



PRECISE PHASE CONTROL

Butler Matrix

ZBLR-4X4E

Mini-Circuits

50Ω 2400 to 7250 MHz 4 x 4 SMA-Female

THE BIG DEAL

- Low loss 4 input to 4 output matrix
- 45° phase shift offsets between outputs
- Excellent phase & amplitude accuracy
- Tightly controlled specifications
- 100% tested & repeatable
- High power handling
- Compact benchtop modules

APPLICATIONS

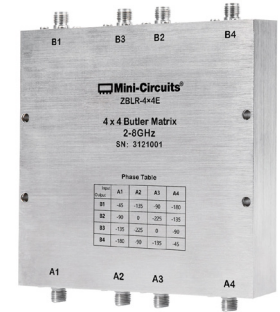
- WiFi 6E, Bluetooth, 5G FR1 & MIMO testing
- Beam-forming antenna arrays
- Emulation of multi-path propagation
- Production, R&D, qualification testing
- Test & measurement systems

PRODUCT OVERVIEW

Mini-Circuits' ZBLR-4X4E is a high-performance Butler matrix from 2.4 to 7.25 GHz, transferring RF signals bi-directionally from all 4 inputs to all 4 outputs with superior phase accuracy, amplitude unbalance and loss. This design uses high performance passive components with custom phase-matched cables to deliver superb phase and amplitude unbalance across the entire frequency band. All units are 100% tested with highly repeatable performance.

Butler matrices provide precise phase relationships, with a 45° phase offset between each adjacent output for a 4 x 4 matrix. This characteristic makes them ideally suited for antenna beam-forming applications and evaluation of 5G & WiFi MIMO transmitter / receivers. Multi-path propagation effects typically seen in over the air transmissions can be conveniently simulated within a lab or production test environment courtesy of the multiple phase paths through the Butler matrix.

The ZBLR series is provided in a rugged and compact package with SMA connectors on opposite faces for convenient connection to Tx and Rx devices and simulators.



Generic photo used for illustration purposes only

KEY FEATURES

Feature	Advantages
4 x 4 matrix	Up to 4x4 MIMO antenna tests can be carried out with 45° phase increments between adjacent paths, supporting thorough evaluation of receiver capabilities.
Precise phase matching	Custom semi-rigid cables used to precisely tune internal phase relationships.
Tightly controlled specifications	Detailed specifications over the full frequency range with 100% RF testing of all units to ensure precise and repeatable performance.
Low insertion loss	Insertion loss minimized by design to limit signal loss during transmitter testing.
High input power	5 W power rating permits direct connection to transmitter outputs without additional signal padding

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ELECTRICAL SPECIFICATIONS AT +25°C

Parameter	Conditions	Min.	Typ.	Max.	Units
Frequency Range		2400		7250	MHz
Insertion Loss ¹	2400 – 2500 MHz		6.8	7.3	dB
	5180 – 5830 MHz		7.1	7.7	
	5900 – 7250 MHz		7.2	7.8	
Amplitude Balance	2400 – 2500 MHz		± 0.3		dB
	5180 – 5830 MHz		± 0.4		
	5900 – 7250 MHz		± 0.5		
Amplitude Flatness	2400 – 2500 MHz		± 0.2		dB
	5180 – 5830 MHz		± 0.3		
	5900 – 7250 MHz		± 0.4		
Isolation ²	2400 – 2500 MHz		18		dB
	5180 – 5830 MHz		17		
	5900 – 7250 MHz		15		
Return Loss ³	2400 – 2500 MHz		20.8		dB
	5180 – 5830 MHz		17.7		
	5900 – 7250 MHz		17.7		
Phase Accuracy ⁴	2400 – 2500 MHz		± 3	± 4	°
	5180 – 5830 MHz		± 3	± 5	
	5900 – 7250 MHz		± 4	± 6	
Input Power (CW)	Single Input ⁵			5	W
	Total power			5	

1. Including 6 dB theoretical signal splitting / combining loss

2. Path loss between adjacent A ports or adjacent B ports

3. All ports

4. Relative to ideal phase relationships shown in the Phase States table below

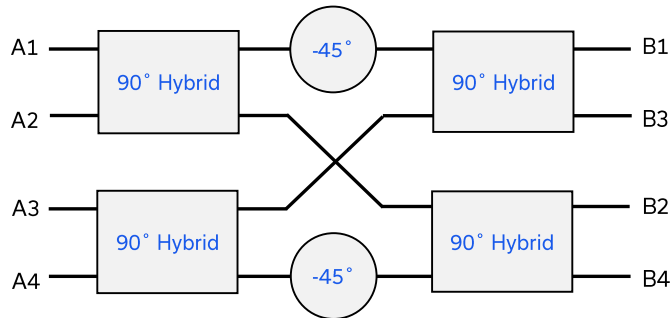
5. Reduce power levels when signals are present on multiple inputs to ensure the total power limit is not exceeded

PHASE STATES

Ports	A1	A2	A3	A4
B1	-45	-135	-90	-180
B2	-90	0	-225	-135
B3	-135	-225	0	-90
B4	-180	-90	-135	-45



FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Parameter	Conditions	Limits	Units
Temperature	Operating	-20 to +70	°C
	Storage	-20 to +70	
Input Power (No Damage)	Total Power	5	W

Permanent damage may occur if any of these limits are exceeded. Operating in the range between operating power limits and absolute maximum ratings for extended periods of time may result in reduced life and reliability.

