

IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF MASSACHUSETTS

UNITED STATES OF AMERICA

v.

HAOYANG YU, *et al.*

No. 19-cr-10195-WGY

**DECLARATION OF MANFRED J. SCHINDLER**

I, Manfred J. Schindler, declare as follows:

1. I have been retained as an expert by defense counsel representing Haoyang Yu in the above-captioned case.

2. I earned a BSEE from Columbia University in 1979 and a MSECE from University of Massachusetts Amherst in 1983.

3. I have spent my career in industry working on RF, microwave, and mm-wave semiconductors, leading the development of advanced RF semiconductor products for commercial and defense applications. A copy of my CV is attached hereto as Exhibit A.

4. I currently work as an independent consultant. I am also the Chief Technology Officer of Anlotek Ltd., a RF technology company. I previously worked as an Engineering Director or Engineering Manager at companies including Qorvo, RFMD, IBM, ATN Microwave, and Raytheon.

5. I hold 11 patents and have published over 40 technical articles.

6. I have been active in professional organizations including IEEE and MTT Society. I served as MTT President, Vice President, and Secretary; Chair of the IEEE

Conferences Committee, founding Chair of the Radio and Wireless Symposium, and Chair of the International Microwave Symposium (IMS).

7. I have extensive experience and expertise with monolithic microwave integrated circuits (“MMICs”), the technology at issue in this case.

8. MMICs are a type of integrated circuit device that operate at microwave and millimeter-wave frequencies. These devices typically perform functions such as microwave mixing, power amplification, low-noise amplification, and high-frequency switching. MMICs are used as components in, for example, radio, cellular, satellite communication, wireless networking, radar, internet-of-things, remote control, and medical devices

9. MMICs are not “new” technology. The design theory is well-known and they have been commercially available since the 1980s.

10. It is not uncommon for companies that design, manufacture, and/or sell MMICs to “reverse engineer” MMICs designed, manufactured, and/or sold by others in order to develop competing products.

11. Unlike today’s state-of-the-art microprocessors, MMICs are relatively easy to reverse engineer. For example, while an Intel Core i7 chip may contain hundreds of millions of transistors, and would be virtually impossible to reverse engineer, a MMIC would typically contain only around 10 transistors. It is therefore straightforward to view a MMIC under a microscope or use a photograph of the chip to replicate the layout. Performance characteristics can then be modeled using modern EDA (Electronic Design Automation) tools.

12. Consequently, MMICs of the type TRICON was selling are “commodity” products for which multiple manufacturers commonly sell individual items with very similar or even identical designs and performance characteristics.

13. MMIC manufacturers commonly make publicly available “data sheets” showing performance characteristics, application information and circuit topology of their products.

14. I have reviewed the indictment in this case. I also have reviewed the Application for a Search Warrant (“Application”) dated September 28, 2018 (DOJ-YU-000571-000597). A copy of the Application is attached hereto as Exhibit B.

15. In paragraph 16 of the Application, the affiant, HSI Special Agent Thomas Anderson, states: “I know that companies that design and manufacture MMICs typically have large facilities to design integrated circuits, operate machinery to manufacture these circuits, conduct business operations, and store products for sale.” The statement that “large facilities” are “typical” is not accurate. This statement ignores the well-known phenomenon of “fables” semiconductor companies, which design and sell MMICs (or other semiconductor products) but outsource the manufacturing to a third-party foundry. “Fables” companies can be established by a handful of people (or even just one person) using computers, with no need for a “large facility.” For example, Hittite Microwave Corporation started this way in 1986, as have many others.

16. I am aware that some, but not all, MMICs can be subject to U.S. government Export Administration Regulations (“EAR”). The U.S. Department of Commerce (“DOC”) Bureau of Industry and Security (“BIS”) implements the EAR. The relevant BIS guidance document is the Commerce Control List (“CCL”) – Category 3 – Electronics (“ccl3”).<sup>1</sup> Export Control Classification Numbers (ECCNs) are alphanumeric designations in the CCL that identify items subject to export control based on the nature of the item and its characteristics. Items not

<sup>1</sup> Available at <https://www.bis.doc.gov/index.php/documents/regulations-docs/2334-ccl3-8/file>.

covered by the CCL criteria are classified as “EAR99,” which means they generally do not require an export license (unless to an embargoed country, to an end user of concern, or in support of a prohibited end-use).<sup>2</sup>

17. In paragraph 23 of the Application, SA Anderson states: “Based on the specification sheet on TRICON’s website, DOC classifies the TM-5054 as ECCN 3A001b.2d, and therefore, it is controlled for National Security (NS1), Regional Stability (RS1) and Anti-terrorism (AT1) reasons.” Based on a letter from the prosecutors to Mr. Yu’s lawyers dated January 10, 2020 (Exhibit C), I understand that DOC made the referenced “classification” in a document (DOJ-YU-0005) (Exhibit D) issued on January 22, 2018 at the request of a law enforcement agent investigating Mr. Yu; that the classification was based solely on the specification sheet from TRICON’s website (DOJ-YU-3414-3417) (Exhibit G); and that it has never been published or released (except to the prosecution team and now the defense in this case).

