TAS Algorithm Validation Report for FCC

(Test Under Dynamic Transmission Condition)

Applicant Name	:	ASUSTeK COMPUTER INC.
Applicant Address	:	1F., No. 15, Lide Rd., Beitou Dist., Taipei City 112, Taiwan
Product Name	:	11ax RTL8852CE Combo module
Brand Name	:	REALTEK
Model Number	:	RTL8852CE
FCC ID	:	MSQ-RTL8852CE

Report Number	:	USSC253113002
Compliant Standards	:	FCC 47 CFR §2.1093
Sample Received Date	:	Mar. 07, 2025
Date of Testing	:	May 05, 2025 ~ May 06, 2025
Report Issue Date	:	May 15, 2025

*The above equipment have been tested by **Eurofins E&E Wireless Taiwan Co., Ltd.**, and found compliance with the requirement of the above standards. The test record, data evaluation & Device Under Test (DUT) configurations represented herein are true and accurate accounts of the measurements of the sample's characteristics under the conditions specified in this report.*

Note:
1. The test results are valid only for samples provided by customers and under the test conditions described in this report.
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3. The relevant information is provided by customers in this test report. According to the correctness, appropriateness or completeness of the information provided by the customer, if there is any doubt or error in the information which affects the validity of the test results, the laboratory does not take the responsibility.

Approved By：

Roy Wu / Technical Director

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Revision History

Rev.	Issue Date	Description	Revised by
00	May 15, 2025	Initial release	Rowan Hsieh

1. Information of Testing Laboratory

Test Facilities

Company Name: Eurofins E&E Wireless Taiwan Co., Ltd.
Address No.: 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan
Website: https://www.atl.com.tw
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Test Site Location

☐ No. 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan
☑ No. 2, Wuquan 5th Rd. Wugu Dist., New Taipei City, Taiwan

Laboratory Accreditation

Location	TAF	FCC	ISED
No. 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan	Accreditation No.: 1330	Designation No.: TW0010	Company No.: 7381A CAB ID: TW1330
No. 2, Wuquan 5th Rd. Wugu Dist., New Taipei City, Taiwan	Accreditation No.: 1330	Designation No.: TW0034	Company No.: 28922 CAB ID: TW1330

2. Device Under Test Information

Product Name	11ax RTL8852CE Combo module	
Brand Name	REALTEK	
Model Name	RTL8852CE	
FCC ID	MSQ-RTL8852CE	
Host Information	Product Name: Notebook PC Trade Name: ASUS Model Name: FX608L, FX608LM, FX608LP, TUF668LP, TUF668LM, TUF608LP, TUF608LM All models are electrically identical (including appearance, dimensions, I/O ports, antenna locations, and RF electrically identical are the same.), different model names are for marketing purpose.	
Testing Sample No.	C253113_A005	
Supported Wireless Technologies	**Tx Frequency (MHz)**	**Operating Mode**
	WLAN 2.4G : 2412 ~ 2472 5G : 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5720, 5745 ~ 5825, 5845 ~ 5885 6G : 5935 ~ 6415, 6435 ~ 6515, 6535 ~ 6875, 6895 ~ 7115	2.4G : 802.11b/g/n/ax 5G : 802.11a/n/ac/ax 6G : 802.11a/ax
	Bluetooth 2402 ~ 2480	BR, EDR, LE

Note:

The above DUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

Time-Averaging SAR Feature

This device is enabled with *Realtek*'s Wi-Fi TAS algorithm to control and manage instantaneous transmitting power in real time for transmit frequencies using *Realtek* Wi-Fi chipset and to ensure that the time-averaged RF exposure from Wi-Fi is in compliance with FCC requirements.

The compliance test under the static transmission scenario and simultaneous transmission analysis are reported in *SAR / APD / IPD Evaluation Report*. The validation of the time-averaging algorithm and compliance under the dynamic (time-varying) transmission scenario for Wi-Fi technologies are reported in this *TAS Algorithm Validation report*.

In addition, this device supports WLAN and Bluetooth technology, but the output power of ***Bluetooth*** modem is not controlled by the Wi-Fi TAS algorithm and has no TAS function.

3. Overview of Wi-Fi TAS Test Proposal

At present, the main application market of *Realtek* chips is notebook computers. The TAS algorithm certification uses the *8852CE* chipsets. It supports Wi-Fi 6 and two spatial streams. Number of antennas required is two.

The Wi-Fi function TAS support table is shown in *Table 3-1*. In the first phase of TAS development, RTK TAS 1.0 only supported the SISO and MIMO functions. In the future, RTK TAS will add band handover and simultaneous transmission functions in the second phase and use the MCC or DBDC function to do the TAS verification in RTK TAS 2.0. *Realtek* will also provide testing procedures and reports to the FCC for review.

Table 3-1: Wi-Fi Functions Supported by Realtek TAS

Wi-Fi Function Name	*Description*	*TAS Support?*
SISO	**Single Input Single Output**	**Yes**
MIMO	**Multiple Input Multiple Output**	**Yes**
MCC	**Multi-Channel Con-Current**	***No***
DBDC	**Dual Band Con-Current**	***No***
MLO	**Multi-Link Operation**	***No***

According to the Wi-Fi time-average function, *Realtek* design several Wi-Fi test scenarios to verify the correctness of the TAS verification algorithm. The applicable Wi-Fi TAS test scenarios are listed in *Table 3-2*.

Table 3-2: Applicable Wi-Fi TAS Verification Scenarios

Test Scenario	*Description*	*Test Required for this DUT*
1	**Change different Tx powers in one test. Use different Tx power changes to verify the correctness of the verification algorithm.**	***YES***
2	**Change different ECI (Exposure Condition Index) in one test. Verify the correctness of the verification algorithm under different ECI.**	***No*** **DUT has only one ECI**
3	**Signal point SAR**	***YES***

Note:

Since the Wi-Fi module does not allow band switch after sync with AP and TAS does not support DBDC, TAS validation test is not required for Band Handover and Simultaneous Transmission scenarios.

4. Wi-Fi TAS Algorithm Concept

This is a proposal of dynamically TX power adjustment with the WLAN module that uses *Realtek* Wi-Fi chipset to comply with time-averaged SAR limit. The target platforms mentioned in this document are PC and laptop. The target devices are Wi-Fi components embedded in the PC and laptop. And there are no specific requirements for the operating system.

