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COMPLIANCE SUMMARY REPORT

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Test Site/Location:
Element, Columbia, MD, USA
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FCC ID:	**A3LSMA356E**
APPLICANT:	**SAMSUNG ELECTRONICS CO., LTD**

Report Type:	Compliance Summary
DUT Type:	Portable Handset
Model(s):	SM-A356E/DS

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TABLE OF CONTENTS

1 STRATEGY FOR COMPLIANCE DEMONSTRATION

1.1 RF Exposure Evaluation Strategy

The FCC RF exposure limits defined based on time-averaged RF exposure. The device under test (DUT) uses the S.LSI TAS feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is in compliance with the FCC requirement for 2G/3G/4G/5G NR operations. Additionally, this device supports WLAN/BT/NFC technologies but the output power of these modems is not controlled by the S.LSI TAS algorithm.

Demonstrating compliance of DUT enabled with S.LSI TAS feature is completed in three parts:

0. RF Exposure Compliance Test Report Part 0: SAR Characterization

The SAR Characterization, denoted as SAR Char, determines the power limit that meets FCC exposure requirement after accounting for device design related uncertainties for each supported radio configuration and RF exposure usage scenario. The determined power limits will be loaded and stored in the EUT, and then used as inputs for S.LSI TAS to operate.

For 2G/3G/4G/5G Sub6, SAR Char is derived from SAR test measurements and conducted power measurements to determine P_{Limit} for each technology/band. The P_{Limit} represents the maximum time-averaged power level for the corresponding radio/antenna configuration.

1. RF Exposure Compliance Test Report Part 1: Test in Static Transmission Condition

Part 1 demonstrates that DUT meets FCC SAR limits when transmitting at pre-determined maximum time-averaged power level: P_{Limit} for 2G/3G/4G/5G Sub6. The SAR measurement in Part 1 is under static transmission condition.

The compliance for WLAN/BT radio is demonstrated at a fixed power level (fixed = maximum RF tune-up level or power-back off level).

The exposure from the simultaneous transmission of WWAN and WLAN/BT is evaluated in Part 1 report.

2. RF Exposure Compliance Test Report Part 2: Test in Dynamic Transmission Condition

Part 2 demonstrates compliance in Tx varying transmission conditions and validates S.LSI TAS algorithm. The test results reported in Part 2 demonstrates that DUT complies with FCC RF exposure requirement under Tx varying transmission scenarios, thereby validity of S.LSI TAS algorithm.

1.2 Nomenclature

Applicable Technologies	Term	Description
WWAN	P_{Limit}	Power level that corresponds to the exposure design target (*SAR_design_target)* after accounting for all device design related uncertainties
	P_{Max}	Maximum tune up output power
	T_{SAR}	Defined time averaging window for f < 6 GHz
	SAR_design_target	Target SAR level resulting in maximum time-averaged exposure optimized from total uncertainty
	SAR Char	Table containing *Plimit* for all technologies
	regulatory body	Regulatory body that the algorithm is designed to comply. Algorithm's time averaging window is dependent on either FCC or ICNIRP requirements.
	reserve_power_margin	Margin below P_{Limit} reserved for future transmission
	$P_{reserve}$	Minimum transmit power with a designated margin below P_{Limit}

1.3 Bibliography

Report Type	Report Serial Number
FCC SAR Evaluation Report (Part 1)	1M2310260110-07.A3L
RF Exposure Part 2 Test Report	1M2310260110-21.A3L
FCC SAR Evaluation Report (Part 0)	1M2310260110-19.A3L

2 TIME AVERAGING ALGORITHM

2.1 Algorithm Description

The FCC RF exposure limit is defined based on time-averaged RF exposure. When running in a wireless device, S.LSI TAS algorithm enables more elegant power control mechanisms for RF exposure management. It ensures at all times the wireless device is in compliance with the FCC limit of RF exposure time-averaged over a defined time window, denoted as T_{SAR} for specific absorption rate (SAR for transmit frequency < 6 GHz).

The S.LSI TAS algorithm not only ensures the wireless device complies with RF exposure requirement, but also improves the user experience and network performance.

For a given wireless device, RF exposure is proportional to the transmitting power.

- Once the SAR of the wireless device is characterized at a transmit power level, RF exposure at a different power level for the characterized configurations can be scaled by the change in the corresponding power level.
- Therefore, for a characterized device, RF exposure compliance can be achieved through transmit power control and management.

