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Mini-Circuits Butler Matrices Enable Repeatable 5G and Wi-Fi MIMO Beamforming and Multipath Testing

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[Mini-Circuits](#) has released a family of high-performance [Butler matrices](#), designed to help engineers reproduce controlled RF phase relationships and multipath propagation conditions in laboratory and production test environments. Covering key Wi-Fi and 5G FR1 frequency bands, the five models provide bidirectional signal transfer between all inputs and outputs while maintaining controlled phase relationships, amplitude balance, and insertion loss across their operating bands.

The Butler matrix architecture is particularly useful for antenna beamforming development and evaluation of MIMO transmitters and receivers. By providing multiple precisely related RF signal paths, the matrices allow engineers to emulate multipath conditions that normally occur during over-the-air transmission without requiring an OTA environment. Every unit is 100% tested for highly repeatable performance.

The portfolio includes two 4 x 4 models and three 8 x 8 models, all with SMA connectors:

- **ZBLR-4X4-0672** — 4 inputs and 4 outputs covering 600 to 7250 MHz, with 7 dB typical loss and a 45° phase increment between adjacent outputs.
- **ZBLR-4X4E** — 4 x 4 configuration covering 2000 to 8000 MHz, with 7 dB typical loss and a 45° phase increment.
- **ZBLR-8X8-0650** — 8 inputs and 8 outputs covering 600 to 5000 MHz, with 12 dB typical loss and a 22.5° phase increment.
- **ZBLR-8X8E** — 8 x 8 configuration covering 2400 to 7200 MHz, with 10 dB typical loss and a 22.5° phase increment.
- **ZBLR-8X8-0672** — 8 x 8 configuration covering 600 to 7250 MHz, with 10 dB typical loss and a 22.5° phase increment.

Designed for Controlled Phase and Amplitude Performance

A key characteristic of the Butler matrix is its defined phase progression between adjacent outputs. The 4 x 4 models provide a 45° phase offset, while the 8 x 8 models provide a 22.5° offset. These phase relationships enable controlled excitation of multiple antenna paths, making the devices suitable for beamforming and MIMO test applications.

The product design uses high-performance passive components and custom phase-matched cables to maintain phase and amplitude performance across the specified frequency bands. This approach provides low amplitude unbalance and controlled loss across the operating range, with every unit

subjected to 100% testing.

For applications requiring programmable path loss in addition to phase-controlled signal distribution, Mini-Circuits also offers multi-channel attenuators that can be used with Butler and other $n \times m$ matrices. These attenuators support individually controlled attenuation, fading, sweep and hop sequences, with USB and Ethernet control and automation capabilities through Python, LabVIEW and other programming environments.

For more information, visit the [Mini-Circuits Butler Matrix product family page](#).

Supporting Links:

<https://www.minicircuits.com/WebStore/products/Butler-Matrices>

Tags:

Cables & Connectors, Power Measurement, RF, Test & Measurement

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About Us:

Heading : About Mini-Circuits

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