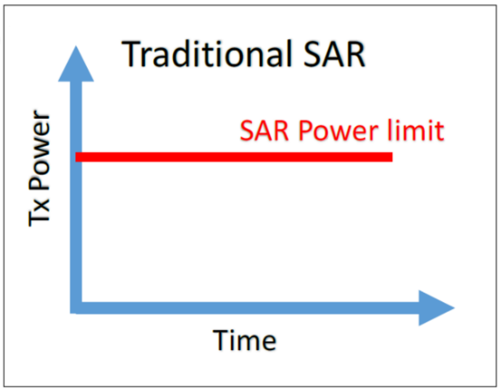
The following sections describe how *Realtek* Wi-Fi devices are capable of actively monitoring and adjusting power output to comply with exposure limits, which are based on averaged exposure over a time period when it is installed into a PC or laptop machine.

4.1. TAS-Base Dynamically Transmit Power Adjustment

The SAR (Specific Absorption Rate) is an RF safety regulation required in a number of countries; various governments have defined maximum SAR levels for RF energy emitted by wireless devices. Hence the compliance to SAR limit is required in the system where antenna radiation is in close proximity to human contact.

In order to meet the SAR limit requirement, the traditional SAR mitigation method of wireless device is to limit the transmit power in a predefined fixed value, such as 17 dBm. It means that the transmitted power can never exceed the 17 dBm.

Figure 4-1: Traditional SAR Mitigation Method

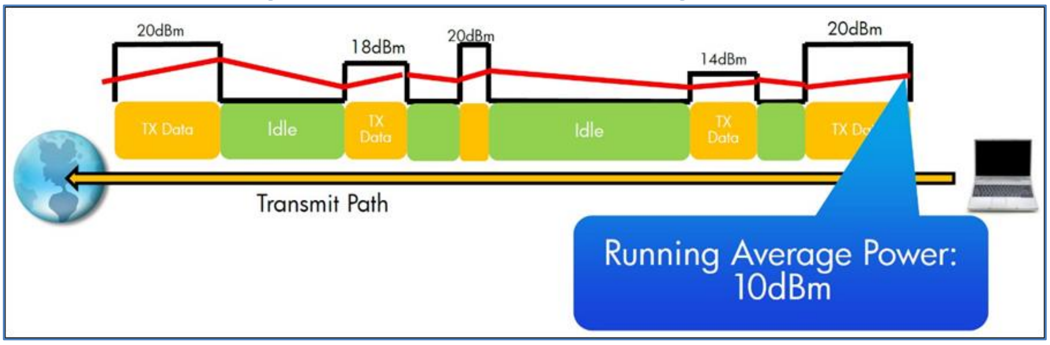


Recently, some regulatory authorities have started to adopt the perspective of the time average SAR to define the compliance of SAR requirement. Base on the concept of time-averaged SAR, a new method is proposed that can control the transmitted averaged power over any Times-Interval. With the new method, the data throughput can be greatly increased for several tens of seconds, while still being compliant with current safety standards. The key is using appropriate power control algorithms.

The concept of time-averaged power is shown in *figure 4-2*. Considering a system without SAR limit, the transmitted power should change over time depending on the data rate, bandwidth or other factors. And then the time-averaged power can be calculated as:

$$Average\_RF\_Exposure = \frac{\sum RF\_Power\_PerPacket \times Tx\_Time\_Period}{AverageTimePeriod}$$

Figure 4-2: Concept of Time-Averaged Power



If the calculated time-averaged power over a time period (e.g., 100 seconds) is less than maximum SAR levels defined by regulatory authorities, then it can be considered that the SAR limit of wireless device is not violated over this time period. And if the time-averaged power over any 100s-interval is less than SAR limit, then we can say that the SAR compliance of wireless device is totally met.

Based on the average time period provided by FCC. Maximum 100 seconds below 3 GHz, 60 seconds from 3-6 GHz, 30 seconds maximum from 6-10 GHz. The power averaging time in the algorithm will also be developed according to this specification.

In order to achieve the above goals, the wireless device is designed to be capable of actively monitoring and adjusting transmitted power over time. The mechanism of time average monitoring has the following basic functions:

- Can continuously track all the outgoing packets (both data and control).
- Can continuously calculate the averaged transmitted power of a pre-defined sliding window (e.g., 100s).
- Can dynamically adjust transmit power when the averaged transmitted power is less than the well-defined lower bound or reaches the upper bound.

4.1.1. Periodically Tx Duty Cycle Measurement

In *Realtek* Wi-Fi devices, we track all transmitted packets from the perspective of duty cycle instead of packet-by-packet tracking. It means the percentage of transmit time to total time in a cycle can be calculated periodically. Then we can define the time duration of the cycle as the parameter t_c that will be used in in next section. Tracking the transmitted power over a cycle of fixed time duration can reduce the system overhead on handling TAS mechanism.

4.1.2. Periodically Averaged Transmitted Power Calculation

With a pre-defined time period of transmit duty cycle t_c, the average transmitted power can be calculated as:

$$New\_Average = \frac{Old\_Tx\_Average \times (t - t_c)}{t} + \frac{Tx\_New\_Value \times t_c}{t}$$

Where:
Rolling Average: The averaged transmitted power over a time period.
t: Total time of rolling average window (i.e., 100s).
t

Old_Tx_Average: Previous rolling transmitted power average.
Tx_New_Value: Current transmitted power associated with latest Tx duty cycle.

This rolling averaged transmitted power will be updated periodically at each time when latest Tx duty cycle measurement is finished. According to *Tx_New_Value*, driver can dynamically adjust transmit power limit for next cycle of Tx duty measurement.

4.1.3. Dynamically Adjust Transmit Power

With the result of periodically calculation of rolling averaged transmitted power, *Realtek* Wi-Fi device will dynamically determine the maximum transmit power limit to make sure every latest rolling averaged transmit power can be under SAR limit of specific regulatory authority.

The algorithm for adjusting maximum transmit power is simply defined as follows.

- Definitions used in algorithm

  TX_PWR_DPR_ON_TH (dBm):
  Transmit power threshold to trigger Dynamic Power Reduction (DPR) on.

  TX_PWR_DPR_OFF_TH (dB):
  This will configure the threshold to turn off DPR (regain max power ceiling) whenever the average power has reached below this threshold.

