

# WIDEBAND HIGH ACCURACY BUTLER MATRICES & THEIR APPLICATIONS

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## WHAT IS BUTLER MATRIX ?

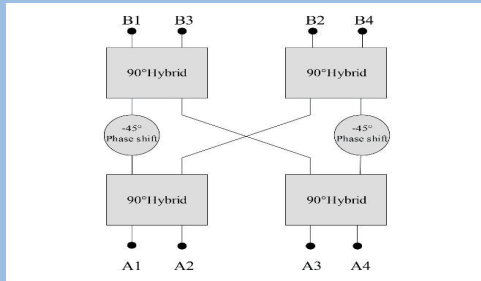
A Butler matrix is a beamforming network used to feed a phased array of antenna elements.

Its purpose is to control the direction of a beam or beams of radio transmission. It consists of an  $N \times N$  matrix of hybrid couplers and fixed-value phase shifters where  $N$  is some power of 2. The device has  $N$  input ports (the beam ports) to which power is applied, and  $N$  output ports (the element ports) to which  $N$  antenna elements are connected.

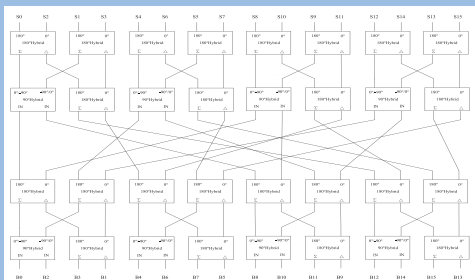
The Butler matrix feeds power to the elements with a progressive phase difference between elements such that the beam of radio transmission is in the desired direction. The beam direction is controlled by switching power to the desired beam port. More than one beam, or even all  $N$  of them can be activated simultaneously.

# TYPICAL BUTLER MATRIX CONFIGURATION

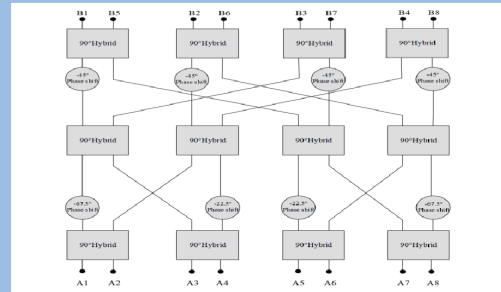
4x4  
Butler  
Matrix



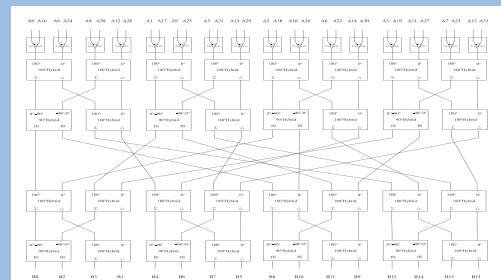
16x16  
Butler  
Matrix



8x8  
Butler  
Matrix



32x16  
Butler  
Matrix



## HIGHLIGHTS OF MICABLE INNOVATION

Leading technologies in three fields which are factors that block the development of butler technologies and products.



Wideband and ultra-wideband hybrid technology (90° & 180°)

Eg. 0.7 to 18GHz, 24-44GHz, 6-40GHz, even wider frequency up 67GHz are available



Wideband passive phase shifter

Eg. we can realize 2-8GHz 45° phase shifter



Precision phase matching & tracking technology of cable assemblies

Eg. we can offer thousands of cable assemblies up to 67GHz with very accurate phase matching

# INNOVATIVE PRODUCTS FROM MICABLE



## Performance & Characteristics

- ⊕ Top high accuracy in the market
- ⊕ Unbelievable very wide instantaneous bandwidth
- ⊕ Ultra low loss
- ⊕ Higher input/output power
- ⊕ Very high channel isolation
- ⊕ Small size
- ⊕ Any butler matrix configuration available
- ⊕ Frequency can go up to 53GHz even higher



## HIGHLIGHTS OF MICABLE PRODUCTS

Almost all the specifications  
are  
the “best” or “unimaginable”  
in the market!



# PERFORMANCE OF PRODUCTS IN THE MARKET

At present, the other products covering whole WIFI 6E frequency bands in the market have the performance as below:

## □ 2.4-7.25GHz 4x4 matrix

Specification optimized for 2.4-2.5 and 4.8-7.25 GHz, phase accuracy  $\pm 15^\circ$  max referenced to 6.5GHz, no spec. given for 6.5 to 7.25GHz and whole frequency bands, insertion loss 11dB max, VSWR 2.0:1 max, Isolation 12dB typ, Power 5W CW

## □ 2.4-7.25GHz 8x8 matrix

Specification optimized for 2.4-2.5 and 4.8-7.25 GHz, phase accuracy  $\pm 20^\circ$  max referenced to 6.5GHz, no spec. given for 6.5 to 7.25GHz and whole frequency bands, insertion loss 16dB max, VSWR 2.2:1 max, Isolation 12dB typ, Power 5W CW

### Note:

The products only give the specifications referenced to 6.5GHz for phase accuracy, if the component is required to work over 2.4-2.5 and 4.8 - 7.25GHz at same time, the actual performance should be much worse.

# PERFORMANCE OF MICABLE PRODUCTS

## □ 2.4-7.25GHz 4x4 matrix (Micable model [SA-07-4B020080](#))

The unit can work over 6GHz BW. Specifications are optimized for all WIFI 6E frequency bands.

Over all frequency bands, phase accuracy  $\pm 6^\circ$  max, insertion loss 7.8dB max, VSWR 1.5:1 max, Isolation 13dB min, Power 5W CW. For different WiFi frequencies, Phase accuracy: 2.4-2.5GHz  $\pm 4^\circ$ , 5.17-5.83GHz  $\pm 5^\circ$ , 5.9-7.25  $\pm 6^\circ$ , amplitude balance typical  $\pm 0.4$  dB

## □ 2.4-7.25GHz 8x8 matrix (Micable model [SA-07-8B020080](#))

The unit can work over 6GHz BW. Specifications are optimized for all WIFI 6E frequency bands.

Over all frequency bands, phase accuracy  $\pm 12^\circ$  max, insertion loss 11.8dB max, VSWR 1.6:1 max, Isolation 12.5dB min, Power 5W CW. For different WiFi frequencies, Phase accuracy: 2.4-2.5GHz  $\pm 8^\circ$ , 5.17-5.83GHz  $\pm 10^\circ$ , 5.9-7.25  $\pm 12^\circ$ , amplitude balance typical  $\pm 0.4$  dB

### Conclusion

Micable products are real wideband products, which can realize

One product covers all three WIFI 6E frequency bands with very high performance,

# COMPARISON BETWEEN MICABLE & OTHER PRODUCTS IN THE MARKET

## □ 2.4-7.25GHz 4x4 matrix (traditional design in the market)

Specification optimized for 2.4-2.5 and 4.8-7.25 GHz in their catalog

Phase accuracy  $\pm 15^\circ$  max referenced to 6.5GHz, no spec. given in the catalog for 6.5 to 7.25GHz and all 2.4 to 7.25GHz, insertion loss 11dB max, VSWR 2.0:1 max, Isolation 12dB typ, Power 5W CW

## 2-8GHz 4x4 matrix (Micable SA-07-4B020080)

The unit can work over 6GHz BW. Specification is optimized for all three WIFI 6E frequency bands.

Phase accuracy  $\pm 6^\circ$  max, insertion loss 7.8dB max, VSWR 1.5:1, Isolation 13dB min, Power 5W CW

For different WiFi 6E frequencies, Phase accuracy: 2.4-2.5GHz  $\pm 4^\circ$ , 5.18-5.83GHz  $\pm 5^\circ$ , 5.9-7.25  $\pm 6^\circ$ , amplitude balance typical  $\pm 0.4$  dB

## Conclusion

All *Micable* specifications are much better. Micable product can significantly improve the signal phase control accuracy (phase accuracy improved by over  $\pm 9^\circ$ ), output 2.09 times higher power (insertion loss lower by 3.2dB), reduce channel interference (higher isolation) and offer better channel signal amplitude consistence (ampl. balance typical  $\pm 0.4$  dB)

**Micable model is real wideband product, has much better performance in every respect !**

# COMPARISON BETWEEN 8X8 BUTLER MATRICES

## □ 2.4-7.25GHz 8x8 matrix (Traditional design in the market)

Specification optimized for 2.4-2.5 and 4.8-7.25 GHz in their catalog

Phase accuracy  $\pm 20^\circ$  max referenced to 6.5GHz, insertion loss 16dB max, VSWR 2.2:1 max, Isolation 12dB typ, Power 5W CW

## 2-8GHz 8x8 matrix (Micable SA-07-8B020080)

The unit can work over 6GHz BW. Specification is optimized for all three WIFI frequency bands.

