



SAR EVALUATION REPORT

**FCC 47 CFR § 2.1093
IEEE Std 1528-2013**

For
GSM Phone + Bluetooth & WLAN 2.4GHz b/g/n

**Model: SM-G316HU/DD
FCC ID: A3LSMG316HU**

**Report Number: 14I19012-S1
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1. Attestation of Test Results

Applicant Name	Samsung Electronics Co., Ltd.		
Application Purpose	<input checked="" type="checkbox"/> Original Grant <input type="checkbox"/> Class II Permissive Change		
FCC ID	A3LSMG316HU		
DUT Description	GSM Phone + Bluetooth & WLAN 2.4GHz b/g/n		
Exposure Category	General Population/Uncontrolled Exposure (1g SAR limit: 1.6 W/kg)		
The highest reported SAR	RF Exposure Conditions	Equipment Class	
		Licensed	DTS
	Head	0.441 W/kg	0.444 W/kg
	Body-worn Accessory	0.896 W/kg	0.140 W/kg
	Wireless Router (Hotspot)		
Wi-Fi Direct	N/A		
Simultaneous Transmission	Head: 0.885 W/kg	Body: 1.036 W/kg	N/A
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013		
Test Results	Pass		
Date tested	10/03/2014 – 10/06/2014		
<p>UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.</p> <p>Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.</p>			
Approved & Released By:	Prepared By:		
			
Dave Weaver Program Manager UL Verification Services Inc.	Coltyce Sanders Laboratory Engineer UL Verification Services Inc.		

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE STD 1528-2003 & 2013, the following FCC Published RF exposure KDB procedures, and TCB workshop updates:

- 447498 D01 General RF Exposure Guidance v05r02
- 648474 D04 Handset SAR v01r02
- 941225 D03 SAR Test Reduction GSM GPRS EDGE v01
- 941225 D04 SAR for GSM E GPRS Dual Xfer Mode v01
- 941225 D06 Hotspot Mode SAR v01r01
- 248227 D01 SAR Meas for 802 11abg v01r02
- 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- 865664 D02 SAR Reporting v01r01
- 690783 D01 SAR Listings on Grants v01r03

3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

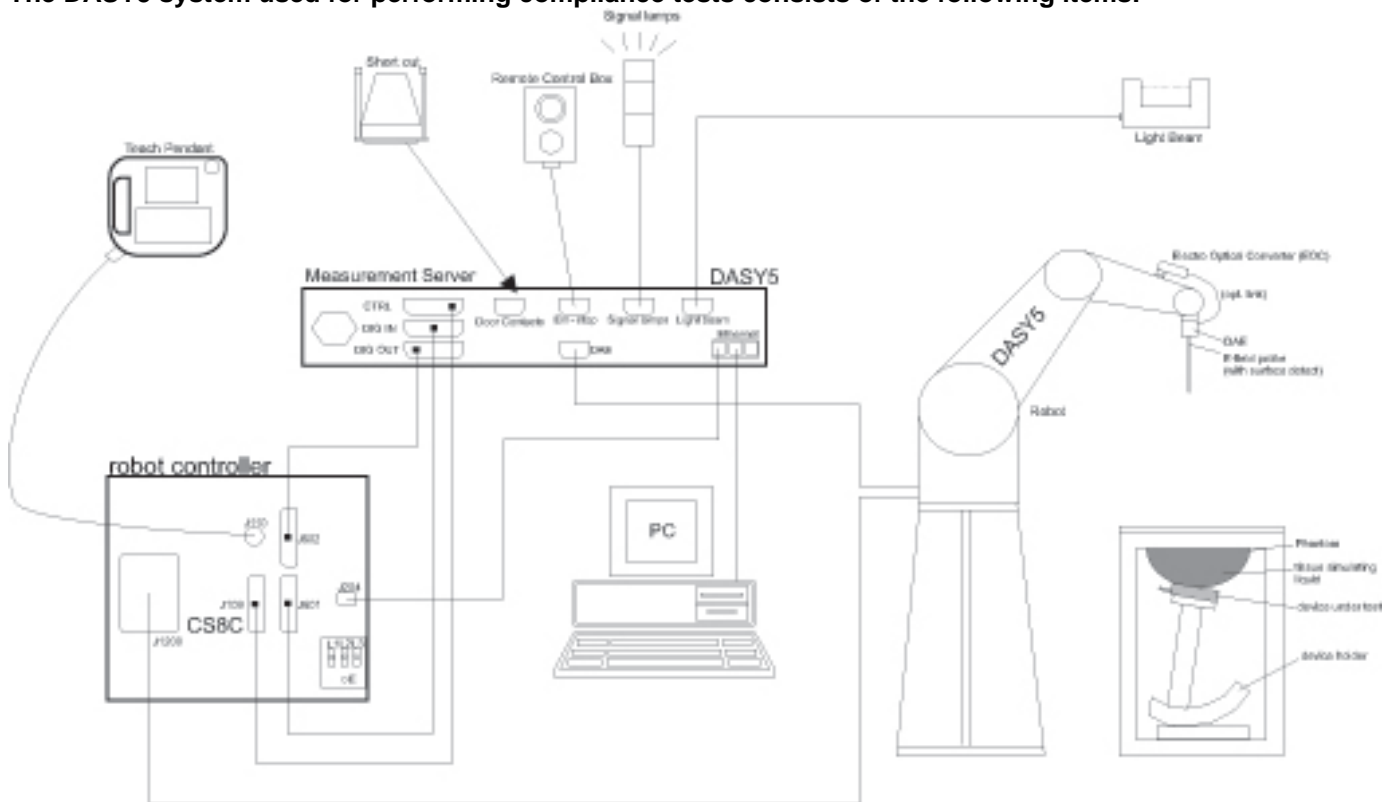
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	SAR Lab 5
SAR Lab F	
SAR Lab G	
SAR Lab H	