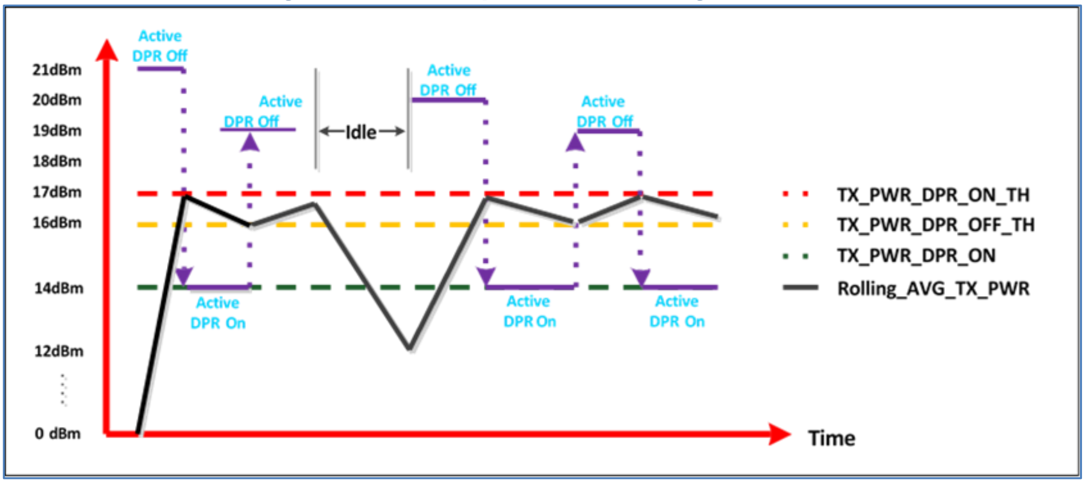
  TX_PWR_DPR_ON (dB):
  The transmit power limit is to be enforced when DPR is on.

  Rolling_AVG_TX_PWR (dB):
  The averaged transmitted power over a time period.

- Algorithm for adjusting transmit power dynamically
  1. The Dynamic Power Reduction (DPR) mechanism will be turned off from initial state.
  2. If the rolling averaged Tx power is above the value *TX_PWR_DPR_ON_TH*, Wi-Fi driver will turn on DPR mechanism and enforce to use a pre-defined fixed value *TX_PWR_DPR_ON* to limit all transmit packets from now on.
  3. If the rolling averaged Tx power is reached below *TX_PWR_DPR_OFF_TH*, Wi-Fi driver will turn off DPR mechanism and start to use maximum power this device can support to transmit packets.

The *Figure 4-3* shows the rolling averaged transmitted power (black line in the figure) over time if the above algorithm is applied. We can see that the rolling average transmitted power will always be less than *TX_PWR_DPR_ON_TH*, which is defined as the SAR limit in traditional SAR requirements. This can ensure that *this dynamically transmitted power adjusting mechanism can meet FCC SAR compliance on the aspect of time averaging exposure*.

Figure 4-3: Concept of Time-Averaged Power



4.2. Wi-Fi TAS Algorithm Parameters Definition

The parameters of the Wi-Fi TAS algorithm are listed in *Table 4-1*.

Table 4-1: Wi-Fi TAS Algorithm Parameters

Term	Description
P_{max} (dBm)	The maximum instantaneous output power that the transmitter is capable of producing. (Enable TAS)
$P_{max,unt}$ (dBm)	The $P_{max,unt}$ is P_{max} in accordance with all applicable tolerances and uncertainties. $P_{max,unt}$ = P_{max} – Tolerances and Uncertainties
P_{limit} (dBm)	The maximum time average output power. Result of ensuring DUT complies with SAR regulations. (Disable TAS, Static SAR)
$P_{limit,unt}$ (dBm)	The $P_{limit,unt}$ is P_{limit} in accordance with all applicable tolerances and uncertainties. $P_{limit,unt}$ = P_{limit} – Tolerances and Uncertainties
SAR_{limit}	Maximum 1g or 10g peak spatially averaged SAR (psSAR) target for the DUT. (Disable TAS, Static SAR)
$SAR_{limit,unt}$	The $SAR_{limit,unt}$ is SAR_{limit} in accordance with all applicable tolerances and uncertainties. $SAR_{limit,unt}$ = SAR_{limit} – Tolerances and Uncertainties

5. Wi-Fi TAS Test Scenarios and Test Procedures

5.1. Scenario 1 – Change Different Tx Powers

Test scenario 1 can be the following situations:
Use maximum power to observe 3 TAS cycles and verify the correctness of the TAS algorithm through the above methods. The correct algorithm behavior will be SAR limit plus 4 dB and SAR limit minus 2 dB. And the average power is always less than the SAR exposure standard.

SAR limit is 1.6 W/kg for 1g SAR or 4.0 W/kg for 10g SAR.

5.1.1. Scenario 1 – Frequency Band Selection

Since the algorithm does not divide frequency bands, the function of each frequency is the same. The idea of selecting test frequency is as follows:

1. $P_{max,unt}$ is greater than $P_{limit,unt}$
   If $P_{max,unt}$ is less than $P_{limit,unt}$, the power of TAS algorithm will be limited by $P_{max,unt}$. There will be no power change at this frequency.

2. Select one channel with $P_{max,unt} – P_{limit,unt}$ is highest.
   Because $P_{max,unt}$ power will not be suppressed, the maximum dynamic range of power changes can be obtained, the instantaneous power of the transmitter can be greater.

5.1.2. Scenario 1 – Procedures

Complete the SAR test of Scenario 1 according to the following test steps:

Step 1: Set AP Band and Channel according to *section 5.1.1*.
Step 2: Connect to AP.
Step 3: Perform script settings country code and TAS enable.
Step 4: Clear Spectrum data and execute *iperf*.
Step 5: Execute script settings scenarios. (Scenario 1)
Step 6: Convert the measured conducted Tx power from Step 5 into 1g-SAR or 10g-SAR value using the following equation.

Mathematical Expression

$$1g\ or\ 10g\ SAR(t) = \frac{Instantaneous\ Conducted\ Tx\ Power(t)}{P_{limit,unt}} \times 1g\ or\ 10g\ SAR_{limit,unt}$$

$$Time\ Average\ SAR(t) = \frac{1}{T_{SAR}} \times \int_{t-T_{SAR}}^{t} 1g\ or\ 10g\ SAR(t)dt$$

Step 7: Plot and label relevant parameters. Two pictures will be provided. One is time-average power relationship diagram, and another is time-average SAR relationship diagram.

