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# Wilkinson Power Divider

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***Abstract: The basic design of a power divider with two symmetrical quarter-wavelength branches that provide matching conditions at all of its ports is the focus of the research. Fr4 was chosen as the design's substrate, and 2.9 GHz is the operating frequency for the circuit. The structure of the power divider rules, which were derived from a circuit-theoretic analysis of AC power-flow expressions, reflects the topology and voltage profile of the network. We show how the power divider laws can be used to analyse power networks. The Wilkinson Power Divider has several uses, including feeding circuits for antenna arrays and measurementsystems.***
***Keywords: HFSS, Power Divider, Network, Feeding Networks Frequency, Microstrip, S Parameter***

## I. INTRODUCTION

Due to the quick expansion of data services, present cellular wireless technology won't be able to satisfy subscriber demand in the upcoming years. The answer to meeting the rising traffic demand and cellular wireless user base would be 5G cellular networks. However, the current frequency spectrum, particularly at low and mid GHz, is nearly full, necessitating a spectrum solution to increase capacity as a way to solve the issue. By developing new methods for more efficiently managing electromagnetic wave transmission, propagation, and detection, such as reconfigurable radiators and metasurfaces, wireless communication technology has evolved significantly during the past ten years. As a result, various generations of communication networks have been proposed, with the fifth-generation (5G) cellular networks garnering the most attention in terms of both practise and demand. Due to improvements in 5G hardware and transceiver gain, the 5G cellular network technology provides higher data speed, greater energy efficiency, and decreased latency. In order to get a precise pencil beam, an antenna system must be directional and have a low sidelobe level. In 5G systems, phased array antennas are a popular arrangement to produce crisp beams. In phased arrays architecture regulated, a minimum number of RF chains, such as variable gain units and phase shifters, should be taken into consideration. For some particular applications, such sidelobe level reduction, it is necessary to regulate the signal's amplitude in addition to power dividing. Several power splitting networks utilizing Wilkinson (or other common types) power dividers as its base units have been developed up to this point, however without additional gain/attenuation control units, this form of divider is unable to provide an arbitrary output power ratio. However, without various and unique tunable parts, other kinds of power splitting networks based on SIW structures are unable to offer such capability. The power in the outputs can now be controlled by photonic devices using various ratios. Also, the cost and computational resource utilisation increase when these simulations are linked to the optimization procedure to identify the target device or function. As a result, more recent research used deep learning techniques and neural networks to anticipate complex input-output correlations with improved time and computation efficiency.

## II. LITERATURE SURVEY

1) Power splitters are sometimes known as power dividers. In numerous RF and communication applications, it serves as the power-combiner when utilised in reverse [1, 2]. It is a passive device used in the field of radio technology that necessitates the distribution of power among several channels. This strategy can be applied most simply by employing a power splitter or division.
2) The power divider which divides the signal into two or more signals is a crucial part of the microwave systems. In microwave power amplifiers (PAs), mixers, and feeding networks for antenna arrays, Wilkinson power dividers (WPDs) are frequently utilized [4] .
3) The applications include WLAN such as 802.11b, 802.11g, and 802.11n throughout a frequency range of 2.4GHz band, as well as TV analyzers, handheld spectrum analyzers, antenna arrays, and microwave applications[3].
4) Particularly for antenna array systems using power-splitting networks, such as a corporate or parallel feed system, power dividers are required. Reactive and resistive power dividers are the two primary kinds, and each is suitable for a particular application that transforms unstructured input into structured data.