18. In paragraph 24 of the Application, SA Anderson states that “Analog Devices representatives noted that the product specifications of the TM-5054 are nearly identical to the HMC-994A, one of the Analog Devices integrated circuit devices that it sells to customers.” What SA Anderson does not mention is that Analog Devices (“ADI”) and its resellers treat the “nearly identical” HMC-994A as “EAR99” — that is, *not* subject to export control.<sup>3</sup>

<sup>2</sup> See <https://www.bis.doc.gov/index.php/regulations/commerce-control-list-ccl>.

<sup>3</sup> See <https://www.arrow.com/en/products/hmc994a/analog-devices> (page for HMC-994A showing U.S. export classification as “EAR99”) (screenshot attached as Exhibit F); *see also* Analog Devices, Inc. – Export / Import Classifications (April 2020) at 1239 (classifying HMC-994A as “EAR99”), *available at* <https://www.analog.com/media/en/Other/Support/Customer-Service/ADI-Export-and-Import-Classifications.pdf>. Also notable is that an earlier version of the ADI product, HMC-994, is

19. The DOC “classification” of TRICON’s TM5054 is surprising because both it and ADI’s HMC-994A are *rated* as 30 GHz products, with the same saturated power output at that frequency that does *not* trigger export controls. *See* Exhibit G (TRICON TM-5054 datasheet); Exhibit E (ADI HMC-994A datasheet).<sup>4</sup>

20. Commerce Control List category ECCN 3A001b.2.c-d covers devices:

b.2.c. Rated for operation with a peak saturated power output greater than 3 W (34.77 dBm) at any frequency exceeding 16 GHz up to and including 31.8 GHz, and with a fractional bandwidth” of greater than 10%.

b.2.d. Rated for operation with a peak saturated power output greater than 0.1w (-70 dBm) at any frequency exceeding 31.8 GHz up to and including 37 GHz.

21. The data sheets for TRICON’s TM-5054 and ADI’s HMC-994A both show “peak saturated power” levels up to 30 GHz that do not trigger the ECCN 3A001b.2.c threshold of 34.77 dBm.

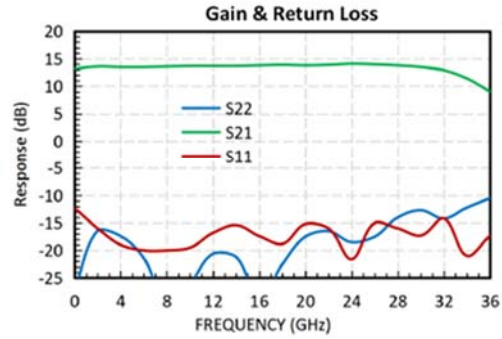
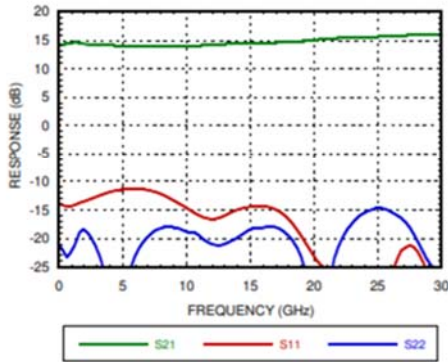
22. The data sheets from both companies do not show “peak saturated power” above 30 GHz. However, available data concerning “gain” shows that ADI’s HMC-994A provides higher signal levels than TRICON’s TM-5054. At 30 GHz, the relevant graph (green lines) from the ADI HMC-994A data sheet (left) shows a gain of slightly *more* than 15 dB, while the analogous graph from the TRICON TM-5054 data sheet (right) shows a gain of slightly *less* than 15 dB. The ADI HMC-994A graph does not display gain above 30 GHz, while the TRICON

described as a 32 GHz device — able to produce even higher signal levels — and yet is also treated by ADI as “EAR99.”

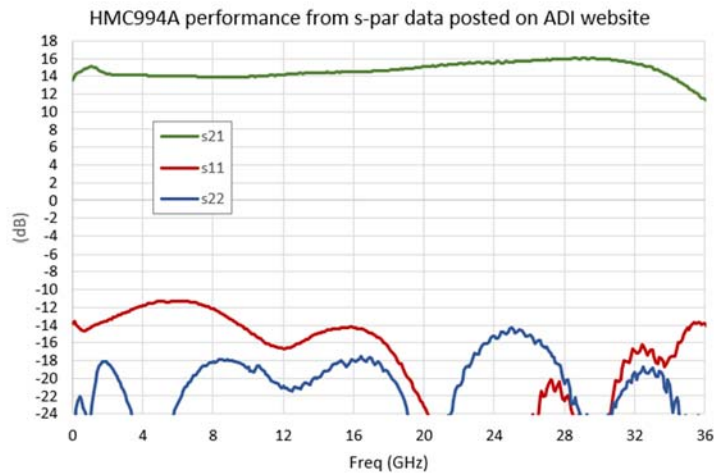
<sup>4</sup> The ADI HMC-994A datasheet is publicly available at <https://www.analog.com/media/en/technical-documentation/data-sheets/HMC994ACHIPS.pdf>.