Phase accuracy  $\pm 12^\circ$  max, insertion loss 11.8dB max, VSWR 1.6:1, Isolation 12dB min, Power 5W CW

For different WiFi frequencies, Phase accuracy: 2.4-2.5GHz  $\pm 8^\circ$ , 5.18-5.83GHz  $\pm 10^\circ$ , 5.9-7.25  $\pm 12^\circ$ , amplitude balance typical  $\pm 0.4$  dB

## Conclusion

All *Micable* specifications are much better. Micable product can significantly improve the signal phase control accuracy (phase accuracy improved by over  $\pm 8^\circ$ ), output 2.63 times higher power (insertion loss lower by 4.2dB), reduce channel interference (higher isolation) and offer better channel signal amplitude consistence (ampl. balance typical  $\pm 0.4$  dB)

**Micable model is real wideband product, has much better performance in every respect !**

# TESTED DATA OF PRACTICAL BUTLER MATRICES

## 2-8GHz 4x4 butler matrix spec. and tested data

### 1.Nominal Phase Table

| Input<br>Output | A1   | A2   | A3   | A4   |
|-----------------|------|------|------|------|
| B1              | -45  | -135 | -90  | -180 |
| B2              | -90  | 0    | -225 | -135 |
| B3              | -135 | -225 | 0    | -90  |
| B4              | -180 | -90  | -135 | -45  |

### 2.Testing Records

#### 2.1 VSWR

| Freq. Range<br>(GHz) | Limits<br>Max(:1) | Input VSWR |      |      |      | Output VSWR |      |      |      |
|----------------------|-------------------|------------|------|------|------|-------------|------|------|------|
|                      |                   | A1         | A2   | A3   | A4   | B1          | B2   | B3   | B4   |
| 2.4-2.5              | 1.40              | 1.11       | 1.13 | 1.15 | 1.08 | 1.10        | 1.11 | 1.10 | 1.08 |
| 5.18-5.83            | 1.50              | 1.25       | 1.27 | 1.21 | 1.19 | 1.31        | 1.24 | 1.29 | 1.22 |
| 5.9-7.1              | 1.50              | 1.21       | 1.20 | 1.16 | 1.12 | 1.24        | 1.17 | 1.23 | 1.19 |

#### 2.2. Insertion Loss

| Input<br>Output | 2.4-2.5 GHz |      |      |      | 5.18-5.83 GHz |      |      |      | 5.9-7.1 GHz |      |      |      |
|-----------------|-------------|------|------|------|---------------|------|------|------|-------------|------|------|------|
|                 | ≤7.30dB*    |      |      |      | ≤7.70dB*      |      |      |      | ≤7.80dB*    |      |      |      |
|                 | A1          | A2   | A3   | A4   | A1            | A2   | A3   | A4   | A1          | A2   | A3   | A4   |
| B1              | 6.96        | 6.50 | 6.52 | 6.38 | 7.32          | 7.02 | 7.02 | 6.83 | 7.13        | 6.95 | 7.13 | 7.38 |
| B2              | 6.43        | 6.90 | 6.46 | 6.62 | 6.93          | 7.42 | 6.91 | 7.11 | 6.75        | 7.18 | 7.43 | 7.21 |
| B3              | 6.57        | 6.28 | 6.88 | 6.57 | 7.13          | 6.93 | 7.38 | 7.00 | 7.33        | 7.31 | 7.18 | 6.95 |
| B4              | 6.40        | 6.71 | 6.52 | 6.81 | 6.84          | 7.12 | 6.91 | 7.16 | 7.34        | 7.25 | 6.84 | 7.04 |

\*Theoretical 6dB included

#### 2.3. Amplitude Bal.

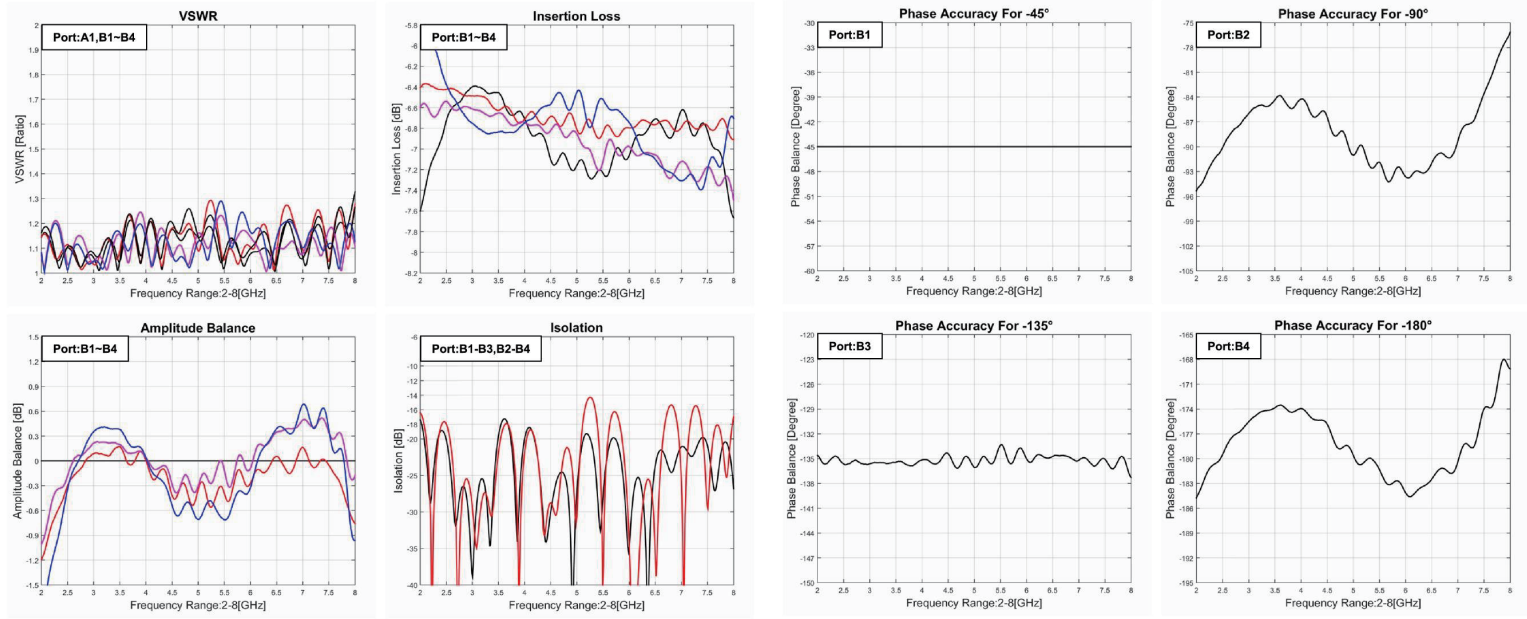
| Input<br>Output | 2.4-2.5 GHz |      |      |      | 5.18-5.83 GHz |      |      |      | 5.9-7.1 GHz |      |      |      |
|-----------------|-------------|------|------|------|---------------|------|------|------|-------------|------|------|------|
|                 | ± 0.50dB    |      |      |      | ± 0.60dB      |      |      |      | ± 0.70dB    |      |      |      |
|                 | A1          | A2   | A3   | A4   | A1            | A2   | A3   | A4   | A1          | A2   | A3   | A4   |
| B1              | 0.00        | 0.00 | 0.00 | 0.00 | 0.00          | 0.00 | 0.00 | 0.00 | 0.00        | 0.00 | 0.00 | 0.00 |
| B2              | 0.26        | 0.20 | 0.07 | 0.18 | 0.28          | 0.30 | 0.15 | 0.28 | 0.23        | 0.34 | 0.26 | 0.24 |
| B3              | 0.20        | 0.16 | 0.19 | 0.15 | 0.19          | 0.18 | 0.23 | 0.24 | 0.28        | 0.29 | 0.34 | 0.27 |
| B4              | 0.34        | 0.13 | 0.03 | 0.28 | 0.36          | 0.17 | 0.07 | 0.30 | 0.53        | 0.23 | 0.16 | 0.56 |