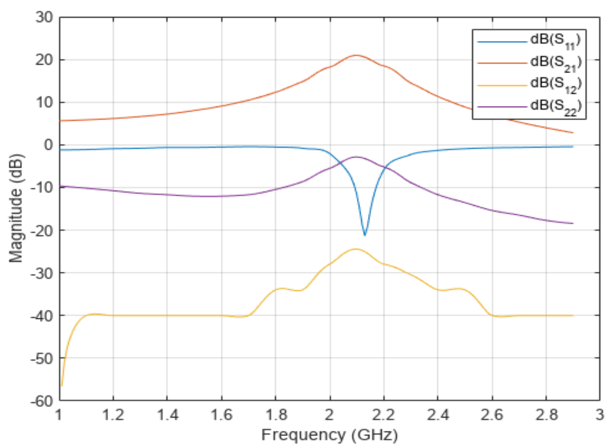
5) The Wilkinson Power Divider has certain unique characteristics, including a lossless network, excellent output port isolation, and minimal insertion and isolation loss [1–3]. It has a single input port and more than one output port. Nonetheless, the fundamental benefit of the divider is that output ports are segregated from one another and all ports are theoretically matched [4].
6) The transmission from the input port to all output ports is often similar, though this is not required. In order to achieve its ideas, it can be designed with various transmission line sections, such as strip-line coaxial, micro-strip, airstrip, and lumped element circuit topographies. Low insertion loss, low isolation loss, high isolation between output ports, and high return loss are desirable characteristics of a power divider. A power divider's broader bandwidth, which increases the number of sections it can accommodate, is an extra desired attribute that is useful for N-way power division [1, 2].

## III. APPLICATIONS

In test systems, the power divider can also be used to measure two distinct signal properties, such as frequency and power, enabling broadband independent signal sampling. Because they are bi-directional, they can also function as power combiners in addition to splitting power. Two resistors are used to build power splitters.
1) It is utilized in microwaves for power combining and dividing.
2) It has its application in the IoT field as well.
3) It's used in making circuits for mixers and transformers.
4) Its usage is in optical switches.
5) It is utilised in multiplexers and demultiplexers in telecommunication switches.
6) It's used in the field of Radio Technology.

## IV. ABOUT S PARAMETERS

The input-output relationship between ports (or terminals) in an electrical system is described by S-parameters. S12, for instance, denotes the power transferred from Port 2 to Port 1 in the case of two ports (intelligently referred to as Port 1 and Port 2). Power was transported from Port 1 to Port 2 as shown by S21. In a multi-port network, SNM typically denotes the power that was transmitted from Port M to Port N.The figure below shows the graph for S Parameters.(Fig 1.)




Each location where we can deliver voltage and current can be considered a port. So, the radio terminals—which supply power to the two antennas—would be the two ports if we had a communication system with two radios (radio 1 and radio 2). S11 would then be the radio 1's reflected power attempt to transmit to antenna 1. The reflected power that radio 2 is attempting to send to antenna 2 is represented by S22. And S12 is the power that radio 2 transmits to radio 1 via antenna 1. Keep in mind that S-parameters typically depend on frequency (i.e. vary with frequency).
In actuality, S11 is the parameter that is most frequently mentioned in relation to antennas. The reflection coefficient, sometimes expressed as gamma: or return loss, or S11, represents how much power is reflected from the antenna. All of the antenna's power is reflected back to it, and nothing is broadcast, if S11=0 dB. If S11=-10 dB, it follows that the reflected power is -7 dB for a 3 dB input of power to the antenna.

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The antenna "accepted by" or received the remaining electricity. The antenna either radiates or absorbs this accepted power as losses. In an ideal world, the majority of the power applied to the antenna is radiated because antennas are normally constructed to have low loss. The input-output interactions between ports in an electrical system are described by scattering parameters. It becomes crucial to define a given network in terms of waves rather than voltage or current, especially at high frequency. Thus, power waves are used in S-parameters.

## V. PARAMETERS

### *A. Return Loss*
It is recommended if it has a higher value. directly impacts how much power a beam former will emit or receive.

### *B. Isolation*
It directly impacts how isolated an array's signal lines are.

### *C. Amplitude Balance*
Aim for an equal power split for each branch and across the whole bandwidth because it has an impact on the amplitude performance and EIRP of a beamformer.

