$R = \ ?$

0.0049 \ \Omega

\sim 5 \text{m} \Omega$
$5 \text{ m}\Omega/1\text{mm width track}$

for every $1\text{cm}$ length
Problem (Parasitics)

- Resistance
- Inductance
- Capacitance

1. Resistance drops
2. Capacitance - capacitive coupling
3. Inductive coupling; Inductive drops
4. Reflection
\[ V_{\text{chip}} = V_{\text{cc}} - 2i_{\text{lead}} - 2L \frac{di}{dt} \]

due to parasitics
De-coupling Capacitors
RESISTANCE OF COPPER TRACKS
RESISTANCE OF COPPER TRACKS

\[ R = \]
RESISTANCE OF COPPER TRACKS

\[ R = \frac{\rho l}{A} \]
RESISTANCE OF COPPER TRACKS

\[ R = \frac{\rho l}{A} \]

Resistivity, ohm-m
RESISTANCE OF COPPER TRACKS

\[ R = \frac{\rho l}{A} \]

- Resistivity, ohm-m
- Length, m
RESISTANCE OF COPPER TRACKS

\[ R = \frac{\rho l}{A} \]

- Resistivity, ohm-m
- Length, m
- Area, m^2
RESISTANCE OF COPPER TRACKS

For Copper \( @20^\circ C \),
1.7241e-8 ohm-m

\[
R = \frac{\rho l}{A}
\]

Resistivity, ohm-m
Length, m
Area, m\(^2\)
RESISTANCE OF COPPER TRACKS

For Copper @20°C,
1.7241e-8 ohm-m

For a track length,
1 cm = 1e-2 m

Resistivity, ohm-m
Length, m

\[ R = \frac{\rho l}{A} \]

Area, m²
RESISTANCE OF COPPER TRACKS

For Copper @ 200°C, 1.7241e-8 ohm-m

For a track length, 1cm = 1e-2 m

Resistivity, ohm-m

Length, m

\[ R = \frac{\rho l}{A} \]

Area, m²

For a 35μm laminate, 1mm track width

= 35e-6 x 1e-3 m²
RESISTANCE OF COPPER TRACKS

For Copper @20°C,
1.7241e-8 ohm-m

For a track length,
1 cm = 1e-2 m

Resistivity,
Ohm-m

Length, m

Area, m²

For a 35μm laminate,
1 mm track width

= 0.0049 ohms

= 35e-6 x 1e-3 m²

\[ R = \frac{\rho l}{A} \]
EFFECT OF TEMPERATURE
EFFECT OF TEMPERATURE

\[ R_{T1} = \]
EFFECT OF TEMPERATURE

\[ R_{T1} = R_{T0} \]
EFFECT OF TEMPERATURE

\[ R_{T1} = R_{T0} + R_{T0} \cdot c_T \cdot (T_1 - T_0) \]
EFFECT OF TEMPERATURE

\[ R_{T1} = R_{T0} + R_{T0} \cdot c_T \cdot (T_1 - T_0) \]
EFFECT OF TEMPERATURE

\[ R_{T1} = R_{T0} + R_{T0} \cdot c_T \cdot (T_1 - T_0) \]

R at temp T0
Change in R due to temp. difference
EFFECT OF TEMPERATURE

\[ R_{T_1} = R_{T_0} + R_{T_0} \cdot c_T \cdot (T_1 - T_0) \]

- \( R_{T_1} \): R at temp \( T_1 \)
- \( R_{T_0} \): R at temp \( T_0 \)
- \( c_T \): Temp difference
- \( T_1 - T_0 \): Change in R due to temp. difference
EFFECT OF TEMPERATURE

\[ R_{T1} = R_{T0} + R_{T0} \cdot c_T \cdot (T_1 - T_0) \]

- \( R_{T1} \): Resistance at temperature \( T_1 \)
- \( R_{T0} \): Initial resistance at temperature \( T_0 \)
- \( c_T \): Temperature coefficient of conductivity
- \( T_1 - T_0 \): Temperature difference

R at temp T0

Temp difference

Change in R due to temp. difference

temperature coefficient of conductivity
EFFECT OF TEMPERATURE

For Copper,
+0.0039/°K

temperature coefficient of conductivity

\[ R_{T_1} = R_{T_0} + R_{T_0} \cdot c_T \cdot (T_1 - T_0) \]

R at temp T0
Temp difference
Change in R due to temp. difference
EFFECT OF TEMPERATURE

For Copper,
+0.0039/°K

\[ R_{T1} = R_{T0} + R_{T0} \cdot c_T \cdot (T_1 - T_0) \]

85°C - 20°C,
ΔT = 65°K

Temp difference

Change in R due to temp. difference
EFFECT OF TEMPERATURE

For Copper,
+0.0039/°K

temperature coefficient of conductivity

\[ R_{T1} = R_{T0} + R_{T0} \cdot c_T \cdot (T_1 - T_0) \]

R at temp T0

For a 35μm laminate, 1mm track width
= 0.0049 ohms @20°C

85°C - 20°C,
ΔT= 65°K
Temp difference

Change in R due to temp. difference
EFFECT OF TEMPERATURE

For Copper,
+0.0039/°K

$R_{T_1} = R_{T_0} + R_{T_0} \cdot c_T \cdot (T_1 - T_0)$

For a 35μm laminate,
1mm track width
= 0.0049 ohms @20°C

85°C - 20°C,
ΔT= 65°K
Temp difference

Change in R due to temp. difference
= 0.00614
≈25% more