#### 2.4. Amplitude Flatness per path

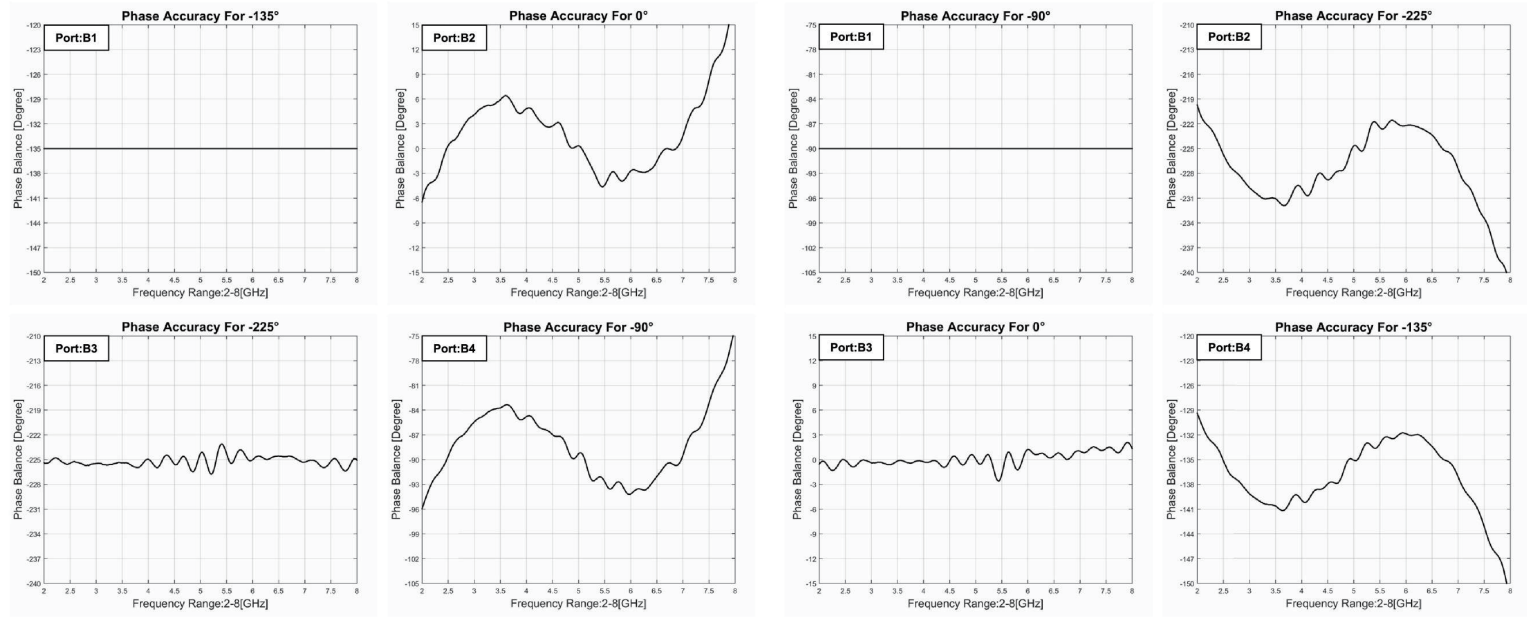
| Input<br>Output | 2.4-2.5 GHz |      |      |      | 5.18-5.83 GHz |      |      |      | 5.9-7.1 GHz |      |      |      |
|-----------------|-------------|------|------|------|---------------|------|------|------|-------------|------|------|------|
|                 | ± 0.30dB    |      |      |      | ± 0.40dB      |      |      |      | ± 0.50dB    |      |      |      |
|                 | A1          | A2   | A3   | A4   | A1            | A2   | A3   | A4   | A1          | A2   | A3   | A4   |
| B1              | 0.09        | 0.02 | 0.00 | 0.06 | 0.15          | 0.16 | 0.10 | 0.14 | 0.23        | 0.10 | 0.10 | 0.30 |
| B2              | 0.01        | 0.11 | 0.04 | 0.03 | 0.10          | 0.19 | 0.14 | 0.13 | 0.04        | 0.28 | 0.31 | 0.11 |
| B3              | 0.01        | 0.05 | 0.11 | 0.01 | 0.10          | 0.21 | 0.19 | 0.12 | 0.16        | 0.31 | 0.29 | 0.07 |
| B4              | 0.06        | 0.01 | 0.03 | 0.10 | 0.13          | 0.10 | 0.06 | 0.10 | 0.31        | 0.09 | 0.05 | 0.27 |

✦ Typical Tested Graph

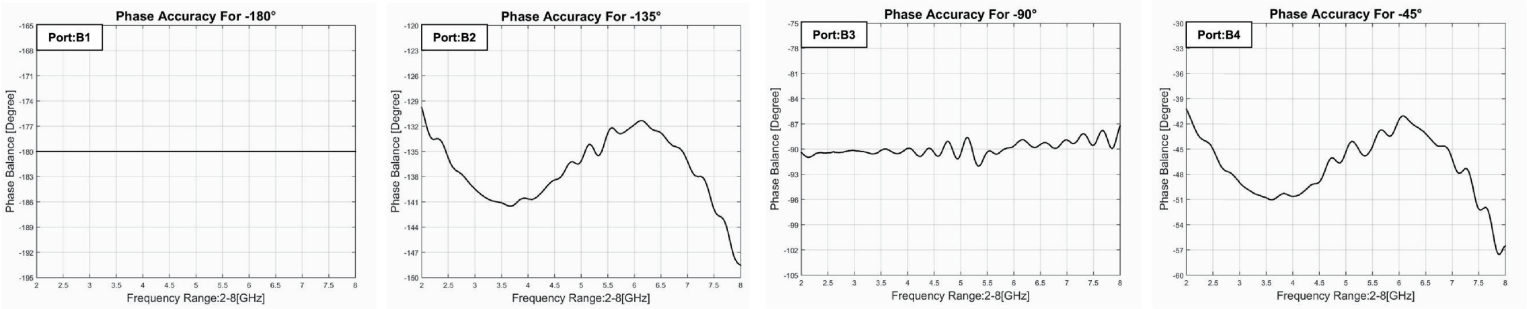
Take A1 As The Input Port



Take A2 As The Input Port



Take A4 As The Input Port



2-8GHz 8x8 butler matrix spec. and tested data

Phase Table

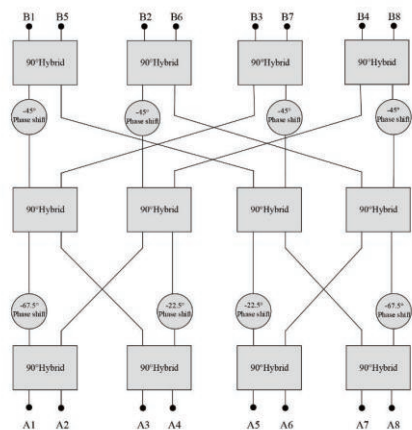
| input<br>output | A1     | A2     | A3     | A4     | A5     | A6     | A7     | A8     |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|
| B1              | -112.5 | -202.5 | -135   | -225   | -112.5 | -202.5 | -180   | -270   |
| B2              | -135   | -45    | -247.5 | -157.5 | -180   | -90    | -337.5 | -247.5 |
| B3              | -157.5 | -247.5 | 0      | -90    | -247.5 | -337.5 | -135   | -225   |
| B4              | -180   | -90    | 0      | -22.5  | -315   | -225   | -292.5 | -202.5 |
| B5              | -202.5 | -292.5 | 0      | -315   | -22.5  | -112.5 | -90    | -180   |
| B6              | -225   | -135   | 0      | -247.5 | -90    | 0      | -247.5 | -157.5 |
| B7              | -247.5 | -337.5 | 0      | -180   | -157.5 | -247.5 | -45    | -135   |
| B8              | -270   | -180   | 0      | -112.5 | -225   | -135   | -202.5 | -112.5 |