CONNECTIONS

Port	Connector
A1 to A4	SMA female
B1 to B4	SMA female



PRECISE PHASE CONTROL

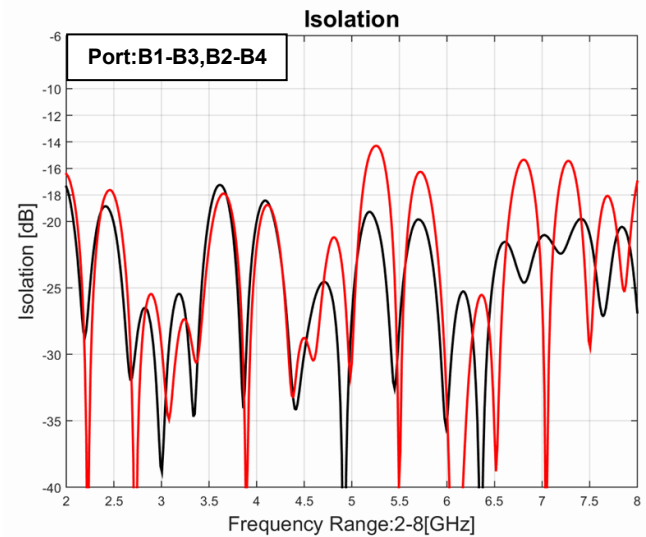
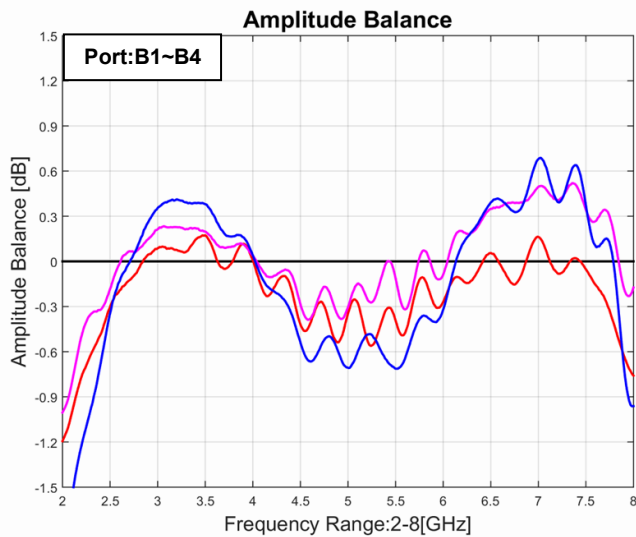
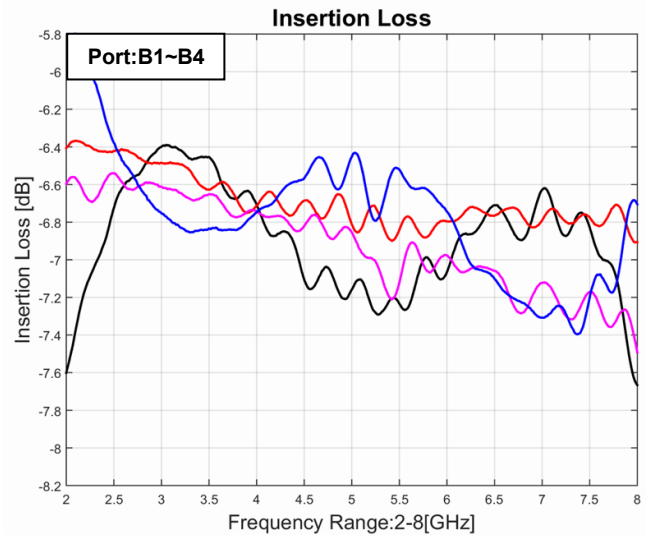
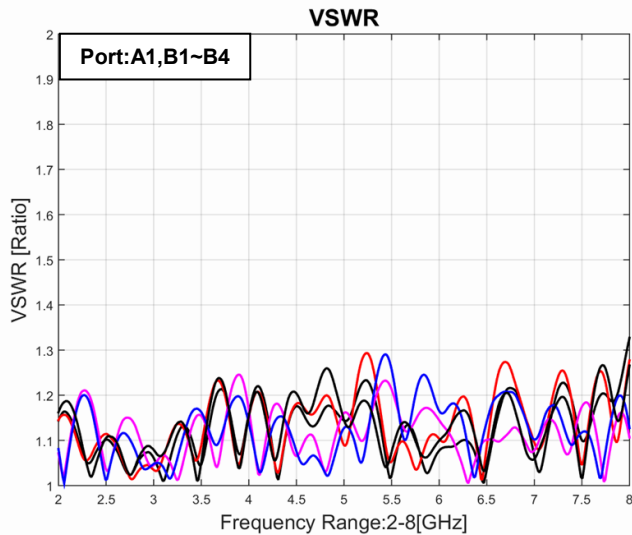