## VI. DIAGRAM FOR THE PROPOSED POWER DIVIDER

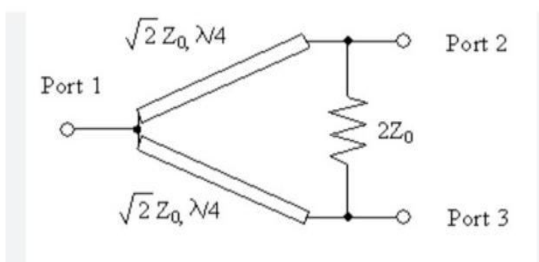


Fig 2: Diagram for the generalized power divider

### *D. Phase Balance*
It encourages maximal power transfer and guarantees the intended branch phase length throughout the whole network.A sufficient phase imbalance will cause EIRP to degrade and may even cause a beamformer's radiation pattern to shift.

## VII. INFERENCE

*1)* As inferred from [2]
BW:3-8GHz
Return Loss:<10 dB
Isolation Loss:<-10 dB
VSWR<2 dB

*2)* As inferred from [5]
Size:5.8*4.3 mm2
Return Loss:20 dB
Isolation Loss:13 Db

*3)* As inferred from [4]
Isolation Loss>20 dB
Size:1.9*0.7 cm2
Return Loss<-25 Db

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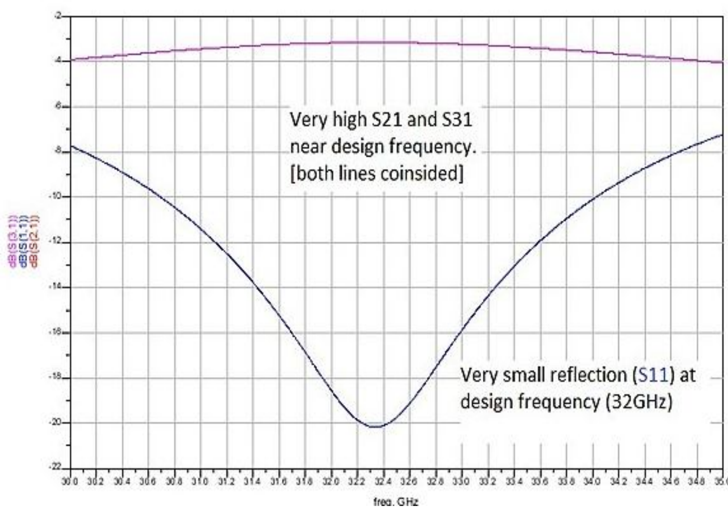
*4)* As inferred from [7]
Size:18*16 mm2
Return Loss:15dB
Thickness:1.6mm
Frequency:3.1-10.6

*5)* As inferred from [9]
Insertion Loss:-6.344 dB
Isolation Loss:-57 dB
Return Loss:-35dB

*6)* As inferred from [3]
Thickness:1.57 mm
Return Loss<-10 dB
VSWR<2 dB

*7)* As inferred from [3]
Thickness:0.635 mm
Size:5.8*4.3 mm2

## VIII. POWER DIVIDER GRAPH




This graph displays the corresponding values for the S port's S(1,1), S(2,1), and S(3,1) parameters (3,1).
As referred from : E.J. Wilkinson, "An N-way Power Divider", IRE Trans. on Microwave Theory and Techniques, vol. 8, p. 116-118, Jan. 1960, doi: 10.1109/TMTT.1960.1124668
In ideal Wilkinson Power Divider;
S11 = S22 = S33 = 0 reveals that all ports are matched.
S23 = S32 = 0 shows output terminals are isolated.
S21 = S31shows power is getting divided equally.
But practically 3 conditions cannot be satisfied at once[1]
It should have the following characteristics:
*1)* Matched
*2)* Lossless
*3)* Reciprocal