Specifications

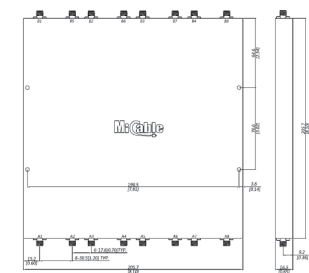
| Frequency Range             | GHz         | 2.4-2.5 | 5.18-5.83 | 5.9-7.25 |
|-----------------------------|-------------|---------|-----------|----------|
| VSWR for all RF ports       | (Typ.)      | 1.2     | 1.3       | 1.3      |
|                             | (Max.)      | 1.5     | 1.5       | 1.55     |
| Insertion Loss              | dB/(Typ.)   | 9.8     | 10.6      | 10.8     |
|                             | dB/(Max.)   | 11.2    | 11.6      | 11.8     |
| Amplitude Balance           | dB/(Typ.)   | ±0.3    | ±0.4      | ±0.5     |
|                             | dB/(Max.)   | ±0.6    | ±0.8      | ±0.9     |
| Amplitude Flatness per path | dB/(Typ.)   | ±0.2    | ±0.3      | ±0.4     |
|                             | dB/(Max.)   | ±0.4    | ±0.5      | ±0.7     |
| Phase Accuracy              | Deg./(Typ.) | ±6      | ±7        | ±8       |
|                             | Deg./(Max.) | ±8      | ±10       | ±12      |
| Isolation                   | dB/(Typ.)   | 18      | 17        | 15       |
|                             | dB/(Min.)   | 13      | 12        | 12       |

- **Average Power:** 5W Max (single Input-Port);
- **Connector:** SMA [F];
- **Case Style:** 205.7x205.7x16.5 mm;
- **Weight(max.):** 1375 g

Schematic Diagram



Outline Drawing



2-8GHz 8x8 butler matrix spec. and tested data

1. VSWR

| Freq. Range (GHz) | Limits Max.(:1) | Input VSWR |      |      |      |      |      |      |      | Output VSWR |      |      |      |      |      |      |      |
|-------------------|-----------------|------------|------|------|------|------|------|------|------|-------------|------|------|------|------|------|------|------|
|                   |                 | A1         | A2   | A3   | A4   | A5   | A6   | A7   | A8   | B1          | B2   | B3   | B4   | B5   | B6   | B7   | B8   |
| 2.4-2.5           | 1.50            | 1.30       | 1.37 | 1.11 | 1.07 | 1.12 | 1.15 | 1.30 | 1.26 | 1.14        | 1.16 | 1.06 | 1.19 | 1.14 | 1.08 | 1.10 | 1.08 |
| 5.18-5.83         | 1.50            | 1.21       | 1.39 | 1.32 | 1.19 | 1.17 | 1.32 | 1.31 | 1.31 | 1.32        | 1.23 | 1.24 | 1.25 | 1.24 | 1.35 | 1.22 | 1.22 |
| 5.9-7.25          | 1.55            | 1.49       | 1.42 | 1.35 | 1.15 | 1.23 | 1.29 | 1.25 | 1.34 | 1.25        | 1.28 | 1.26 | 1.28 | 1.25 | 1.32 | 1.23 | 1.38 |

2. Insertion Loss

| Input<br>Output | 2.4-2.5 GHz |       |       |       |       |       |       |       | 5.18-5.83 GHz |       |       |       |       |       |       |       | 5.9-7.25 GHz |       |       |       |       |       |       |       |
|-----------------|-------------|-------|-------|-------|-------|-------|-------|-------|---------------|-------|-------|-------|-------|-------|-------|-------|--------------|-------|-------|-------|-------|-------|-------|-------|
|                 | ≤11.2dB     |       |       |       |       |       |       |       | ≤11.6dB       |       |       |       |       |       |       |       | ≤11.8dB      |       |       |       |       |       |       |       |
|                 | A1          | A2    | A3    | A4    | A5    | A6    | A7    | A8    | A1            | A2    | A3    | A4    | A5    | A6    | A7    | A8    | A1           | A2    | A3    | A4    | A5    | A6    | A7    | A8    |
| B1              | 10.19       | 9.76  | 9.80  | 9.80  | 9.77  | 9.76  | 9.89  | 9.82  | 10.76         | 10.31 | 10.35 | 10.27 | 10.39 | 10.33 | 10.45 | 10.27 | 10.52        | 10.62 | 10.81 | 10.82 | 10.32 | 10.49 | 10.48 | 11.05 |
| B2              | 10.18       | 10.53 | 9.64  | 9.71  | 9.88  | 9.98  | 9.62  | 9.64  | 10.55         | 11.25 | 10.15 | 10.41 | 10.73 | 10.86 | 9.99  | 10.13 | 10.79        | 10.79 | 10.89 | 10.73 | 10.94 | 10.77 | 10.73 | 10.32 |
| B3              | 9.94        | 9.69  | 10.12 | 9.94  | 9.75  | 9.66  | 9.85  | 9.93  | 10.85         | 10.42 | 10.83 | 10.71 | 10.36 | 10.26 | 10.46 | 10.29 | 10.73        | 10.85 | 10.45 | 10.50 | 10.71 | 10.98 | 10.38 | 11.00 |
| B4              | 9.83        | 10.09 | 10.08 | 10.36 | 9.60  | 9.70  | 10.10 | 10.19 | 10.13         | 10.55 | 10.85 | 10.90 | 9.97  | 10.15 | 10.72 | 10.68 | 10.50        | 10.47 | 10.57 | 10.71 | 10.79 | 10.54 | 11.16 | 10.88 |
| B5              | 10.06       | 9.73  | 9.73  | 9.68  | 10.25 | 9.92  | 10.04 | 10.07 | 10.56         | 10.31 | 10.36 | 10.27 | 10.64 | 10.53 | 10.59 | 10.44 | 10.58        | 10.56 | 10.82 | 11.20 | 10.33 | 10.42 | 10.48 | 10.84 |
| B6              | 9.91        | 10.09 | 9.65  | 9.74  | 10.12 | 10.40 | 9.72  | 9.73  | 10.57         | 10.90 | 10.17 | 10.27 | 10.88 | 11.14 | 10.15 | 10.20 | 11.05        | 10.83 | 10.92 | 10.75 | 10.77 | 10.82 | 10.47 | 10.23 |
| B7              | 10.26       | 10.01 | 9.70  | 9.65  | 9.86  | 9.77  | 10.28 | 10.30 | 10.47         | 10.19 | 10.55 | 10.36 | 10.61 | 10.47 | 10.89 | 10.68 | 10.82        | 11.11 | 10.36 | 10.54 | 10.49 | 10.87 | 10.39 | 10.70 |
| B8              | 9.78        | 9.97  | 9.74  | 9.78  | 9.68  | 9.79  | 10.33 | 10.14 | 9.90          | 10.26 | 10.52 | 10.62 | 10.08 | 10.26 | 10.90 | 10.96 | 10.69        | 10.51 | 11.00 | 10.70 | 10.52 | 10.24 | 10.89 | 10.62 |

\*Theoretical 9dB included

3. Amplitude Bal.

| Freq. Range (GHz) | Limits Max.(dB) | Amplitude Balance |      |      |      |      |      |      |      |
|-------------------|-----------------|-------------------|------|------|------|------|------|------|------|
|                   |                 | A1                | A2   | A3   | A4   | A5   | A6   | A7   | A8   |
| 2.4-2.5           | ±0.60           | 0.38              | 0.39 | 0.26 | 0.29 | 0.24 | 0.32 | 0.29 | 0.27 |
| 5.18-5.83         | ±0.80           | 0.53              | 0.52 | 0.34 | 0.45 | 0.45 | 0.51 | 0.37 | 0.40 |
| 5.9-7.25          | ±0.90           | 0.45              | 0.41 | 0.47 | 0.37 | 0.40 | 0.37 | 0.53 | 0.57 |