5.2. Scenario 2 – Change Different ECI

This scenario tests that when the exposure condition index changes, the time-averaged Tx power is always less than the predefined $SAR_{target,nom}$. This application occurs when the laptop switches between tablet and laptop modes. This scenario selects any frequency band with two different $SAR_{limit,unt}$ values less than $P_{SAR\text{-}max,nom}$ in the two ECI groups. One test is sufficient as the functional operation is technology and frequency band independent.

5.2.1. Scenario 2 – Procedures

Complete the SAR tested of Scenario 2 according to the following test steps:

Step 1: Set AP Band and Channel. The channel selection follows *section 5.1.1.*

Step 2: Connect to AP.

Step 3: Execute script settings country code and TAS enable.

Step 4: Clear Spectrum data and execute *iperf*.

Step 5: Execute script settings scenarios. (Scenario 2, ECI Change)
When the TAS algorithm is stable (3 TAS cycles), switch to another ECI and execute 3 TAS cycles to verify the correctness of the algorithm. In this situation, the conducted power is set to max power.

Step 6: Convert the measured conducted Tx power from Step 5 into 1g-SAR or 10g-SAR value using the following equation.

Mathematical Expression

$$1g\ or\ 10g\ SAR\_1(t) = \frac{Instantaneous\ Conducted\ Tx\ Power\_1(t)}{P_{limit,unt\_1}} \times 1g\ or\ 10g\ SAR_{limit,unt\_1}$$

$$1g\ or\ 10g\ SAR\_2(t) = \frac{Instantaneous\ Conducted\ Tx\ Power\_2(t)}{P_{limit,unt\_2}} \times 1g\ or\ 10g\ SAR_{limit,unt\_2}$$

$$Normalize\ SAR\_1(t) = \frac{\frac{1}{T_{SAR}} \times \int_{t-T_{SAR}}^{t} 1g\ or\ 10g\ SAR\_1(t)dt}{FCC\ SAR\ Limit}$$

$$Normalize\ SAR\_2(t) = \frac{\frac{1}{T_{SAR}} \times \int_{t-T_{SAR}}^{t} 1g\ or\ 10g\ SAR\_2(t)dt}{FCC\ SAR\ Limit}$$

Conditions for Passing

$$Normalize\ Time\ Average\ SAR\_1(t) + Normalize\ Time\ Average\ SAR\_2(t) \le 1$$

Step 7: Plot and label relevant parameters. Two pictures will be provided. One is time-average power relationship diagram and another is the normalize time-average SAR relationship diagram.

5.3. Scenario 3 – Single Point SAR

Single point SAR measurements shall be performed to validate the TAS algorithm; however, compared with the requirements for conducted power measurements, fewer test cases are required: Single-point SAR measurements need to be performed only for changes in requested power and only for configurations involving a single transmitter, i.e., not for simultaneous transmission.

The purpose of this test is to connect single-point SAR to conducted power measurements and RF exposure.

5.3.1. Scenario 3 – Single Point SAR Measurement Method

The single-point SAR measurement method is as follows,

Location of Maximum SAR:

Disable the TAS algorithm and set the DUT output power to $P_{limit,unt}$, and perform an area scan to determine the maximum 1g SAR. Then, move the probe to the peak SAR point in the maximum 1g SAR. The remaining measurements should be taken at this point.

Point SAR $P_{limit,unt}$ Measurement:

Single-point SAR measurements are performed with the TAS algorithm disabled and the DUT output power set to $P_{limit,unt}$. In order to ensure the stability of $P_{limit,unt}$, this test uses a fixed frequency tool. Because dynamic software will have a certain proportion of Rx time, so the overall $P_{limit,unt}$ will not be concentrated.

Instantaneous Point SAR Measurement:

Enable the TAS algorithm and perform the given verification steps when measuring single-point SAR.

5.3.2. Scenarios 3 – Procedures

Since the single point SAR is connected to the conducted power, the test scenario uses condition 1. The purpose is to compare at the same conditions.

Step 1: Set AP Band and Channel according to *section 5.1.1.*

Step 2: Connect to AP.

Step 3: Execute script settings country code and TAS enable.

Step 4: Execute *iperf* and fixed frequency tool.

Step 5: Follow the measurement steps in *section 5.3.1.* and use scenario1 test.

Step 6: Convert the measured 1g-SAR or 10g-SAR value using the following equation.

Mathematical Expression

$$1g\ or\ 10g\ SAR(t) = \frac{Single\ Point\ SAR(t)}{Sinlge\ Point\ SAR\ P_{limit,unt}} \times 1g\ or\ 10g\ SAR_{limit,unt}$$

$$Time\ Average\ SAR(t) = \frac{1}{T_{SAR}} \times \int_{t-T_{SAR}}^{t} 1g\ or\ 10g\ SAR(t)dt$$

Step 7: Plot and label relevant parameters. One picture will be provided. The picture is time-average SAR relationship diagram.

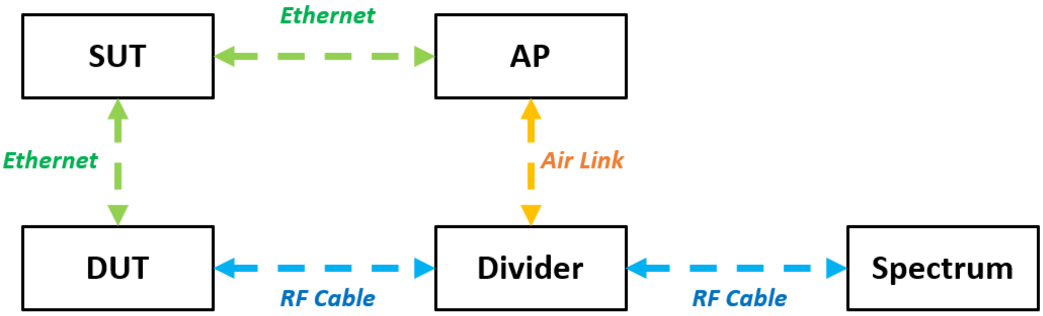
6. Wi-Fi TAS Validation via Conducted Power Measurement

6.1. Measurement Setup

The conducted power measurement test setup is described in the following.

a. The DUT is a laptop computer which contains *Realtek 8852CE* WLAN NIC.
b. DUT connects to AP via RF cable link and signal also pass-through RF cable link to Spectrum Analyzer.
c. The SUT connects to AP via Ethernet cable and is under the same local area network with DUT.
d. DUT performs throughput tests with SUT.
e. Uplink signal power is monitored by the Spectrum Analyzer.
f. After collecting all the power results, the test tool can calculate the average power values and plot the diagram.