TM-5054 shows the gain “roll off” sharply at frequencies above 30 GHz, which is what one would expect in a product *rated* at 30 GHz.

**Gain & Return Loss**



23. ADI publishes additional performance data on its website<sup>5</sup> that permits creation of an extended graph to displays the gain for HMC-994A above 30 GHz:



The data show that the gain on the ADI HMC-994A at 31.8GHz remains *higher* than the gain on the TRICON TM-5054 at 31.8 GHz., and the gain on the ADI product begins to “roll off” at a

<sup>5</sup> Available at [https://www.analog.com/media/en/simulation-models/s-parameters/HMC994A\\_Die-S-parameters.zip](https://www.analog.com/media/en/simulation-models/s-parameters/HMC994A_Die-S-parameters.zip).

higher frequency than that at which the TRICON product begins to “roll off.” The bottom line is that the ADI’s HMC-994A has greater performance capability than TRICON’s TM-5054.

24. Many other companies also produce MMICs similar to ADI’s HMC-994A and TRICON’s TM-5054. A chart compiling publicly available information about a sample of such products, including performance data, manufacturer’s export self-classification (where available), schematics, and layouts, is attached as Exhibit H.

25. Notably, among the MMICs for which the manufacturer’s export self-classification is publicly available, all but one is treated as EAR99. The one exception, custom MMIC’s CMD-292, does not show a performance “roll off” until more than 34 GHz.

26. The chart also illustrates the many similarities among the products. The schematics and layouts are functionally the same and the performance data are very similar and sometimes indiscernible. The schematics and layouts of the Microsemi and Microwave Technology products may “look” different from the others to a lay person but that is because they contain even more details than the other products’ block diagrams. Even with that level of detail, the products are still functionally very similar.

27. In paragraph 24 of the Application, SA Anderson states: “Yu’s former supervisor at Analog Devices stated that TRICON’s TM-5021 device is identical to Analog Devices’ HMC-462 device. The similarities extend not only to the product specifications but also the design of the integrated circuits. Yu’s former supervisor said that his ‘jaw dropped when he saw TRICON’s diagram of the TM-5021,’ because of how identical the two devices were. According to his former supervisor, YU could not have built TRICON’s integrated circuit devices unless he had help from a current employee or took Analog Devices’ proprietary modeling and file reviews.” In fact, there is nothing remarkable about the similarities between the functional

diagrams of the referenced products, precisely because the data sheets are publicly available and the products are straightforward to reverse engineer. The data sheet for the TRICON TM-5021 is attached as Exhibit I. The publicly available data sheet for the ADI HMC-462 is attached as Exhibit J.<sup>6</sup> A chart showing other similar products from other manufacturers is attached as Exhibit K.

28. In paragraph 25 of the Application, SA Anderson states: “As shown in the table below, TRICON markets devices with virtually the same or identical performance metrics as Analog Devices.” In fact, the performance characteristics in the referenced table are not *identical* across the board. And again, there is nothing remarkable about the existence of competing MMIC products, from different manufacturers, “with virtually the same or identical performance metrics.” For each of the devices listed in the referenced table, other manufacturers also sell devices with similar characteristics, as noted in the table at Exhibit L, to which data from other manufacturers is added.

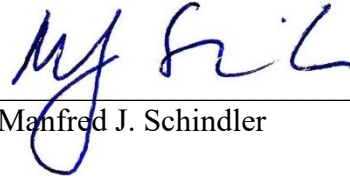
29. In paragraph 30 of the Application, SA Anderson states: “I have learned that several TRICON parts are presently being advertised for sale by Chinese companies on websites in the People’s Republic of China. Some of the Chinese companies identify themselves as ‘sales representatives’ for TRICON or as suppliers of integrated circuit devices.” SA Anderson does not state whether any efforts were made to determine whether these Chinese companies actually possessed or sold TRICON products. It is well known that on-line sellers in China sometimes falsely purport to sell various electronics products to which they do not, in fact, have access in order to substitute some other product that they do sell — what might commonly be called a

<sup>6</sup> <https://www.analog.com/media/en/technical-documentation/data-sheets/hmc462chips.pdf>.



“bait and switch” tactic. Alternatively, such vendors might try to obtain the desired product for resale once a potential customer has been identified.

I declare under the penalty of perjury that the foregoing is true and correct.

A handwritten signature in blue ink, appearing to read "M J Schindler", is written above a horizontal line.

Manfred J. Schindler

Date: 8 June 2020