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://ts.nist.gov/standards/scopes/2000650.htm>.

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY5 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.2. SAR Scan Procedure

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: Δx_{Area} , Δy_{Area}	≤ 2 GHz: ≤ 15 mm $2 - 3$ GHz: ≤ 12 mm	$3 - 4$ GHz: ≤ 12 mm $4 - 6$ GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

		≤ 3 GHz	> 3 GHz	
Maximum zoom scan spatial resolution: $\Delta x_{Zoom}, \Delta y_{Zoom}$		≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*	
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$	≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm	
	graded grid	$\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5 · $\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z	≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm	
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details. * When zoom scan is required and the <i>reported</i> SAR from the area scan based <i>1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan (FCC only)

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation the extrapolated distance should not be larger than the step size in Z-direction.

4.3. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Agilent	E753ES	MY40000980	4/7/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1087	11/13/2014
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Cole-Parmer Instrument Co.	91100-50	1007	7/31/2015
Thermometer	EXTECH	445703	CCS-200	3/24/2015

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
HP Signal Generator	HP	8665B	3546A00784	6/23/2015
Power Meter	HP	437B	3125U16345	6/16/2015
Power Sensor	Agilent	8481A	2702A60780	6/16/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1622052	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2711	N/A
DC Power Supply	Sorensen Ametek	XT20-3	1318A00530	N/A
Synthesized Signal Generator	Agilent	8665B	3438A00633	7/10/2015
Power Meter	Agilent	N1911A	MY53060016	8/7/2015
Power Sensor	Agilent	E9323A	MY53070003	5/1/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1808938	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2710	N/A
DC Power Supply	HP	6296A	2841A-05955	N/A
E-Field Probe (SAR 1)	SPEAG	EX3DV4	3902	5/19/2015
E-Field Probe (SAR 3)	SPEAG	EX3DV4	3773	4/22/2015
Data Acquisition Electronics (SAR 1)	SPEAG	DAE3	427	1/21/2015
Data Acquisition Electronics (SAR 3)	SPEAG	DAE4	1380	7/23/2015
System Validation Dipole	SPEAG	D835V2	4d117	5/16/2015
System Validation Dipole	SPEAG	D1900V2	5d043	11/12/2014
System Validation Dipole	SPEAG	D2450V2	706	5/20/2015
Thermometer (SAR Lab 1)	EXTECH	445703	CCS-205	3/24/2015
Thermometer (SAR Lab 3)	EXTECH	445703	CCS-237	6/3/2015

Others

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Agilent	N1912A	MY53040015	7/10/2015
Power Sensor	Agilent	N1921A	MY52020011	5/6/2015
Base Station Simulator	R & S	CMW500	137873-WG	7/14/2015
Base Station Simulator	R & S	CMW500	104245-jz	3/26/2015

5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2003 & 2013 is not required in SAR reports submitted for equipment approval.

6. Device Under Test (DUT) Information

6.1. DUT Description

Model: SM-G316HU/DD	
Device Dimension	Overall (Length x Width): 121.4 mm x 62.9 mm Overall Diagonal: 136.7 mm Display Diagonal: 115.7 mm
Battery Back Cover	<input checked="" type="checkbox"/> Normal Battery Cover <input type="checkbox"/> Normal Battery Cover with NFC <input type="checkbox"/> Wireless Charger Battery Cover <input type="checkbox"/> Wireless Charger Battery Cover with NFC.
Battery Options	<input checked="" type="checkbox"/> Standard – Lithium-ion battery, Rating 3.8Vdc, 5.70Wh <input type="checkbox"/> Extended (large capacity)
Accessory	Headset
Wireless Router (Hotspot)	Wi-Fi Hotspot mode permits the device to share its cellular data connection with other Wi-Fi-enabled devices. <input checked="" type="checkbox"/> Mobile Hotspot (Wi-Fi 2.4 GHz) <input type="checkbox"/> Mobile Hotspot (Wi-Fi 5 GHz)
Wi-Fi Direct	Wi-Fi Direct enabled devices transfer data directly between each other <input checked="" type="checkbox"/> Wi-Fi Direct (Wi-Fi 2.4 GHz) <input type="checkbox"/> Wi-Fi Direct (Wi-Fi 5 GHz)
SIM Information	<input type="checkbox"/> Single SIM <input checked="" type="checkbox"/> Dual SIM