Figure 6-1: General Setup for TAS Conducted Power Measurement



TAS Test Configuration:

The following *Table 6-1* lists the maximum $P_{max,unt} - P_{limit,unt}$ frequencies of different bands. Since the *Realtek*'s Wi-Fi TAS algorithm does not divide the frequency band and is different. Therefore, only one frequency band is selected for each scenario for testing (as shown in the *Table 6-1*).

Table 6-1: Wi-Fi TAS Verification Scenarios

	2.4GHz	5GHz, 802.11ac VHT80, CH155	6GHz
$P_{max,unt}$	17.5 dBm	16.5 dBm	12.0 dBm
$P_{limit,unt}$	13.5 dBm	12.5 dBm	8.0 dBm
TAS Test Scenario Case		1 and 3	

The TAS algorithm verification uses 5G band. The channel is selected following *Section 5.1.1*, and it can better verify the limit of the algorithm verification. Since the TAS algorithm for Antenna 0 or Antenna 1 is the same, only one Antenna is chosen to verify the correctness of TAS algorithm.

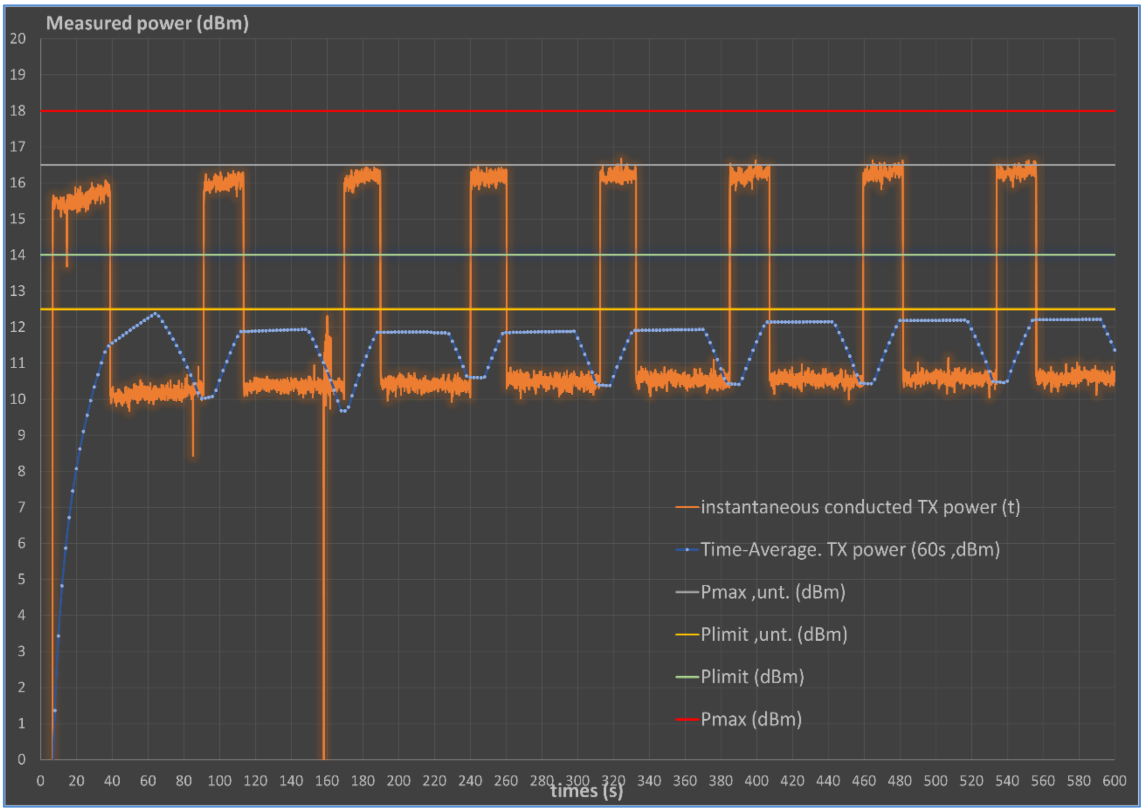
6.2. Conducted Power Measurement Results for Scenario 1: Change Different Tx Powers

The behavior of this test is to conduct experiments according to the description in *Section 5.1*. The relevant process and parameter calculation are as described in *Section 5.1*. This test is a measurement of the conduction power change. The passing standard is that the time average power is less than P_{limit}. However, considering the uncertainties such as production, more optimizations have been done in the algorithm, so that even if the instantaneous power exceeds $P_{max,unt}$, the *Time-Averaged Tx Power* can be less than $P_{limit,unt}$.

