         |  | μm                | L <sub>drawn</sub> = 1.5μm                   |                        |
| Gate Propagation Delay<br>Propagation Delay Time per Stage<br>(47 Stage Ring Oscillator) | Typ. = 2.4 ns @1.2V         |                             |  | Typ. = 530 ps @3.3V         |                             |  | Typ. = 380 ps @5.0V         |                             |  |                   |  | P 6.3/1.5<br>N 2.3/1.5 |

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## Capacitances (fF/ $\mu\text{m}^2$ )

|             | 1.5 $\mu\text{m}$ |      |      |
|-------------|-------------------|------|------|
|             | min.              | typ. | max. |
| Inter-poly  | 0.62              | 0.72 | 0.84 |
| Gate oxide  | 1.3               |      |      |
| N+ Junction | 0.29              |      |      |
| P+ Junction | 0.27              |      |      |

## Resistances ( $\Omega/\text{sq.}$ )

|                 | 1.5 $\mu\text{m}$ |      |      |
|-----------------|-------------------|------|------|
|                 | min.              | typ. | max. |
| Pwell           | 5700              |      |      |
| Pfield in Pwell | 2600              | 3000 | 3400 |
| N+              | 30                | 40   | 50   |
| P+              | 70                | 90   | 110  |
| Poly gate       | 15                | 20   | 25   |
| Poly capacitor  | 75                | 100  | 125  |
| Metal I         | 0.038             |      |      |
| Metal II        | 0.038             |      |      |

## Bipolar gain<sup>1</sup>

|              | 1.5 $\mu\text{m}$ - 5 volts |      |      |
|--------------|-----------------------------|------|------|
|              | min.                        | typ. | max. |
| NPN vertical | 180                         |      |      |

<sup>1</sup>Test condition :  $V_{ce} = 5$  volts

FIG 1 : I-V Characteristics for a 10x1.5 $\mu\text{m}$  N-MOSFET (1.5 $\mu\text{m}$  5 volts process)

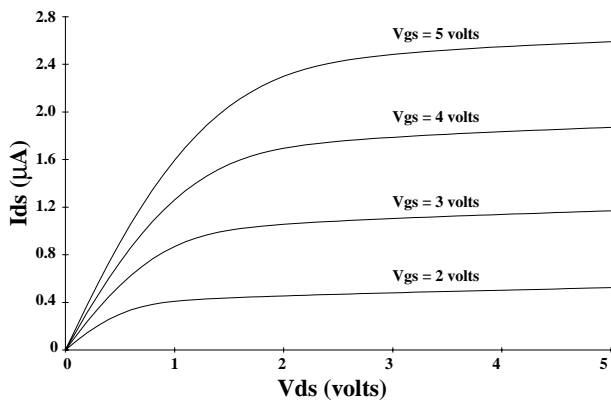


FIG 2 : I-V Characteristics for a 10x1.5 $\mu\text{m}$  P-MOSFET (1.5 $\mu\text{m}$  5 volts process)

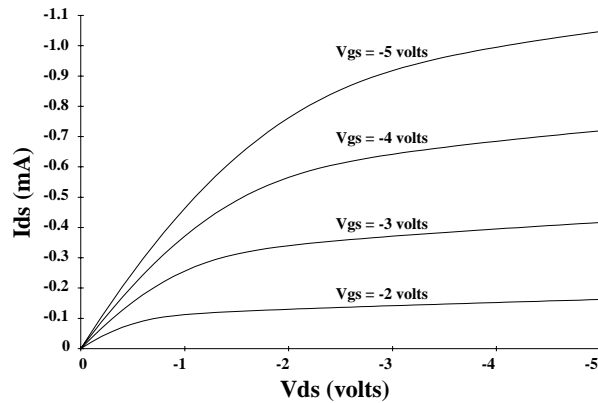


FIG 3 : Subthreshold Characteristics at  $V_{ds}=0.1$  volt for a 10x1.5 $\mu\text{m}$  N-MOSFET (1.5 $\mu\text{m}$  5 volts process)

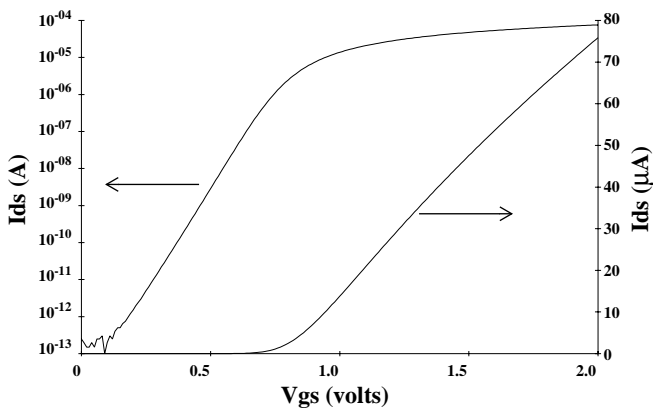


FIG 4 : Subthreshold Characteristics at  $V_{ds}=-0.1$  volt for a 10x1.5 $\mu\text{m}$  P-MOSFET (1.5 $\mu\text{m}$  5 volts process)