4. Amplitude Flatness per path

| Input<br><br>Output | 2.4-2.5 GHz |      |      |      |      |      |      |      | 5.18-5.83 GHz |      |      |      |      |      |      |      | 5.9-7.25 GHz |      |      |      |      |      |      |      |
|---------------------|-------------|------|------|------|------|------|------|------|---------------|------|------|------|------|------|------|------|--------------|------|------|------|------|------|------|------|
|                     | ±0.40dB     |      |      |      |      |      |      |      | ±0.50dB       |      |      |      |      |      |      |      | ±0.70dB      |      |      |      |      |      |      |      |
|                     | A1          | A2   | A3   | A4   | A5   | A6   | A7   | A8   | A1            | A2   | A3   | A4   | A5   | A6   | A7   | A8   | A1           | A2   | A3   | A4   | A5   | A6   | A7   | A8   |
| B1                  | 0.12        | 0.02 | 0.10 | 0.01 | 0.07 | 0.11 | 0.10 | 0.09 | 0.21          | 0.16 | 0.12 | 0.15 | 0.19 | 0.20 | 0.17 | 0.09 | 0.37         | 0.30 | 0.37 | 0.28 | 0.16 | 0.22 | 0.24 | 0.37 |
| B2                  | 0.09        | 0.20 | 0.06 | 0.03 | 0.05 | 0.03 | 0.07 | 0.04 | 0.11          | 0.32 | 0.10 | 0.18 | 0.24 | 0.17 | 0.24 | 0.14 | 0.25         | 0.29 | 0.41 | 0.36 | 0.21 | 0.23 | 0.37 | 0.19 |
| B3                  | 0.04        | 0.02 | 0.19 | 0.08 | 0.04 | 0.09 | 0.07 | 0.15 | 0.24          | 0.26 | 0.18 | 0.24 | 0.16 | 0.21 | 0.14 | 0.10 | 0.19         | 0.27 | 0.29 | 0.15 | 0.26 | 0.35 | 0.21 | 0.39 |
| B4                  | 0.08        | 0.05 | 0.12 | 0.23 | 0.06 | 0.02 | 0.11 | 0.16 | 0.14          | 0.19 | 0.21 | 0.16 | 0.28 | 0.24 | 0.21 | 0.11 | 0.21         | 0.23 | 0.12 | 0.33 | 0.44 | 0.31 | 0.30 | 0.26 |
| B5                  | 0.25        | 0.15 | 0.02 | 0.07 | 0.22 | 0.07 | 0.15 | 0.23 | 0.18          | 0.22 | 0.24 | 0.31 | 0.20 | 0.17 | 0.29 | 0.17 | 0.26         | 0.22 | 0.30 | 0.47 | 0.28 | 0.18 | 0.24 | 0.23 |
| B6                  | 0.04        | 0.01 | 0.14 | 0.11 | 0.11 | 0.23 | 0.02 | 0.01 | 0.18          | 0.13 | 0.22 | 0.18 | 0.26 | 0.24 | 0.21 | 0.12 | 0.31         | 0.20 | 0.38 | 0.33 | 0.18 | 0.39 | 0.22 | 0.17 |
| B7                  | 0.13        | 0.14 | 0.03 | 0.01 | 0.05 | 0.04 | 0.18 | 0.28 | 0.24          | 0.22 | 0.20 | 0.20 | 0.14 | 0.16 | 0.32 | 0.19 | 0.30         | 0.57 | 0.14 | 0.18 | 0.12 | 0.24 | 0.30 | 0.23 |
| B8                  | 0.17        | 0.14 | 0.06 | 0.05 | 0.01 | 0.08 | 0.13 | 0.05 | 0.19          | 0.19 | 0.17 | 0.19 | 0.12 | 0.17 | 0.23 | 0.20 | 0.39         | 0.23 | 0.30 | 0.23 | 0.27 | 0.20 | 0.21 | 0.35 |

5. Phase Accuracy

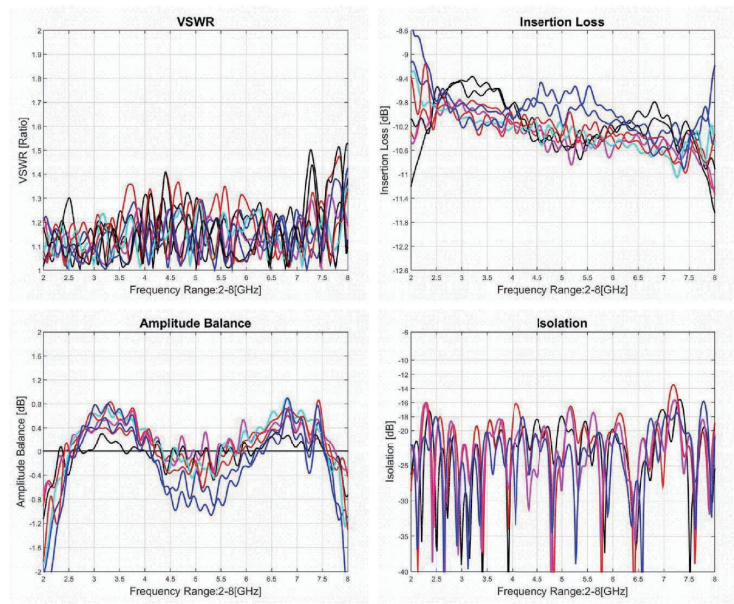
| Freq. Range (GHz) | Limits Max.(Deg.) | Phase Accuracy |     |     |     |     |     |     |     |
|-------------------|-------------------|----------------|-----|-----|-----|-----|-----|-----|-----|
|                   |                   | A1             | A2  | A3  | A4  | A5  | A6  | A7  | A8  |
| 2.4-2.5           | ±8.0              | 2.4            | 2.9 | 4.3 | 3.4 | 3.5 | 4.1 | 3.5 | 4.0 |
| 5.18-5.83         | ±10.0             | 4.8            | 4.8 | 4.2 | 4.7 | 3.7 | 3.8 | 4.7 | 4.4 |
| 5.9-7.25          | ±12.0             | 4.9            | 5.5 | 5.0 | 4.8 | 4.5 | 4.3 | 4.3 | 4.5 |

6. Isolation

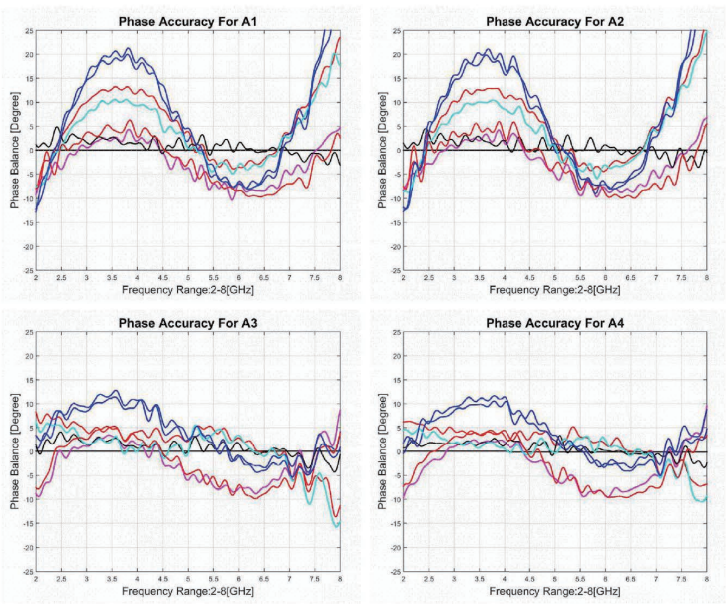
| Freq. Range (GHz) | Limits Min.(dB) | Isolation |       |       |       |
|-------------------|-----------------|-----------|-------|-------|-------|
|                   |                 | B1-B5     | B2-B6 | B3-B7 | B4-B8 |
| 2.4-2.5           | 13.0            | -18.4     | -22.0 | -21.0 | -18.0 |
| 5.18-5.83         | 12.0            | -18.7     | -16.6 | -17.2 | -20.3 |
| 5.9-7.25          | 12.0            | -16.6     | -13.5 | -15.7 | -17.5 |

◆ Typical Testing Plots (Freq. Range: 2-8GHz)