Table 6-2: TAS Parameters Setting for Test Scenario 1

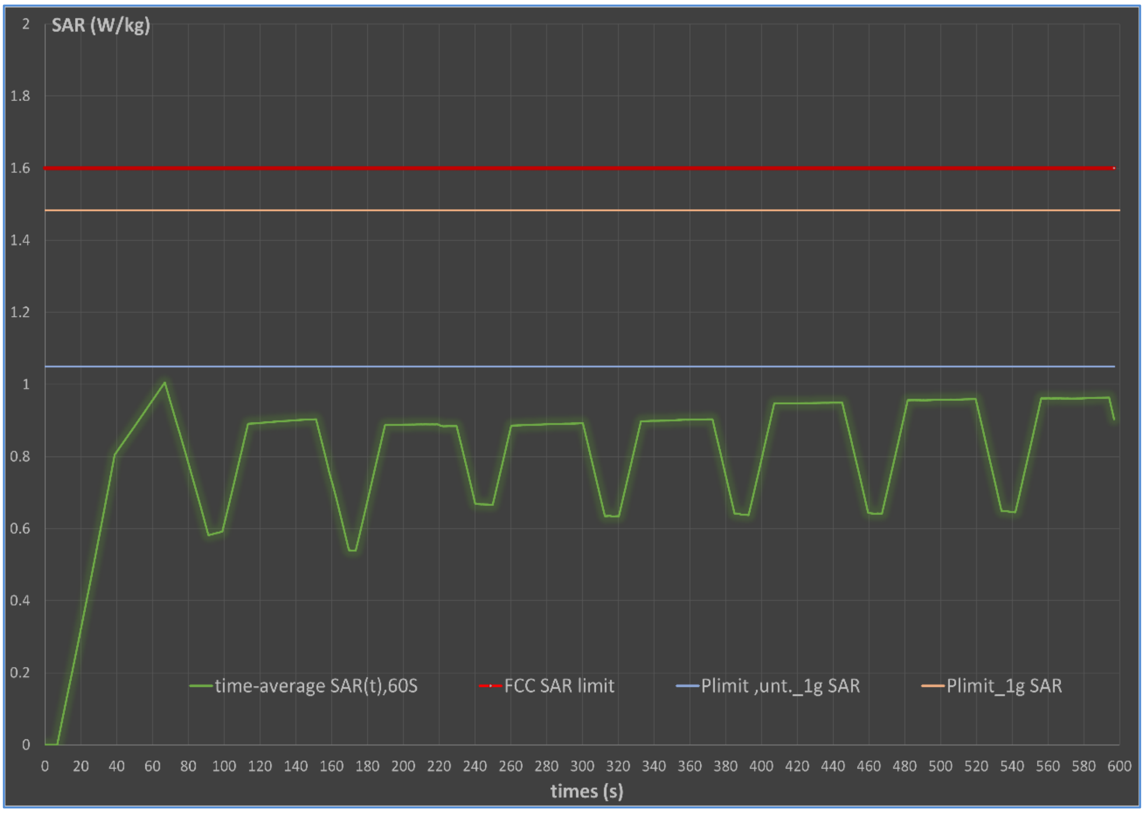
Test Band	Antenna	T_{SAR} (Sec.)	P_{max} (dBm)	$P_{max,unt}$ (dBm)	P_{limit} (dBm)	$P_{limit,unt}$ (dBm)	Validation Result
5 GHz	1	60	18.0	16.5	14.0	12.5	Pass

Figure 6-2: Time-Averaged Conducted Tx Power Over Time for Test Scenario 1



According to the Time-Average SAR conversion mathematical formula in *Section 5.1.2*, it can be converted into the SAR form in the figure below. From the perspective of FCC SAR standards, *Realtek*'s Wi-Fi TAS algorithm is also compliant.

Figure 6-3: Time-Averaged SAR Over Time for Test Scenario 1



7. Wi-Fi TAS Validation via SAR Measurement

7.1. Measurement Setup

The SAR measurement photos are shown in *Appendix A*.

7.2. DASY8 System Verification for SAR Measurement

Tissue Verification

The dielectric properties of the tissue simulating liquid have been measured within 24 hours before the SAR testing and within ±10 % of the target values. Liquid temperature during the SAR testing has kept within ±2 ℃.

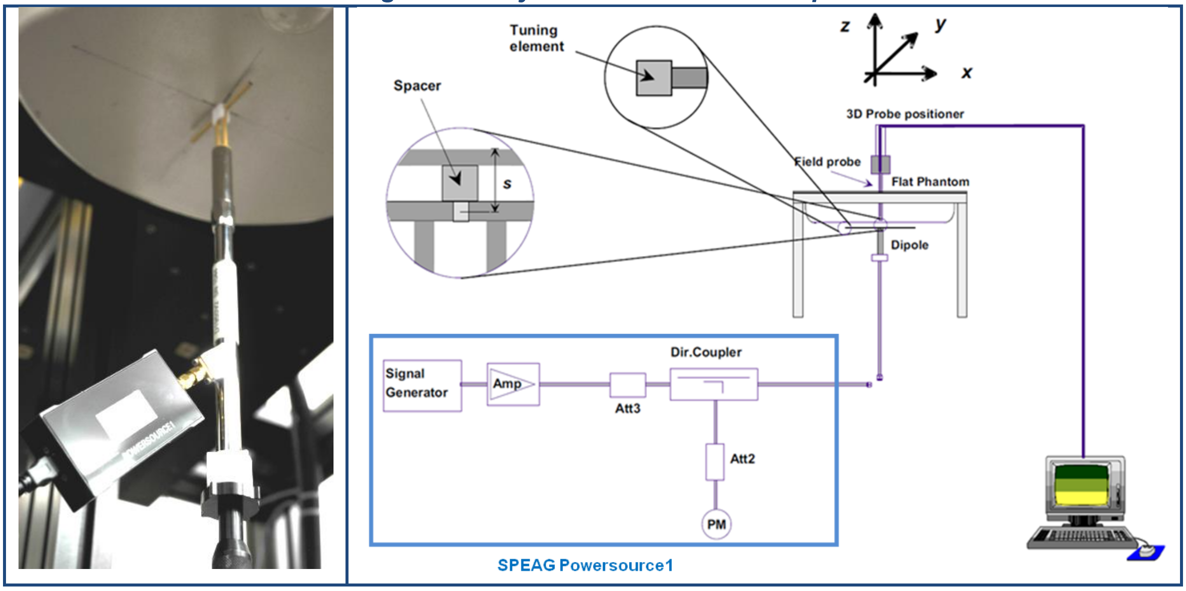
Test Results for Tissue Simulating Liquid

Frequency (MHz)	Liquid Temp. (℃)	Permittivity (εr)	Conductivity (σ)	Permittivity Target (εr)	Conductivity Target (σ)	Permittivity Deviation (%)	Conductivity Deviation (%)	Testing Date
5800	21.7	32.9	4.87	35.3	5.27	-6.80	-7.59	May 06, 2025

Test System Verification

Before time-averaged SAR measurements, DASY8 system has been verified. The result normalized to 1W comparing to the reference SAR value provided by SPEAG in dipole calibration certificate, the deviation of system check results is within its specification of 10 %. The below test results indicate the system check can meet the variation criterion.