The TAS algorithm embedded in S.LSI modems reliably controls the transmit power of the wireless device in real time to maintain the time-averaged transmit power, in turn, time-averaged RF exposure, below the predefined time-averaged power limit for each characterized technology and band.

- This predefined time-averaged power limit is denoted as P_{Limit} corresponding SAR limit (frequency < 6 GHz in this report.
- The wireless device continuously transmitting at P_{Limit} level level complies with the FCC RF exposure requirement.

In a simultaneous transmission scenario, the algorithm manages all active transmitters and make sure the total exposure ratio from each transmitter not exceeding to 1.

2.2 Basic concept of the algorithm

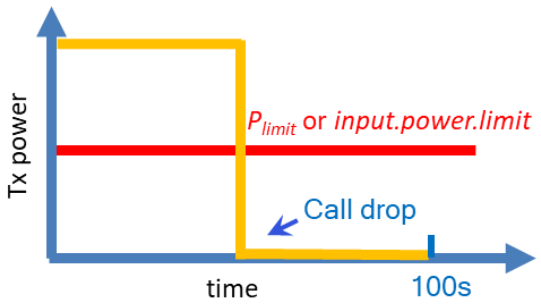
The S.LSI TAS algorithm controls and manages the instantaneous transmit power (Tx) to maintain the time averaged Tx power and therefore, time-averaged RF exposure in compliance with FCC limits.

- If time-averaged transmit power approaches P_{Limit}, then the modem needs to limit instantaneous transmit power to ensure the time-averaged transmit power does not exceed P_{Limit} in any T_{SAR} time windows since the time-averaged RF exposure is required to comply with the FCC RF exposure limit in any T_{SAR} time window.
- The wireless device can instantaneously transmit at high transmit powers and exceed the P_{Limit} level for a short duration before limiting the power to maintain the time-averaged transmit power under P_{Limit} .
- If the wireless device transmits at high power for a long time, then the radio link needs to be dropped to be compliant with time-averaged Tx power requirement (see Figure 2-1).
- To avoid dropping the radio link, S.SLI TAS algorithm starts the power limiting enforcement earlier in time to back off the Tx power to a reserve level (denoted as $P_{reserve}$), so the wireless device can maintain the radio link at a minimum reserve power level for as long as needed, and at the same time ensure the time-averaged Tx power over any defined time window is less than P_{Limit} at all times (see Figure 2-2). At all times, Smart Transmit meets the below equation:

$$time.avg.Tx\ power = \frac{1}{T_{SAR}} \int_{t-T_{SAR}}^{t} inst.Tx\ power(t)\, dt \leq P_{limit}$$

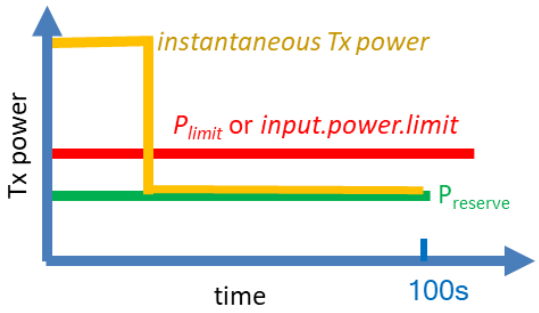
Equation 2-1

where, $time.avg.Tx\ power$ is the transmit power averaged between t-T_{SAR} and t time period; T_{SAR} is the time window defined by FCC for time-averaging RF exposure for Tx frequency less than 6GHz (sub6); *inst. Tx power (t)* is the instantaneous transmit power at t time instant; P_{Limit} is the predefined time-averaged power limit.



(a)

Figure 2-1
Transmit at high power when needed and permitted



(b)

Figure 2-2
Transmit with reserve power to support continuous transmission at a minimum power level ($P_{reserve}$)

- In the case of simultaneous transmission, TAS manages all active transmitters and make sure the total exposure ratio is less than 1

$$\sum \frac{\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^{t} SAR(t)\, dt}{FCC\ SAR\ limit} \leq 1$$

Equation 2-2

2.3 Configurable Parameters

The following input parameters are required for functionality of S.LSI. Smart Transmit algorithm. These parameters cannot be accessed by the end user, because at the factory they are entered through the embedded file system (EFS) entries by the OEM