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
GSM	850, 1900	Voice (GMSK) GPRS (GMSK) EGPRS (8PSK)	GSM Voice: 12.5%; GPRS/EGPRS: 1 Slot: 12.5%; 2 Slots: 25%, 3 Slots: 37.5%, 4 Slots: 50%,
		GPRS Multi-Slot Class: <input type="checkbox"/> Class 8 - One Up <input type="checkbox"/> Class 10 - Two Up <input checked="" type="checkbox"/> Class 12 - Four Up <input type="checkbox"/> Class 33 - Four Up DTM (Dual Transfer Mode): Not support	
Wi-Fi	2.4 GHz	802.11b 802.11g 802.11n (HT20)	100%
Bluetooth	2.4 GHz	Version 4.0 LE	32.25% (DH1), 66.68% (DH3), 77.52% (DH5)

6.3. Nominal and Maximum Output Power

Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
GSM850	Voice	32.5	33.0
	GPRS 1 slot	32.5	33.0
	GPRS 2 slots	30.0	30.5
	GPRS 3 slots	28.5	29.0
	GPRS 4 slots	27.0	27.5
GSM1900	Voice	29.2	29.7
	GPRS 1 slot	29.2	29.7
	GPRS 2 slots	27.2	27.7
	GPRS 3 slots	25.2	25.7
	GPRS 4 slots	24.0	24.5

Upper limit (dB): 0.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 2.4 GHz	802.11b	16.0	16.5
	802.11g	14.0	14.5
	802.11n HT20	12.0	12.5
Bluetooth		8.5	9.0
Bluetooth LE		8.0	8.5

6.4. Simultaneous Transmission Condition

RF Exposure Condition	Capable Transmit Configurations
Head	<ol style="list-style-type: none"> GSM 850/1900 Voice + Wi-Fi 2.4GHz GSM 850/1900 (GPRS/EDGE) + Wi-Fi 2.4GHz
Body-worn Accessory	<ol style="list-style-type: none"> GSM 850/1900 Voice + Wi-Fi 2.4GHz GSM 850/1900 Voice + BT GSM 850/1900 (GPRS/EDGE) + Wi-Fi 2.4GHz GSM 850/1900 (GPRS/EDGE) + BT
Wireless Router (Hotspot)	<ol style="list-style-type: none"> GSM 850/1900 (GPRS/EDGE) + Wi-Fi 2.4GHz

Notes:

- Wi-Fi 2.4GHz supports Hotspot.
- GPRS/EDGE support Hotspot.
- VoIP is supported in GPRS/EDGE.
- Wi-Fi 2.4 GHz Radio cannot transmit simultaneously with Bluetooth Radio.

7. RF Exposure Conditions (Test Configurations)

Refer to “Photos and Antenna Locations” Appendix for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	SAR Required	Antenna-to-edge/surface	Note
WWAN	Head	0 mm	Left Touch	Yes	N/A	
			Left Tilt (15°)	Yes	N/A	
			Right Touch	Yes	N/A	
			Right Tilt (15°)	Yes	N/A	
	Body	10 mm	Rear	Yes	N/A	
			Front	Yes	N/A	
	Hotspot / Wi-Fi Direct	10 mm	Rear	Yes	< 25 mm	
			Front	Yes	< 25 mm	
			Edge 1 (Top)	No	> 25 mm	1
			Edge 2 (Right)	Yes	< 25 mm	
			Edge 3 (Bottom)	Yes	< 25 mm	
			Edge 4 (Left)	Yes	< 25 mm	
WLAN	Head	0 mm	Left Touch	Yes	N/A	
			Left Tilt (15°)	Yes	N/A	
			Right Touch	Yes	N/A	
			Right Tilt (15°)	Yes	N/A	
	Body	10 mm	Rear	Yes	N/A	
			Front	Yes	N/A	
	Hotspot / Wi-Fi Direct	10 mm	Rear	Yes	< 25 mm	
			Front	Yes	< 25 mm	
			Edge 1 (Top)	Yes	< 25 mm	
			Edge 2 (Right)	No	> 25 mm	1
			Edge 3 (Bottom)	No	> 25 mm	1
			Edge 4 (Left)	Yes	< 25 mm	

Notes:

- SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 941225 D06 Hot Spot SAR.