Figure 7-1: System Verification Setup



Test Results for SAR System Verification

Date	Frequency (MHz)	Targeted 1g SAR (W/kg)	Measured 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)	Dipole S/N	Probe S/N	DAE S/N
May 06, 2025	5800	79.4	3.80	75.82	-4.51	1358	7757	1743

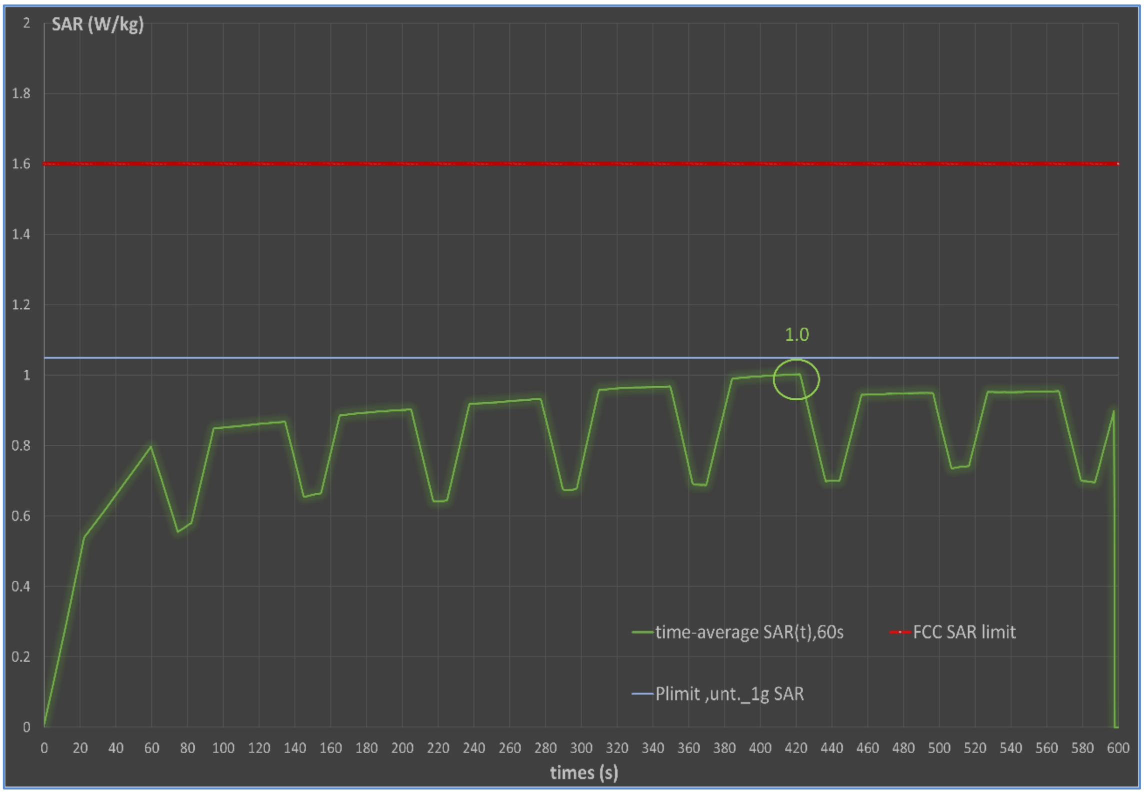
7.3. SAR Measurement Results for Scenario 3: Single Point SAR

The behavior of this test is to conduct experiments according to the description in *Section 5.3*. The relevant process and parameter calculation are as described in *Section 5.3*. This test is using SPEAG DASY8 system to measured single point SAR.

Table 7-1: TAS Parameters Setting for Test Scenario 3

Test Band	Antenna	T_{SAR} (Sec.)	P_{max} (dBm)	$P_{max,unt}$ (dBm)	P_{limit} (dBm)	$P_{limit,unt}$ (dBm)
5 GHz	1	60	18.0	16.5	14.0	12.5

Figure 7-2: Time-Averaged SAR Measurement Result for Test Scenario 3



FCC Limit for 1g-SAR (W/kg)	**1.6**
Max. Time-Averaged 1g-SAR (W/kg)	**1.00**
Validation Result：*Pass*	

8. Conclusions for Time-Averaging Feature Validation

This ***TAS Algorithm Validation Report*** proposes Wi-Fi TAS test scenarios and procedures, and proves *Realtek*'s Wi-Fi TAS algorithm can meet the FCC RF exposure regulations with the proposed test scenarios and procedures.

As shown in ***Chapter 6***, *Realtek*'s Wi-Fi TAS algorithm is able to maintain SAR over time under the FCC regulatory limits. Furthermore, the near-field measurements are also done in *Eurofins E&E Wireless Taiwan* lab to further validate the proposed test methodologies, and the results shown in ***Chapter 7*** demonstrate that *Realtek*'s Wi-Fi TAS algorithm can maintain SAR over time under the FCC regulatory limits with the proposed test procedures.

Based on the provided measurement results, it is concluded that *Realtek*'s Wi-Fi TAS algorithm can be validated by using the proposed test methodology for FCC compliance.

9. Equipment List

Manufacturer	Equipment	Model No.	Serial No.	Cal. Date	Cal. Interval
SPEAG	5 GHz System Validation Kit	D5GHzV2	1358	Jun. 12, 2024	1 year
SPEAG	Isotropic E-Field Probe	EX3DV4	7757	Sep. 18, 2024	1 year
SPEAG	Data Acquisition Electronics	DAE4	1743	Sep. 19, 2024	1 year
SPEAG	Dielectric Probe Kit	DAK-3.5	1219	Mar. 13, 2025	1 year
SPEAG	Powersource1	SE UMS 160 CA	4283	Aug. 15, 2024	1 year
R&S	Spectrum Analyzer	FSV3013	101679	Jun. 27, 2024	1 year