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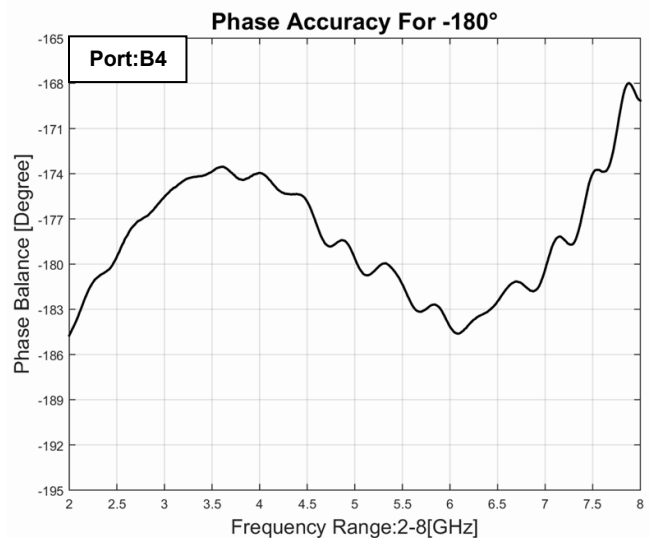
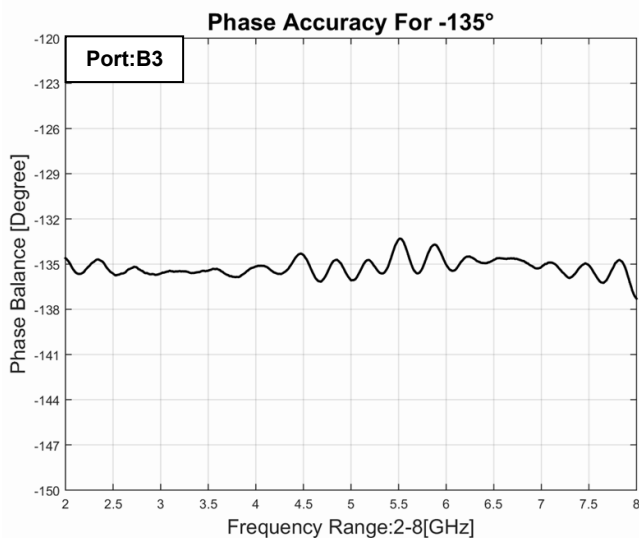
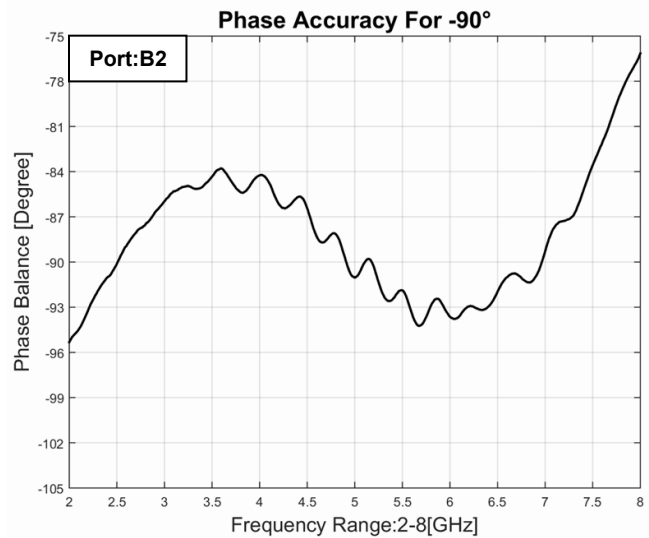
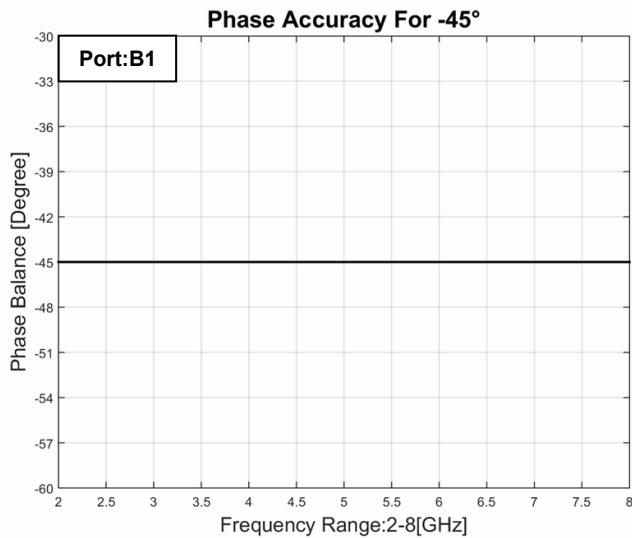
TYPICAL PERFORMANCE GRAPHS
ALL PLOTS MEASURED WITH PORT A1 AS INPUT:



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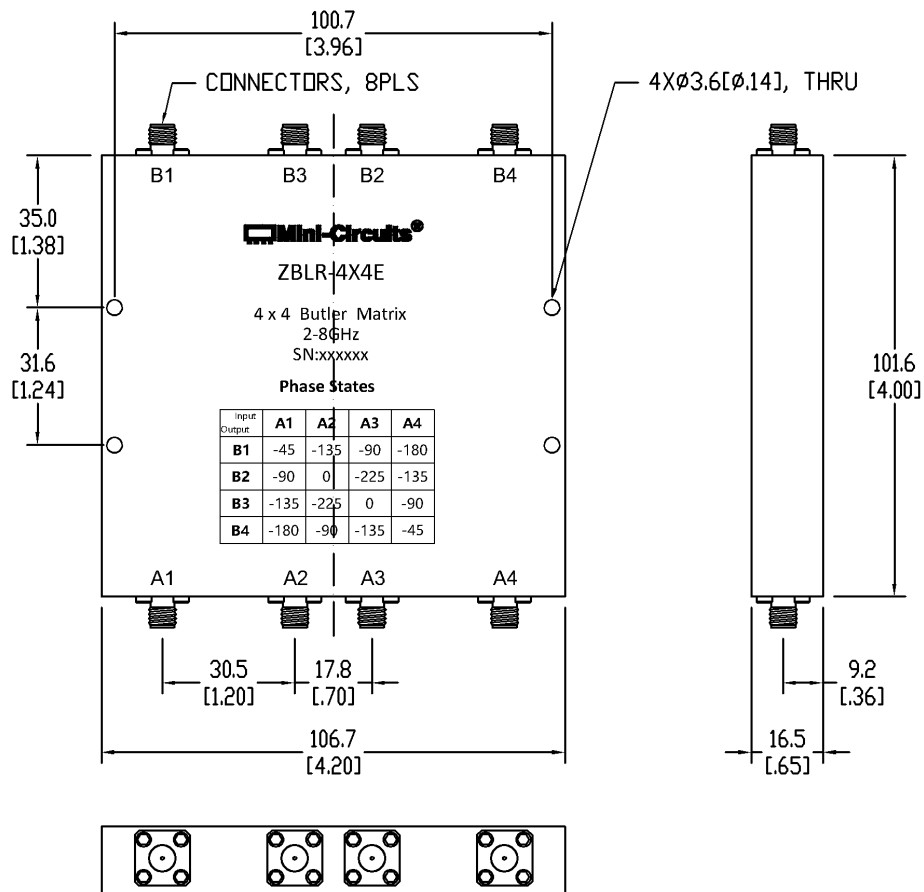


TYPICAL PERFORMANCE GRAPHS
ALL PLOTS MEASURED WITH PORT A1 AS INPUT:





OUTLINE DRAWING



PRODUCT MARKING*

Product Marking: ZBLR-4X4E

Product Description: 4 x 4 Butler Matrix

Product Frequency: 2-8 GHz

Phase Table

Unit ID Label: Serial number and other identification marks

*Marking may contain other features or characters for internal lot control



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DETAILED MODEL INFORMATION IS AVAILABLE ON OUR WEBSITE [CLICK HERE](#)

Environmental Rating	ENV55
Regulatory Compliance	RoHS compliant

Contact Us: testsolutions@minicircuits.com

NOTES

- Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the standard. Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/MCLStore/terms.jsp





Environmental Specifications ENV55

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-0° to 50° C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-20° to 60° C Ambient Environment	Individual Model Data Sheet
Operating and Storage Humidity	5% to 85% RH (non-condensing)	Ambient
Bench Handling Test	Bench Top Tip 45° & Drop	MIL-PRF-28800F
Transit Drop Test	Free Fall Drop, 20 cm (7.9 inches)	MIL-PRF-28800F Class 3