Take A1 As The Input Port

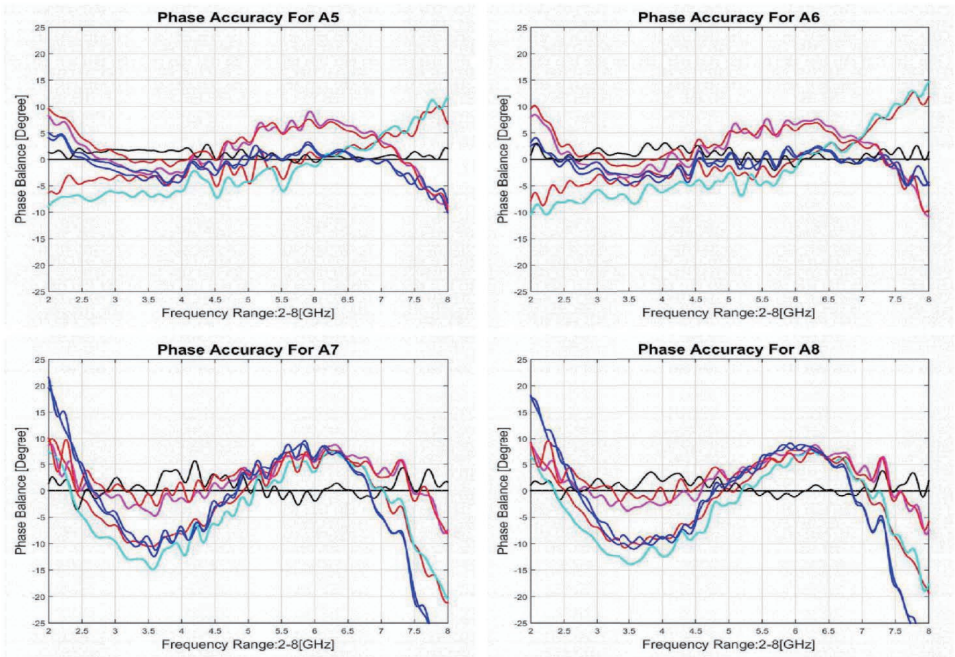


Phase Accuracy For A1~A4



◆ Typical Testing Plots (Freq. Range: 2-8GHz)

Phase Accuracy For A5~A8



## CAPABILITY OF MICABLE

### ✓ We can realize very wideband butler matrix

Bandwidth can be 4-octave, frequency up to 53GHz even higher

### ✓ We can offer the higher phase control accuracy, better signal output consistency and higher input/output signal in the market

### ✓ We can realize various configuration

4x4, 8x8, 16x16, 16x32, 32x32, even more like 64x64

#### **Micable butler matrix & specifications index**

| Freq. Range(GHz)                             | 1.5 ~ 8                  |                            | 6 ~ 12                   |                            | 12 ~ 24                  |                            | 24 ~ 53                  |                            |
|----------------------------------------------|--------------------------|----------------------------|--------------------------|----------------------------|--------------------------|----------------------------|--------------------------|----------------------------|
| Any given bandwidth within freq. range (MHz) | 200                      |                            | 400                      |                            | 600                      |                            | 1000                     |                            |
| Specifications                               | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) |
| 4*4                                          | ±0.4                     | ±2.0                       | ±0.5                     | ±5.0                       | ±0.6                     | ±6.0                       | ±0.8                     | ±8.0                       |
| 8*8                                          | ±0.5                     | ±3.0                       |                          |                            |                          |                            |                          |                            |
| 16*16                                        | ±0.6                     | ±4.0                       |                          |                            |                          |                            |                          |                            |
| 32*16                                        | ±0.7                     | ±5.0                       |                          |                            |                          |                            |                          |                            |

## CAPABILITY OF MICABLE

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### ✓ We can realize various configuration

4x4, 8x8, 16x16, 16x32, 32x32, even more like 64x64

#### **Micable butler matrix & specifications index**

| Freq. Range(GHz)                             | 1.5 ~ 8                  |                            | 6 ~ 12                   |                            | 12 ~ 24                  |                            | 24 ~ 53                  |                            |
|----------------------------------------------|--------------------------|----------------------------|--------------------------|----------------------------|--------------------------|----------------------------|--------------------------|----------------------------|
| Any given bandwidth within freq. range (MHz) | 200                      |                            | 400                      |                            | 600                      |                            | 1000                     |                            |
| Specifications                               | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) | AMP. Bal.<br>Max. ( dB ) | PHA. Bal.<br>Max. ( Deg. ) |
| 4*4                                          | ±0.4                     | ±2.0                       | ±0.5                     | ±5.0                       | ±0.6                     | ±6.0                       | ±0.8                     | ±8.0                       |
| 8*8                                          | ±0.5                     | ±3.0                       |                          |                            |                          |                            |                          |                            |
| 16*16                                        | ±0.6                     | ±4.0                       |                          |                            |                          |                            |                          |                            |
| 32*16                                        | ±0.7                     | ±5.0                       |                          |                            |                          |                            |                          |                            |

# PRODUCT LIST AND KEY PERFORMANCE

## ■4x4 Butler Matrices

| Part Number     | Structure | Frequency Range*<br>(GHz) | VSWR<br>:1(Max.) | Insertion Loss*<br>dB(Max.) | Amplitude Balance<br>dB(Max.) | Amplitude Flatness<br>dB(Max.) | Phase Accuracy<br>Deg.(Max.) | Isolation<br>dB(Min.) |
|-----------------|-----------|---------------------------|------------------|-----------------------------|-------------------------------|--------------------------------|------------------------------|-----------------------|
| SA-07-4B006050  | 4×4       | 0.617-0.821               | 1.4              | 8.2                         | ±1.1                          | ±0.8                           | ±10                          | 16                    |
|                 |           | 0.832-0.96                | 1.4              | 8.2                         | ±1.1                          | ±0.7                           | ±9                           | 16                    |
|                 |           | 1.427-1.71                | 1.5              | 8.3                         | ±0.9                          | ±0.7                           | ±9                           | 15                    |
|                 |           | 1.71-2.2                  | 1.5              | 8.5                         | ±0.9                          | ±0.8                           | ±10                          | 14                    |
|                 |           | 2.496-2.69                | 1.5              | 8.7                         | ±0.9                          | ±0.7                           | ±9                           | 13                    |
|                 |           | 3.3-4.2                   | 1.6              | 8.9                         | ±1                            | ±0.7                           | ±12                          | 13                    |
|                 |           | 4.4-5                     | 1.6              | 9.2                         | ±1                            | ±0.8                           | ±12                          | 13                    |
| SA-07-4B007022  | 4×4       | 0.7-2.2                   | 1.3              | 7.8                         | ±0.8                          | ±0.8                           | ±8                           | 16                    |
|                 |           | 0.7-0.915                 | 1.2              | 7.2                         | ±0.5                          | ±0.5                           | ±5                           | 18                    |
|                 |           | 1.427-1.785               | 1.3              | 7.5                         | ±0.6                          | ±0.5                           | ±6                           | 16                    |
|                 |           | 1.85-2.2                  | 1.3              | 7.8                         | ±0.6                          | ±0.6                           | ±6                           | 16                    |
| SA-07-4B017022  | 4×4       | 1.7-2.2                   | 1.3              | 7                           | ±0.5                          | ±0.4                           | ±3                           | 18                    |
| SA-07-4B020060  | 4×4       | 2-6                       | 1.5              | 7.8                         | ±0.9                          | ±0.8                           | ±8                           | 14                    |
|                 |           | 2.4-2.5                   | 1.4              | 7.3                         | ±0.5                          | ±0.3                           | ±4                           | 15                    |
|                 |           | 5.18-5.83                 | 1.5              | 7.7                         | ±0.6                          | ±0.4                           | ±5                           | 14                    |
| SA-07-4B020080  | 4×4       | 2.4-2.5                   | 1.4              | 7.3                         | ±0.5                          | ±0.3                           | ±4                           | 14                    |
|                 |           | 5.18-5.83                 | 1.5              | 7.7                         | ±0.6                          | ±0.4                           | ±5                           | 13                    |
|                 |           | 5.9-7.25                  | 1.5              | 7.8                         | ±0.7                          | ±0.5                           | ±6                           | 13                    |
| SA-07-4B020080E | 4×4       | 2.4-2.5                   | 1.5              | 7.5                         | ±0.6                          | ±0.5                           | ±7                           | 12                    |
|                 |           | 5.18-5.83                 | 1.5              | 7.9                         | ±0.7                          | ±0.6                           | ±8                           | 12                    |
|                 |           | 5.9-7.25                  | 1.5              | 8                           | ±0.8                          | ±0.7                           | ±9                           | 12                    |
| SA-07-4B023025  | 4×4       | 2.3-2.5                   | 1.3              | 7                           | ±0.4                          | ±0.4                           | ±3                           | 18                    |
| SA-07-4B024028  | 4×4       | 2.4-2.8                   | 1.3              | 7.3                         | ±0.4                          | ±0.5                           | ±3                           | 18                    |
| SA-07-4B048060  | 4×4       | 4.8-6                     | 1.5              | 7.6                         | ±0.5                          | ±0.6                           | ±4                           | 16                    |
| SA-07-4B057059  | 4×4       | 5.7-5.9                   | 1.5              | 7.5                         | ±0.4                          | ±0.5                           | ±4                           | 16                    |
| SA-07-4B058060  | 4×4       | 5.85-5.95                 | 1.5              | 7.5                         | ±0.4                          | ±0.3                           | ±4                           | 16                    |
| SA-07-4B060080  | 4×4       | 6-8                       | 1.5              | 8                           | ±0.5                          | ±0.8                           | ±5                           | 14                    |
| SA-07-4B242275E | 4×4       | 24.25-27.5                | 1.9              | 11                          | ±1                            | ±1                             | ±14                          | 8                     |
| SA-07-4B265295  | 4×4       | 26.5-29.5                 | 1.8              | 11                          | ±0.8                          | ±0.8                           | ±8                           | 10                    |
| SA-07-4B265295E | 4×4       | 26.5-29.5                 | 1.9              | 11.4                        | ±1                            | ±1                             | ±14                          | 8                     |
| SA-07-4B275284E | 4×4       | 27.5-28.35                | 1.9              | 11                          | ±1                            | ±1                             | ±14                          | 8                     |
| SA-07-4B318334E | 4×4       | 31.8-33.4                 | 1.9              | 11.9                        | ±1                            | ±1                             | ±15                          | 7                     |
| SA-07-4B370386E | 4×4       | 37-38.6                   | 2                | 12.8                        | ±1                            | ±1                             | ±15                          | 7                     |
| SA-07-4B386400E | 4×4       | 38.6-40                   | 2                | 13.2                        | ±1                            | ±1                             | ±16                          | 7                     |
| SA-07-4B405435E | 4×4       | 40.5-43.5                 | 2                | 13.7                        | ±1                            | ±1                             | ±16                          | 7                     |