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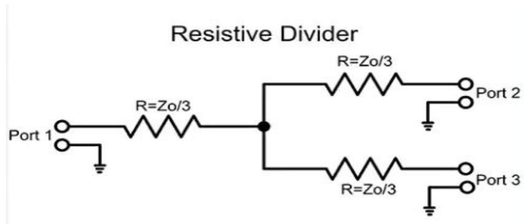
## IX. TYPES OF POWER DIVIDERS

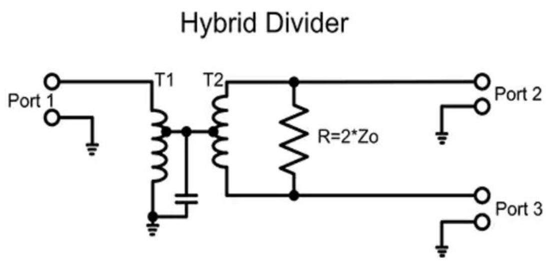
### *A. Resistive Power Divider*

These power splitters and combiners use resistors, as the name would imply. Although they can keep the system's characteristic impedance constant, resistors add loss above the minimal level, which splits the signal. They are affordable and simple to make.



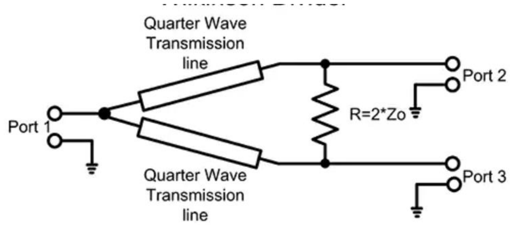

### *B. Hybrid Power Divider*

Transformers are used in hybrid splitters, which can offer low amounts of loss. Although the transformer has some physical losses, the main "loss" is caused by the splitting process, which divides the identical signal among several outputs.




### *C. Reactive Power Divider*

These reactive power dividers (splitters) have two (or more) outputs and one input. These are outstanding output amplitude and phase balancing lossless broadband devices. They are appropriate for cellular applications requiring high power.




## X. WILKINSON OVER OTHER POWER DIVIDER

The Perfect Wilkinson Power Divider belongs to a particular type of power divider circuits that can accomplish output port isolation while keeping all ports in matched state

In order to achieve the best outcomes, substrate parameters have been appropriately adjusted while discussing transparency. By further creating an identical circuit on ADS for purposes of verification, it is made lossless and extremely effective [1].

Power from the input port is divided equally between the two output ports by the Wilkinson divider. Due to the high output port isolation, which results in all ports being matched and just reflected power dissipating from the output ports, the Wilkinson divider seems lossless.

## XI. SOFTWARES USED

### *A. HFSS*

A 3D electromagnetic (EM) simulation programme called Ansys HFSS is used to design and simulate high-frequency electronic devices such antennas, antenna arrays, RF or microwave components, high-speed interconnects, filters, connectors, IC packages, =and printed circuit boards. Ansys HFSS software is used by engineers all around the world to create the high-frequency, high-speed circuits used in satellites, ADAS, communications systems, and internet-of-things (IoT) products.

An adaptive meshing technology-based programme called HFSS from ANSYS is used to model 3-D full-wave electromagnetic fields. In the RF & Microwave Industry, it is among the most effective and widely used software tools. It offers cutting-edge solver technologies for a variety of microwave, RF, and high-speed digital applications based on finite element, integral equation, asymptotic, and sophisticated hybrid methods.

A linear circuit simulator with integrated Optimetrics for input and matching network design is also included in the package. By employing HFSS, it is able to construct Full-Wave SPICE models that connect to circuit simulations, extract parasitic parameters (S, Y, Z), and see 3D electromagnetic fields (near- and far-field).

### *B. ADS*

To assist you in getting started more quickly, PathWave ADS provides integrated design guidance through templates. It is simple to find the part you need thanks to extensive component libraries. When creating schematic drawings, automatic sync with layout enables you to see the physical layout.