Input Parameter	Description
regulatory body	• Inputs of "0" and "1" corresponding to FCC and ICNIRP requirements for the averaging time windows. • For FCC, algorithm uses an averaging window of 100 seconds for *f* < 3 GHz, 60 seconds for 3 GHz < *f* < 6 GHz, and 4 seconds for 24 GHz < *f* < 42 GHz.
Tx_power_at_SAR_design_target (P_{Limit} *in dBm*) *f* < 6 GHz	The maximum time-averaged transmit power, in dBm, corresponding to the *SAR_design_targe*t. *SAR_design_target* is pre-determined for this DUT and it is less than regulatory SAR limit after accounting for all design related tolerances. The time-averaged SAR is assessed against this *SAR_design_target* in real time to determine the compliance.

	P_{Limit} could vary with technology, band and Device State Index (DSI) and therefore, it has the unique value for each technology, band and DSI.
reserve_power_margin ($P_{reserve}$ *in dBm)*	The margin below P_{Limit} reserved for future transmission with a minimum transmit power $P_{reserve}$ $P_{reserve}$ (dBm) = P_{limit} (dBm) – *Reserve_power_margin* (dB) When the *Reserve_power_margin* is set to 0 dB, Smart Transmit effectively limits the upper bound of the transmit power to P_{limit} and the DUT transmits continuously at P_{limit} without utilizing Smart Transmit dynamic control feature.

3 DUT DESCRIPTION

3.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
GSM/GPRS/EDGE 850	Voice/Data	824.20 - 848.80 MHz
GSM/GPRS/EDGE1900	Voice/Data	1850.20 - 1909.80 MHz
UMTS 850	Voice/Data	826.40 - 846.60 MHz
UMTS 1750	Voice/Data	1712.4 - 1752.6 MHz
UMTS 1900	Voice/Data	1852.4 - 1907.6 MHz
LTE Band 12	Voice/Data	699.7 - 715.3 MHz
LTE Band 17	Voice/Data	706.5 - 713.5 MHz
LTE Band 13	Voice/Data	779.5 - 784.5 MHz
LTE Band 26	Voice/Data	814.7 - 848.3 MHz
LTE Band 5	Voice/Data	824.7 - 848.3 MHz
LTE Band 66	Voice/Data	1710.7 - 1779.3 MHz
LTE Band 4	Voice/Data	1710.7 - 1754.3 MHz
LTE Band 25	Voice/Data	1850.7 - 1914.3 MHz
LTE Band 2	Voice/Data	1850.7 - 1909.3 MHz
LTE Band 41	Voice/Data	2498.5 - 2687.5 MHz
NR Band n5	Voice/Data	826.5 - 846.5 MHz
NR Band n66	Voice/Data	1712.5 - 1777.5 MHz
NR Band n41	Voice/Data	2501.01 - 2685 MHz
NR Band n77	Voice/Data	3455.01 - 3544.98 MHz; 3705 - 3975 MHz
2.4 GHz WIFI	Voice/Data	2412 - 2472 MHz
5 GHz WIFI	Voice/Data	U-NII-1: 5180 - 5240 MHz U-NII-2A: 5260 - 5320 MHz U-NII-2C: 5500 - 5720 MHz U-NII-3: 5745 - 5825 MHz
2.4 GHz Bluetooth	Data	2402 - 2480 MHz
NFC	Data	13.56 MHz

This device uses the S.LSI TAS feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is in compliance with the FCC requirement for 2G/3G/4G/5G operations. Additionally, this device supports WLAN/BT/NFC technologies but the output power of these modems is not controlled by the S.LSI TAS algorithm.

4 COMPLIANCE SUMMARY

4.1 RF Exposure Compliance Summary

All transmission scenarios that the DUT supports comply with FCC time-averaged RF exposure requirements, as shown in Table 4-1.

Table 4-1
Reported RF Exposure Levels

	RFx Evaluation	Power Level	FCC Limit	***Reported*** RF Exposure Level	Test Report
SAR (W/kg)	Standalone 1g SAR	P_{limit}	1.6	1.05	FCC SAR Evaluation Report (Part 1)
	Standalone 10g SAR	P_{limit}	4.0	2.29	
	Simultaneous Tx 1g SAR	P_{limit}	1.6	1.59	
	Simultaneous Tx 10g SAR	P_{limit}	4.0	3.50	