EMC Forum 2023 - Researcher Poster Session

Using the Orbital Angular Momentum(OAM) Mode System on Multiconductor Transmission Lines

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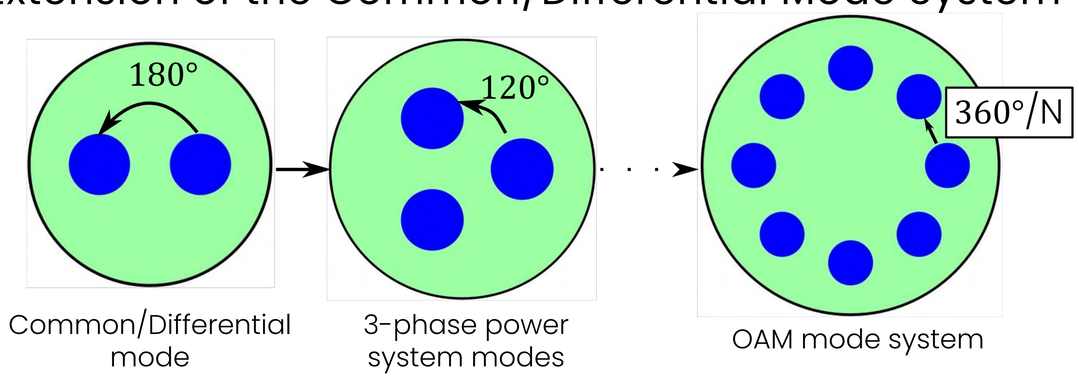
Extension of the Common/Differential Mode System



Common/Differential mode | 3-phase power system modes | OAM mode system

- OAM modes are a natural extension of the common /differential mode system for N conductor transmission lines [1, 2]

The OAM Mode System

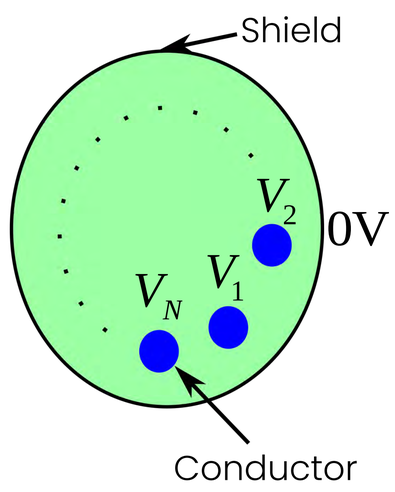
- N conductor in a circular arrangement
- Feed with phase shifted signals:

$$V_n = V_0 e^{j\frac{2\pi}{N}*n*l}$$

N: Number of transmission lines

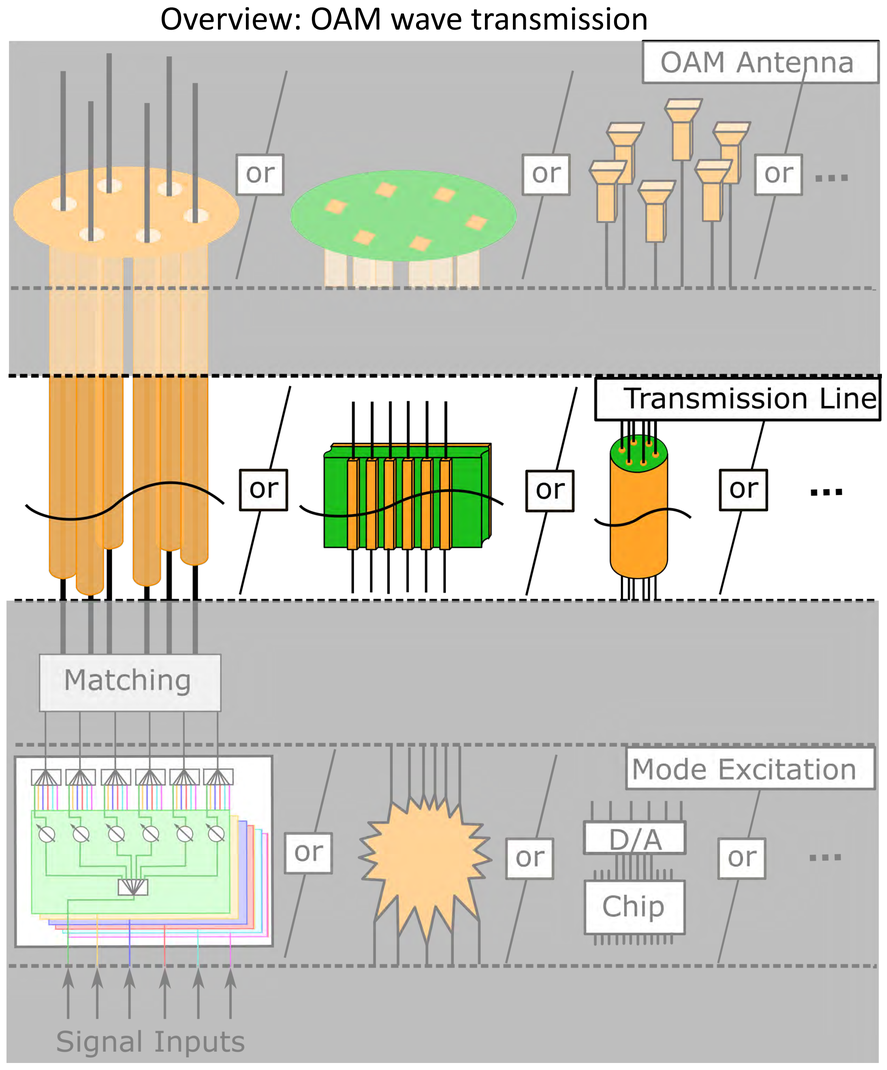
l: OAM mode number

- N conductors allow the excitation of N orthogonal OAM modes



Application (Antenna Feed)

Overview: OAM wave transmission

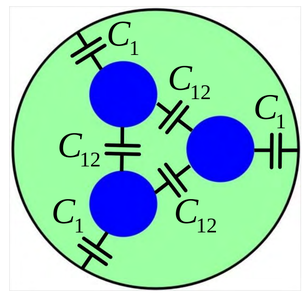


- The multiconductor transmission lines provides compact feed for OAM arrays [2]

Requirements for the Mode Orthogonality

- The network parameter matrixes S, Z, Y, … need to be cyclic
- ➢ The capacitance per length matrix C' and Inductance per length matrix L' need to be cyclic [1]

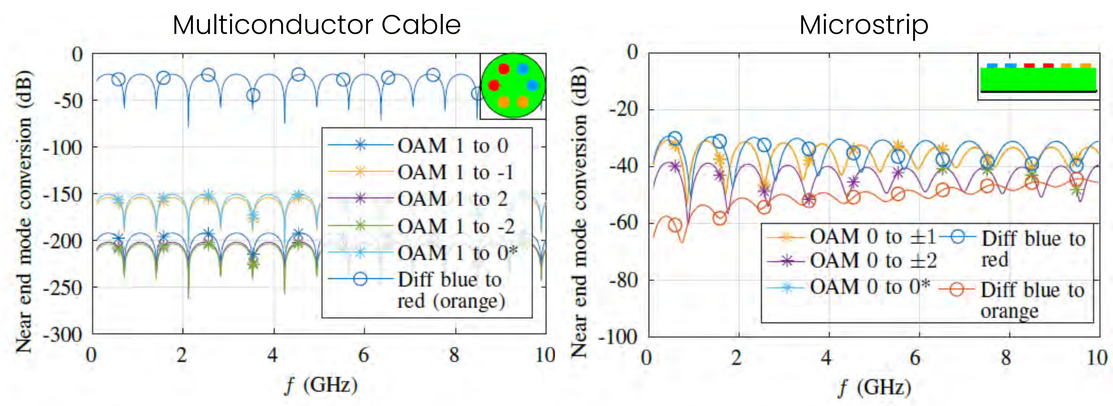
$$C' = \begin{pmatrix} C_1 + C_{12} + C_{13} & -C_{12} & -C_{13} \\ -C_{13} & C_1 + C_{12} + C_{13} & -C_{12} \\ -C_{12} & -C_{13} & C_1 + C_{12} + C_{13} \end{pmatrix}$$



$$C_{12} = C_{13}$$

Performance (NEXT)

OAM modes are compared to color coded differential modes [1]



- The NEXT of the OAM modes an the multiconductor cable is negligibly small
- On the one layer stripline and microstrip the OAM modes are not orthogonal
- The multilayer stripline provides a small NEXT for most mode pairs

Conclusion

- Mulitconductor transmission lines can carry OAM modes
- The OAM modes are a natural extension of the common/differential mode system
- OAM modes require a cyclic symmetry in C' and L' to be orthogonal
- The cyclic multiconductor cable is an ideal transmission lines for the OAM modes
- The multilayer stripline has to be optimized to produce low crosstalk for the OAM modes

[1] M. Wulff, L. Wang, C. Yang, H. D. Brüns and C. Schuster, "Using Orbital Angular Momentum (OAM) Modes on Multi-Conductor Cables for Crosstalk Mitigation," 2020 IEEE 24th Workshop on Signal and Power Integrity (SPI), Cologne, Germany, 2020

[2] M. Wulff, T. Hillebrecht, L. Wang, C. Yang and C. Schuster, "Multiconductor Transmission Lines for Orbital Angular Momentum (OAM) Communication Links," in IEEE Transactions on Components, Packaging and Manufacturing Technology, vol. 12, no. 2, pp. 329-340, Feb. 2022.

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