# HFSS 3D Layout - IHP Technology Layer Stackup Definition

EM Simulation Setup Reference

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## 1 Material Properties

### 1.1 Conductor Materials

| Material Name | Conductivity (S/m) | Permit. | Color |
|---|---|---|---|
| Activ | 3.57141e5 | 1 | 00ff00 |
| Metal1 | 2.164e7 | 1 | 39bfff |
| Metal2 | 2.319e7 | 1 | ccccd9 |
| Metal3 | 2.319e7 | 1 | d80000 |
| Metal4 | 2.319e7 | 1 | 93e837 |
| Metal5 | 2.319e7 | 1 | dcd146 |
| TopMetal1 | 2.78e7 | 1 | ffe6bf |
| TopMetal2 | 3.03e7 | 1 | ff8000 |
| TopVia2 | 3.143e6 | 1 | ff8000 |
| TopVia1 | 2.191e6 | 1 | ffe6bf |
| Via4 | 1.66e6 | 1 | deac5e |
| Via3 | 1.66e6 | 1 | 9ba940 |
| Via2 | 1.66e6 | 1 | ff3736 |
| Via1 | 1.66e6 | 1 | ccccff |
| Cont | 2.39e6 | 1 | 00ffff |
| LOWLOSS | 1e10 | 1 | ff0000 |

### 1.2 Dielectric Materials

| Material | Permit. | Loss Tan. | Cond. | Color |
|---|---|---|---|---|
| Passive | 6.6 | 0.0 | 0 | a0a0f0 |
| SiO2 | 4.1 | 0.0 | 0 | fffcad |
| AIR | 1.0 | 0.0 | 0 | d0d0d0 |
| MIM_equiv | 16.87 | 0.0 | 0 | ff0000 |

### 1.3 Semiconductor Materials

| Material | Permit. | Loss Tan. | Cond. (S/m) | Color |
|---|---|---|---|---|
| Substrate | 11.9 | 0 | 2.0 | 01e0ff |
| EPI | 11.9 | 0 | 5.0 | 294fff |

## 2 Complete Layer Stackup (Bottom to Top)

**Important Setup Parameters:**

- **Substrate Offset:** 283.75 $\mu$m
- **Length Unit:** Micrometers ($\mu$m)
- **Layer Type:** Use "signal" for all conductor/via layers, "dielectric" for dielectric layers

| # | Layer Name | Type | Zmin | Zmax | Thick. | Material | L# |
|---|---|---|---|---|---|---|---|
| **SUBSTRATE REGION** | | | | | | | |
| 1 | Substrate | dielectric | -283.75 | -3.75 | 280.00 | Substrate | - |
| 2 | SUBGND | signal | -283.75 | -283.75 | 0.00 | LOWLOSS | 210 |
| 3 | EPI | dielectric | -3.75 | 0.00 | 3.75 | EPI | - |
| **ACTIVE & INTERCONNECT REGION** | | | | | | | |
| 4 | Activ | signal | 0.00 | 0.40 | 0.40 | Activ (3.57e5) | 1 |
| 5 | Passive fill | dielectric | 0.40 | 1.04 | 0.64 | Passive | - |
| 6 | Cont | signal | 0.40 | 1.04 | 0.64 | Cont (2.39e6) | 6 |
| **METAL1 LAYER** | | | | | | | |
| 7 | SiO2 fill | dielectric | 1.04 | 1.46 | 0.42 | SiO2 | - |
| 8 | Metal1 | signal | 1.04 | 1.46 | 0.42 | Metal1 (2.164e7) | 8 |
| 9 | SiO2 fill | dielectric | 1.46 | 2.00 | 0.54 | SiO2 | - |
| 10 | Via1 | signal | 1.46 | 2.00 | 0.54 | Via1 (1.66e6) | 19 |
| **METAL2 LAYER** | | | | | | | |
| 11 | SiO2 fill | dielectric | 2.00 | 2.49 | 0.49 | SiO2 | - |
| 12 | Metal2 | signal | 2.00 | 2.49 | 0.49 | Metal2 (2.319e7) | 10 |
| 13 | SiO2 fill | dielectric | 2.49 | 3.03 | 0.54 | SiO2 | - |
| 14 | Via2 | signal | 2.49 | 3.03 | 0.54 | Via2 (1.66e6) | 29 |
| **METAL3 LAYER** | | | | | | | |
| 15 | SiO2 fill | dielectric | 3.03 | 3.52 | 0.49 | SiO2 | - |
| 16 | Metal3 | signal | 3.03 | 3.52 | 0.49 | Metal3 (2.319e7) | 30 |
| 17 | SiO2 fill | dielectric | 3.52 | 4.06 | 0.54 | SiO2 | - |
| 18 | Via3 | signal | 3.52 | 4.06 | 0.54 | Via3 (1.66e6) | 49 |
| **METAL4 LAYER** | | | | | | | |
| 19 | SiO2 fill | dielectric | 4.06 | 4.55 | 0.49 | SiO2 | - |