Test Engineer：Raymond Wu

10. Measurement Uncertainties

SAR Uncertainty Budget for Frequency Range of 300 MHz to 3 GHz

Symbol	Error Description	Uncertainty (± %)	Probability Distribution	Divisor	C_i (1g)	C_i (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)
Measurement System Errors								
CF	Probe Calibration	12.0	N	2	1	1	6.0	6.0
CF_{drift}	Probe Calibration Drift	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
LIN	Probe Linearity	4.7	R	$\sqrt{3}$	1	1	2.7	2.7
BBS	Broadband Signal	2.8	R	$\sqrt{3}$	1	1	1.6	1.6
ISO	Probe Isotropy	7.6	R	$\sqrt{3}$	1	1	4.4	4.4
DAE	Other Probe+Electronic	0.8	N	1	1	1	0.8	0.8
AMB	RF Ambient	0.7	N	1	1	1	0.7	0.7
Δ_{sys}	Probe Positioning	0.006	N	1	0.14	0.14	0.0	0.0
DAT	Data Processing	1.2	N	1	1	1	1.2	1.2
Phantom and Device Errors								
$LIQ(\sigma)$	Conductivity (meas.)DAK	2.5	N	1	0.78	0.71	2.0	1.8
$LIQ(T_\sigma)$	Conductivity (temp)BB	3.3	R	$\sqrt{3}$	0.78	0.71	1.5	1.4
EPS	Phantom Permittivity	14.0	R	$\sqrt{3}$	0	0	0.0	0.0
DIS	Distance DUT-TSL	2.0	N	1	2	2	4.0	4.0
D_{xyz}	Device Positioning	1.0	N	1	1	1	1.0	1.0
H	Device Holder	2.5	N	1	1	1	2.5	2.5
MOD	DUT Modulation	2.4	R	$\sqrt{3}$	1	1	1.4	1.4
TAS	Time-average SAR	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
RF_{drift}	DUT drift	2.5	N	1	1	1	2.5	2.5
Correction to the SAR Results								
$C(\varepsilon, \sigma)$	Deviation to Target	1.9	N	1	1	0.84	1.9	1.6
$C(R)$	SAR Scaling	0.0	R	$\sqrt{3}$	1	1	0.0	0.0
$u(\Delta SAR)$	**Combined Uncertainty**					**RSS**	10.5	10.4
U	**Expanded Uncertainty**					**k=2**	**21.0**	**20.8**

SAR Uncertainty Budget for Frequency Range of 3 GHz to 6 GHz

Symbol	Error Description	Uncertainty (± %)	Probability Distribution	Divisor	C_i (1g)	C_i (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)
Measurement System Errors								
CF	Probe Calibration	13.1	N	2	1	1	6.55	6.55
CF_{drift}	Probe Calibration Drift	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
LIN	Probe Linearity	4.7	R	$\sqrt{3}$	1	1	2.7	2.7
BBS	Broadband Signal	2.6	R	$\sqrt{3}$	1	1	1.5	1.5
ISO	Probe Isotropy	7.6	R	$\sqrt{3}$	1	1	4.4	4.4
DAE	Other Probe+Electronic	1.2	N	1	1	1	1.2	1.2
AMB	RF Ambient	0.7	N	1	1	1	0.7	0.7
Δ_{sys}	Probe Positioning	0.005	N	1	0.29	0.29	0.0	0.0
DAT	Data Processing	2.3	N	1	1	1	2.3	2.3
Phantom and Device Errors								
$LIQ(\sigma)$	Conductivity (meas.)DAK	2.5	N	1	0.78	0.71	2.0	1.8
$LIQ(T_\sigma)$	Conductivity (temp)BB	3.4	R	$\sqrt{3}$	0.78	0.71	1.5	1.4
EPS	Phantom Permittivity	14.0	R	$\sqrt{3}$	0.25	0.25	2.0	2.0
DIS	Distance DUT-TSL	2.0	N	1	2	2	4.0	4.0
D_{xyz}	Device Positioning	1.0	N	1	1	1	1.0	1.0
H	Device Holder	2.5	N	1	1	1	2.5	2.5
MOD	DUT Modulation	2.4	R	$\sqrt{3}$	1	1	1.4	1.4
TAS	Time-average SAR	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
RF_{drift}	DUT drift	2.5	N	1	1	1	2.5	2.5
Correction to the SAR Results								
$C(\varepsilon, \sigma)$	Deviation to Target	1.9	N	1	1	0.84	1.9	1.6
$C(R)$	SAR Scaling	0.0	R	$\sqrt{3}$	1	1	0.0	0.0
$u(\Delta SAR)$	**Combined Uncertainty**					**RSS**	11.2	11.1
U	**Expanded Uncertainty**					**k=2**	**22.4**	**22.2**

SAR Uncertainty Budget for Frequency Range of 6 GHz to 10 GHz

Symbol	*Error Description*	*Uncertainty (± %)*	*Probability Distribution*	*Divisor*	*C_i (1g)*	*C_i (10g)*	*Standard Uncertainty (± %, 1g)*	*Standard Uncertainty (± %, 10g)*
Measurement System Errors								
CF	Probe Calibration	18.6	N	2	1	1	9.3	9.3
CF_{drift}	Probe Calibration Drift	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
LIN	Probe Linearity	4.7	R	$\sqrt{3}$	1	1	2.7	2.7
BBS	Broadband Signal	2.6	R	$\sqrt{3}$	1	1	1.5	1.5
ISO	Probe Isotropy	7.6	R	$\sqrt{3}$	1	1	4.4	4.4
DAE	Other Probe+Electronic	2.4	N	1	1	1	2.4	2.4
AMB	RF Ambient	0.7	N	1	1	1	0.7	0.7
Δ_{sys}	Probe Positioning	0.005	N	1	0.5	0.5	0.0	0.0
DAT	Data Processing	3.5	N	1	1	1	3.5	3.5
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)DAK	2.5	N	1	0.78	0.71	2.0	1.8
LIQ(T_σ)	Conductivity (temp)BB	2.4	R	$\sqrt{3}$	0.78	0.71	1.1	1.0
EPS	Phantom Permittivity	14.0	R	$\sqrt{3}$	0.5	0.5	4.0	4.0
DIS	Distance DUT-TSL	2.0	N	1	2	2	4.0	4.0
D_{xyz}	Device Positioning	1.0	N	1	1	1	1.0	1.0
H	Device Holder	2.5	N	1	1	1	2.5	2.5
MOD	DUT Modulation	2.4	R	$\sqrt{3}$	1	1	1.4	1.4
TAS	Time-average SAR	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
RF_{drift}	DUT drift	2.5	N	1	1	1	2.5	2.5
Correction to the SAR Results								
C(ε, σ)	Deviation to Target	1.9	N	1	1	0.84	1.9	1.6
C(R)	SAR Scaling	0.0	R	$\sqrt{3}$	1	1	0.0	0.0
u(Δ SAR)	**Combined Uncertainty**					**RSS**	13.9	13.8
U	**Expanded Uncertainty**					**k=2**	**27.8**	**27.6**

************************************ End of Report ************************************