Capacitance Matrix: Background

- Capacitance matrix of an electrical system allows one to evaluate cross talk between excitation ports
- The capacitance values, terminal charges, and terminal voltages are related by the following matrix relation:
 Ground

$$\begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$
Terminal 1
Terminal 2
V₁, Q₁
V₂, Q₂
Terminal 3
V₃, Q₃

• If we excite terminal j with voltage V_j and set the other terminals to ground, then elements of the capacitance matrix are evaluated as

$$C_{ij} = \frac{Q_i}{V_j}, \quad i = 1, 2, 3$$

• By repeating the procedure of the excitation of one terminal at a time, we calculate the full mutual capacitance matrix



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Terminal Sweep

- Comsol offers **Terminal Sweep** functionality which allows to sweep the excitation over different terminals, one at a time
- This allows to evaluate the full capacitance matrix in a single run
- □ To enable terminal sweep functionality, check **Activate terminal sweep** box in the settings window for the Electrostatics (es) interface

 Charge Conservation 1 Zero Charge 1 Initial Values 1 Ground 1 Terminal 1 Terminal 2 Terminal 3 	Settings Electrostatics
	Label: Electrostatics Name: es
	✓ Terminal Sweep Settings
	Reference impedance: Zref 50[ohm] Ω ✓ Activate terminal sweep Sweep parameter name: PortName
	 Note that PortName parameter is generated automatically as a Sweep parameter name We will use this parameter to setup Parametric Sweep under Study node
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Results: Full Maxwell Capacitance Matrix

□ Right-click Derived Values and choose Global Matrix Evaluation



• Use Comsol's build-in **Transformation** options to obtain capacitance matrix in different formats:

▲ ^{8.85} _{e+12} Derived Values	Label: Global Matrix Evaluation 1		▼ Transformation		
(III) Global Matrix Evaluation 1	Data		Transformation:	None	
	👻 Exp	pression	\$ •		None Inverse
	Matrix variable: es.C Unit:			From S to Y From S to Z From Y to S From Y to Z From Z to S From Z to Y From Maxwell to mutual capacitance From mutual to Maxwell capacitance	
	pF 💌				
	Description:				
	Date	ta Series Operation			
			Capacitance (pF) 233.53	20.765 1.4199	
	Transfor	mation: From mutual to Maxwell	capacitance 🔹	20.765 1.4199	217.71 20.767 20.767 233.56
		The hast	1917		



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