\*All units are wideband, can meet performance according to listed frequencies

\*Theoretical IL. Included

*Our goal is to offer high performance and quality products with quick delivery*

# PRODUCT LIST AND KEY PERFORMANCE

## ■8x8 Butler Matrices

| Part Number     | Structure | Frequency Range*<br>(GHz) | VSWR<br>:1(Max.) | Insertion Loss*<br>dB(Max.) | Amplitude Balance<br>dB(Max.) | Amplitude Flatness<br>dB(Max.) | Phase Accuracy<br>Deg. (Max.) | Isolation<br>dB(Min.) |
|-----------------|-----------|---------------------------|------------------|-----------------------------|-------------------------------|--------------------------------|-------------------------------|-----------------------|
| SA-07-8B006050  | 8×8       | 0.617-0.821               | 1.6              | 12.7                        | ±1.5                          | ±1.2                           | ±16                           | 15                    |
|                 |           | 0.832-0.96                | 1.6              | 12.7                        | ±1.5                          | ±1.1                           | ±14                           | 15                    |
|                 |           | 1.427-1.71                | 1.6              | 13.1                        | ±1.3                          | ±1.1                           | ±15                           | 14                    |
|                 |           | 1.71-2.2                  | 1.7              | 13.3                        | ±1.3                          | ±1.2                           | ±15                           | 13                    |
|                 |           | 2.496-2.69                | 1.7              | 13.7                        | ±1.3                          | ±1.1                           | ±14                           | 12                    |
|                 |           | 3.3-4.2                   | 1.7              | 14.5                        | ±1.4                          | ±1.1                           | ±20                           | 12                    |
|                 |           | 4.4-5                     | 1.7              | 14.9                        | ±1.4                          | ±1.2                           | ±20                           | 12                    |
| SA-07-8B020060  | 8×8       | 2-6                       | 1.6              | 12                          | ±1.2                          | ±1.2                           | ±12                           | 12                    |
|                 |           | 2.4-2.5                   | 1.5              | 11.4                        | ±0.7                          | ±0.5                           | ±8                            | 13                    |
|                 |           | 5.18-5.83                 | 1.6              | 12                          | ±0.9                          | ±0.6                           | ±10                           | 12                    |
| SA-07-8B020080  | 8×8       | 2.4-2.5                   | 1.5              | 11.2                        | ±0.6                          | ±0.4                           | ±8                            | 13                    |
|                 |           | 5.18-5.83                 | 1.5              | 11.6                        | ±0.8                          | ±0.5                           | ±10                           | 12                    |
|                 |           | 5.9-7.25                  | 1.55             | 11.8                        | ±0.9                          | ±0.7                           | ±12                           | 12                    |
| SA-07-8B020080E | 8×8       | 2.4-2.5                   | 1.6              | 11.4                        | ±0.6                          | ±0.5                           | ±12                           | 12                    |
|                 |           | 5.18-5.83                 | 1.6              | 11.8                        | ±0.8                          | ±0.6                           | ±14                           | 12                    |
|                 |           | 5.9-7.25                  | 1.6              | 12                          | ±0.9                          | ±0.8                           | ±16                           | 12                    |
| SA-07-8B023025  | 8×8       | 2.3-2.5                   | 1.4              | 10.8                        | ±0.6                          | ±0.5                           | ±4                            | 16                    |
| SA-07-8B024028  | 8×8       | 2.4-2.8                   | 1.4              | 11.2                        | ±0.6                          | ±0.6                           | ±4                            | 16                    |
| SA-07-8B048060  | 8×8       | 4.8-6                     | 1.6              | 11.5                        | ±0.8                          | ±1                             | ±6                            | 14                    |
| SA-07-8B060080  | 8×8       | 6-8                       | 1.6              | 12                          | ±0.8                          | ±1                             | ±0.8                          | 13                    |
| SA-07-8B060180  | 8×8       | 6-18                      | 1.8              | 14.5                        | ±1.3                          | ±2                             | ±15                           | 8                     |
|                 |           | 6-8                       | 1.7              | 12                          | ±1                            | ±0.7                           | ±12                           | 9                     |
|                 |           | 8-12                      | 1.7              | 13                          | ±0.9                          | ±0.8                           | ±12                           | 9                     |
|                 |           | 12-18                     | 1.8              | 14.5                        | ±1                            | ±1                             | ±14                           | 8                     |

\*All units are wideband, can meet performance according to listed frequencies  
\*Theoretical IL. Included