Electronic design automation software for RF, microwave, and high-speed digital applications is called ADS (Advanced Design System) from Keysight. It makes use of some of the most cutting-edge and lucrative technologies, such as 3D EM simulators, Keysight Ptolemy, Harmonic Balancing, Circuit Envelope, Transient Convolution, and Keysight Ptolemy (including both FEM and FDTD solvers).

For WiMAX, LTE, multi-gigabit per second data lines, radar, and satellite applications, ADS delivers full, standards-based design and verification with Wireless Library and circuit-system-EM co-simulation in an integrated platform.

## XII. COMPARATIVE ANALYSIS

| Ref | Frequency(f) | Dielectric Constant(Er) |
|---|---|---|
| [1] | 2.9 GHz | 7.8 |
| [2] | 3-8GHz | 4.3 |
| [3] | 26.5-38.2GHz | 2.2 |
| [4] | 1.5GHz | 3.38 |
| [5] | 7GHz | 2.9 |
| [6] | 0.9-3.5GHz | 2.2 |
| [7] | 3.1-10.6GHz | 3.38 |
| [8] | 1176.6MHz | 4.6 |

**Comparison of Various Parameters**

## XIII. CONCLUSION

We present a technique for suggesting microstrip power splitters with controlled output power. We first look into the dispersion of dielectric vias and the effects of their existence in the substrate through the design process. Next, we use them as inclusions in the multimode region of our device along with PEC vias. splitter remains acceptable.

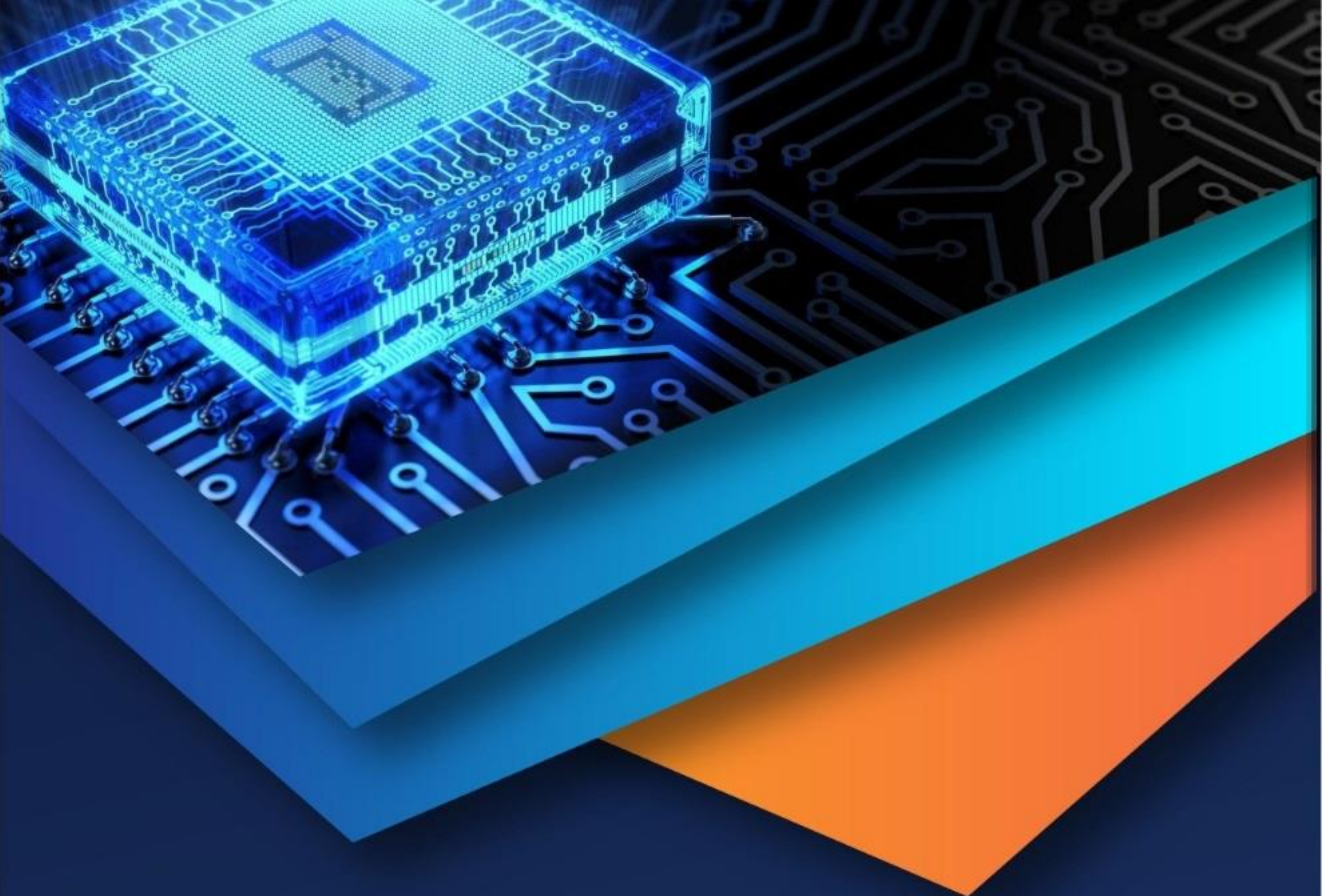
We are able to identify an optimum pattern of hybrid perturbations, such as Fr4 or PEC and dielectric/air vias, for a desired power division ratio using a neural network with two convolutional layers and one fully connected layer. As the neural network's training dataset includes a variety of use cases, it is possible to create a device with nearly any power division ratio and still have a good total transmittance.