| # | Layer Name | Type | Zmin | Zmax | Thick. | Material | L# |
|---|---|---|---|---|---|---|---|
| 20 | Metal4 | signal | 4.06 | 4.55 | 0.49 | Metal4 (2.319e7) | 50 |
| 21 | SiO2 fill | dielectric | 4.55 | 5.09 | 0.54 | SiO2 | - |
| 22 | Via4 | signal | 4.55 | 5.09 | 0.54 | Via4 (1.66e6) | 66 |
| **METAL5 & MIM LAYERS** | | | | | | | |
| 23 | SiO2 fill | dielectric | 5.09 | 5.58 | 0.49 | SiO2 | - |
| 24 | Metal5 | signal | 5.09 | 5.58 | 0.49 | Metal5 (2.319e7) | 67 |
| 25 | MIM_DK | dielectric | 5.58 | 5.68 | 0.10 | MIM_equiv | 136 |
| 26 | MIM | signal | 5.68 | 5.78 | 0.10 | Metal5 (2.319e7) | 137 |
| 27 | SiO2 fill | dielectric | 5.58 | 6.43 | 0.85 | SiO2 | - |
| 28 | TopVia1 | signal | 5.58 | 6.43 | 0.85 | TopVia1 (2.191e6) | 125 |
| **TOPMETAL1 LAYER** | | | | | | | |
| 29 | SiO2 fill | dielectric | 6.43 | 8.43 | 2.00 | SiO2 | - |
| 30 | TopMetal1 | signal | 6.43 | 8.43 | 2.00 | TopMetal1 (2.78e7) | 126 |
| 31 | SiO2 fill | dielectric | 8.43 | 11.23 | 2.80 | SiO2 | - |
| 32 | TopVia2 | signal | 8.43 | 11.23 | 2.80 | TopVia2 (3.143e6) | 133 |
| **TOPMETAL2 LAYER (TOP)** | | | | | | | |
| 33 | SiO2 fill | dielectric | 11.23 | 14.23 | 3.00 | SiO2 | - |
| 34 | TopMetal2 | signal | 11.23 | 14.23 | 3.00 | TopMetal2 (3.03e7) | 134 |
| 35 | AIR | dielectric | 14.23 | 314.23 | 300.00 | AIR | - |

Table 4: Complete unified stackup with conductors and dielectric fillers (all dimensions in $\mu$m)

# 3 Manual Entry Steps in HFSS 3D Layout

## 3.1 Material Properties Quick Reference

- **Conductors:** Activ (3.57e5), Metal1 (2.164e7), Metal2-5 (2.319e7), TopMetal1 (2.78e7), TopMetal2 (3.03e7), Cont (2.39e6), Via1-4 (1.66e6), TopVia1 (2.191e6), TopVia2 (3.143e6), LOWLOSS (1e10)
- **Dielectrics:** SiO2 ($\varepsilon_r$=4.1), Passive ($\varepsilon_r$=6.6), AIR ($\varepsilon_r$=1.0), MIM_equiv ($\varepsilon_r$=16.87)
- **Semiconductors:** Substrate ($\varepsilon_r$=11.9, $\sigma$=2.0), EPI ($\varepsilon_r$=11.9, $\sigma$=5.0)

## 3.2 Stackup Entry Procedure

1. Create all materials first using the tables above
2. In Layer Stackup Manager, set Substrate Offset = 283.75 $\mu$m
3. Enter layers from bottom to top following the unified stackup table
4. For conductor layers: Enter Name, Type=signal, Zmin, Zmax, Material, Layer#
5. For dielectric fill: Enter Name, Type=dielectric, Zmin, Zmax, Material (no Layer# needed)
6. **Note:** Dielectric fills represent the insulating material between and around conductors