Our goal is to offer high performance and quality products with quick delivery

# PRODUCT LIST AND KEY PERFORMANCE

## ■ 16x16 & 16x32 Butler Matrices

| Part Number        | Structure | Frequency Range*<br>(GHz) | VSWR<br>:1(Max.) | Insertion Loss*<br>dB(Max.) | Amplitude Balance<br>dB(Max.) | Amplitude Flatness<br>dB(Max.) | Phase Accuracy<br>Deg.(Max.) | Isolation<br>dB(Min.) | Dimension<br>LxWxH(mm) |
|--------------------|-----------|---------------------------|------------------|-----------------------------|-------------------------------|--------------------------------|------------------------------|-----------------------|------------------------|
| SA-07-16B017022    | 16×16     | 1.7-2.2                   | 1.4              | 15                          | ±0.8                          | ±0.8                           | ±4                           | 14                    | 2U                     |
| SA-07-16B020060    | 16×16     | 2.3-2.7                   | 1.6              | 17                          | ±1.2                          | ±0.8                           | ±12                          | 10                    | 2U                     |
|                    |           | 3.3-3.8                   | 1.6              | 18                          | ±1.2                          | ±0.8                           | ±12                          | 9                     |                        |
|                    |           | 4.4-5                     | 1.7              | 19                          | ±1.2                          | ±0.8                           | ±14                          | 8                     |                        |
| SA-07-16B020060E   | 16×16     | 2.3-2.7                   | 1.6              | 17.5                        | ±1.6                          | ±1.2                           | ±16                          | 10                    | 2U                     |
|                    |           | 3.3-3.8                   | 1.6              | 18.5                        | ±1.6                          | ±1.2                           | ±16                          | 9                     |                        |
|                    |           | 4.4-5                     | 1.7              | 19.5                        | ±1.6                          | ±1.2                           | ±18                          | 8                     |                        |
| SA-07-16B023024    | 16×16     | 2.3-2.4                   | 1.4              | 14.8                        | ±0.5                          | ±0.5                           | ±4                           | 15                    | 2U                     |
| SA-07-16B023027    | 16×16     | 2.3-2.7                   | 1.4              | 15.2                        | ±0.7                          | ±0.8                           | ±4                           | 14                    | 2U                     |
| SA-07-16B023038    | 16×16     | 2.3-2.7                   | 1.5              | 15                          | ±1                            | ±0.8                           | ±8                           | 12                    | 2U                     |
|                    |           | 3.3-3.8                   | 1.6              | 16                          | ±1                            | ±0.8                           | ±10                          | 10                    |                        |
| SA-07-16B023050    | 16×16     | 2.3-2.7                   | 1.6              | 17                          | ±1.2                          | ±0.8                           | ±12                          | 10                    | 2U                     |
|                    |           | 4.4-5                     | 1.7              | 19                          | ±1.2                          | ±0.8                           | ±14                          | 8                     |                        |
| SA-07-16B023050E   | 16×16     | 2.3-2.7                   | 1.6              | 17.5                        | ±1.6                          | ±1.2                           | ±16                          | 10                    | 2U                     |
|                    |           | 4.4-5                     | 1.7              | 19.5                        | ±1.6                          | ±1.2                           | ±18                          | 8                     |                        |
| SA-07-16B024027    | 16×16     | 2.496-2.696               | 1.4              | 14.7                        | ±0.6                          | ±0.6                           | ±4                           | 14                    | 2U                     |
| SA-07-16B025036    | 16×16     | 2.57-3.6                  | 1.5              | 16                          | ±0.9                          | ±1                             | ±6                           | 13                    | 2U                     |
|                    |           | 2.57-2.62                 | 1.4              | 15.4                        | ±0.6                          | ±0.6                           | ±4                           | 14                    |                        |
|                    |           | 3.4-3.6                   | 1.5              | 16                          | ±0.7                          | ±0.7                           | ±4                           | 13                    |                        |
| SA-07-16B033038    | 16×16     | 3.3-3.8                   | 1.5              | 16                          | ±0.8                          | ±1                             | ±5                           | 13                    | 2U                     |
| SA-07-16B033042E   | 16×16     | 3.3-4.2                   | 1.5              | 16.4                        | ±1.0                          | ±1.2                           | ±8                           | 12                    | 2U                     |
| SA-07-16B033050    | 16×16     | 3.3-3.8                   | 1.6              | 15.5                        | ±1                            | ±0.8                           | ±8                           | 10                    | 2U                     |
|                    |           | 4.4-5                     | 1.6              | 16.5                        | ±1                            | ±0.8                           | ±10                          | 10                    |                        |
| SA-07-16B033050E   | 16×16     | 3.3-3.8                   | 1.6              | 16                          | ±1.4                          | ±1.2                           | ±12                          | 10                    | 2U                     |
|                    |           | 4.4-5                     | 1.6              | 17                          | ±1.4                          | ±1.2                           | ±14                          | 10                    |                        |
| SA-07-16B034036    | 16×16     | 3.4-3.6                   | 1.5              | 15                          | ±0.6                          | ±0.6                           | ±7                           | 13                    | 2U                     |
| SA-07-16B051060E   | 16×16     | 5.1-6                     | 1.6              | 16.7                        | ±1.0                          | ±1.3                           | ±10                          | 11                    | 2U                     |
| SA-07-3216B017022  | 32×16     | 1.7-2.2                   | 1.5              | 18.4                        | ±0.9                          | ±1                             | ±5                           | 13                    | 3U                     |
| SA-07-3216B023024  | 32×16     | 2.3-2.4                   | 1.5              | 18.3                        | ±0.6                          | ±0.6                           | ±5                           | 13                    | 3U                     |
| SA-07-3216B023027  | 32×16     | 2.3-2.7                   | 1.5              | 18.6                        | ±0.8                          | ±0.9                           | ±5                           | 13                    | 3U                     |
| SA-07-3216B024027  | 32×16     | 2.496-2.696               | 1.5              | 18                          | ±0.7                          | ±0.7                           | ±5                           | 13                    | 3U                     |
| SA-07-3216B033038  | 32×16     | 3.3-3.8                   | 1.6              | 19.6                        | ±1                            | ±1.2                           | ±6                           | 12                    | 3U                     |
| SA-07-3216B033042E | 32×16     | 3.3-4.2                   | 1.6              | 20                          | ±1.2                          | ±1.4                           | ±10                          | 12                    | 3U                     |
| SA-07-3216B034036  | 32×16     | 3.4-3.6                   | 1.6              | 18.5                        | ±0.7                          | ±0.8                           | ±5                           | 12                    | 3U                     |
| SA-07-3216B051060E | 32×16     | 5.1-6                     | 1.7              | 20.3                        | ±1.2                          | ±1.5                           | ±12                          | 11                    | 3U                     |

\*All units are wideband, can meet performance according to listed frequencies  
\*Theoretical IL. Included

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## QUALITY CONTROL & DELIVERY

- Mlcable has ISO9001 and GJB9001B (China military standard) Certificate.
- Passive components and cable assemblies in butler matrix are all designed for military environment standard.
- All materials are strictly inspected and quality control is executed in every stage.
- All cable assemblies and passive components are manufactured according to same quality control standard as SSI Cable and Mini-Circuits.
- All butler matrices are tested in automatic test platform

*Our goal is to offer  
high performance and quality products with quick delivery*



## POSSIBLE APPLICATIONS

Because the butler matrices have the following characteristics:

- Produce the multiple beams and combined beam
- Expand the coverage of the signal
- Have very wide bandwidth and higher accuracy
- Have lower insertion loss and higher power handling
- Have stable performance and lower cost than active P/A module

We expect the products can have the applications as attached.



# APPLICATION LIST

WIFI, WiMAX, 4G/5G LTE Testing, Link Simulation

MIMO Testing

Multi-path Simulation and Performance Evaluation

Antenna Array Beam-forming

IOT test & Communication simulation

Radar & Communication System of Driverless Car

Interferometer Systems Simulation and Test



## ROAD MAP

-  Various millimeter wave butler matrix based on the customer requirements.
-  High precision small phase shift butler matrix.
-  Other derivative products



## OTHER PRODUCTS FROM MICABLE



Test and engineering cable assemblies up to 67 GHz

Various precision adapters, terminations up to 67GHz



Wideband/Ultra wideband power dividers/combiners, couplers/dual couplers, 90 & 180° hybrids up to 67GHz, including high power components.

Wideband GaN high power linear amplifiers up to 40GHz



Low loss high isolation solid state switch matrices up to 40GHz

Wideband high accuracy phase & amplitude controlled matrices

## ABOUT MICABLE

- Micable's main shareholders include **Mitron**, **SSI Cable (USA)** and **Mini-Circuits (USA)**.
- Micable has headquarters in Fuzhou, a cable assembly factory in Fuzhou, a passive components and assemblies factory in Chengdu, a test equipment R&D center in Shanghai. And Micable will build new factory in 1.3 hectares land.
- Our R&D people and management team have very strong professional background, come from international, China famous companies & research institutes.
- We have the leading technology in cable assembly, wideband high performance passive components, wideband high accuracy phase and amplitude controlled modules/matrices and GaN power amplifiers. Our products and technical papers were published in Microwave Journal due to the innovation.