With the purpose of reducing unintentional radiation, curved corners were used in the construction of the power divider rather than sharp edges. The length of the matching stub has been altered to improve performance.

## REFERENES

[1] Renu Kumrai , Vishal Acharya "Deign and Simulation of Two way Power Divider in S Band", 2017 11 th European Conference on Antennas and Propagation (EUCAP), pp. 3079-3081, 2017.
[2] Faraz Ahmed Shaikh,Sheroz Khan,Ahm Zahirul Alam,Mohamed Hadi Habaebi, "Design and Analysis of 1-4 Wilkinson Power Divider for antenna array feeding network", 2018 IEEE International Conference on Ubiquitous Wireless Broadband (ICUWB), pp. 1-4, 2018.
[3] S. X. Ta, H. Choo and I. Park, "Broadband Printed-Dipole Antenna and Its Arrays for 5G Applications", IEEE Antennas and Wireless Propagation Letters, vol. 16, pp. 2183-2186, 2017.
[4] M. Heydari and S. Roshani, "Miniaturized unequal Wilkinson power divider using lumped component elements", Electronics Letters, vol. 53, no. 16, pp. 1117-1119, 2017.
[5] Hazeri Ali Reza, "An ultra wideband Wilkinson power divider", *International Journal of Electronics*, vol. 99.4, pp. 575-584, 2012.
[6] M. A. Maktoomi and M. S. Hashmi, "A Performance Enhanced Port Extended Dual-Band Wilkinson Power Divider", IEEE Access, vol. 5, pp. 11832-11840, 2017.

[7] Zhou Bo, Hao Wang and Weixing Sheng, "A novel UWB Wilkinson power divider", *Information Science and Engineering (ICISE) 2010 2nd International Conference on*, 2010.
[8] Nakum Ashvin , Prof. Anil K Sisodia"Design of Corporate Feed Network using Wilkinson Power Divider", 2015 International Conference on Microwave and Millimeter Wave Technology, pp. 360-362, 2008.

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