8. Conducted Output Power Measurements

8.1. GSM850 and GSM1900

GSM850 Measured Results

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Burst Pwr (dBm)	Frame Pwr (dBm)	
850	GSM (Voice)	CS1	1	128	824.2	32.5	23.4	
				190	836.6	32.6	23.5	
				251	848.8	32.6	23.6	
	GPRS (GMSK)	CS1	1	1	128	824.2	32.5	23.5
					190	836.6	32.6	23.5
					251	848.8	32.6	23.6
				2	128	824.2	29.8	23.7
					190	836.6	29.8	23.8
					251	848.8	29.9	23.9
			3	128	824.2	28.2	23.9	
				190	836.6	28.3	24.0	
				251	848.8	28.3	24.1	
			4	1	128	824.2	26.7	23.6
					190	836.6	26.7	23.7
					251	848.8	26.8	23.8

Notes:

The worst-case configuration and mode for SAR testing is determined to be as follows:

- Head & Body-worn Accessory: GMSK Voice Mode
- Hotspot mode: GMSK (GPRS) mode with 3 time slots, based on the output power measurements above
- SAR is not required for EGPRS (8PSK) mode because it is Rx only.

GSM1900 Measured Results

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Burst Pwr (dBm)	Frame Pwr (dBm)	
1900	GSM (Voice)	CS1	1	512	1850.2	29.4	20.3	
				661	1880.0	29.4	20.3	
				810	1909.8	29.5	20.4	
	GPRS (GMSK)	CS1	1	1	512	1850.2	29.4	20.3
					661	1880.0	29.4	20.3
					810	1909.8	29.5	20.4
				2	512	1850.2	27.3	21.2
					661	1880.0	27.3	21.2
					810	1909.8	27.2	21.1
			3	1	512	1850.2	25.3	21.0
					661	1880.0	25.3	21.0
					810	1909.8	25.2	21.0
			4	1	512	1850.2	24.1	21.1
					661	1880.0	24.1	21.1
					810	1909.8	24.0	21.0

Notes:

The worst-case configuration and mode for SAR testing is determined to be as follows:

- Head & Body-worn Accessory: GMSK Voice Mode
- Hotspot mode: GMSK (GPRS) mode with 2 time slots, based on the output power measurements above
- SAR is not required for EGPRS (8PSK) mode because it is Rx only.

8.2. Wi-Fi (2.4 GHz Band) (reference to additional KDB in footnote)

Required Test Channels per KDB 248227 D01

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)
2.4 (DTS)	802.11b	1 Mbps	1	2412	16.3	Yes
			6	2437	16.3	
			11	2462	16.1	
	802.11g	6 Mbps	1	2412	13.7	No
			6	2437	14.5	
			11	2462	14.5	
	802.11n (HT20)	MCS0	1	2412	12.5	No
			6	2437	12.5	
			11	2462	12.3	

Note(s):

- Per KDB 248227 D01, SAR is not required for 802.11g/HT20 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels.

Power measurements to determine worst-case data rates

Mode	Ch #	Freq. (MHz)	Data Rate	Avg Pwr (dBm)	SAR test (Yes/No)
802.11b	6	2437	1 Mbps	16.3	Yes
			2 Mbps	16.2	No
			5.5 Mbps	16.2	No
			11 Mbps	15.9	No

8.3. Bluetooth

Maximum tune-up tolerance limit is 9.0 dBm. This power level qualifies for exclusion of SAR testing. Refer to Standalone SAR Test Exclusion Section.

9. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.

The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.

Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

9.1. Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	ϵ_r	σ (S/m)	ϵ_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

9.2. Dielectric Property Measurements Results

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.

The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.

Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

SAR Lab 1

Date	Freq. (MHz)	Liquid Parameters		Measured	Target	Delta (%)	Limit ±(%)	
10/6/2014	Head 2450	e'	37.3100	Relative Permittivity (ϵ_r):	37.31	39.20	-4.82	5
		e"	12.7500	Conductivity (σ):	1.74	1.80	-3.51	5
	Head 2410	e'	37.5100	Relative Permittivity (ϵ_r):	37.51	39.28	-4.50	5
		e"	12.5900	Conductivity (σ):	1.69	1.76	-4.17	5
	Head 2475	e'	37.2400	Relative Permittivity (ϵ_r):	37.24	39.17	-4.92	5
		e"	12.8000	Conductivity (σ):	1.76	1.83	-3.59	5
10/6/2014	Body 2450	e'	50.4200	Relative Permittivity (ϵ_r):	50.42	52.70	-4.33	5
		e"	14.7700	Conductivity (σ):	2.01	1.95	3.18	5
	Body 2410	e'	50.5600	Relative Permittivity (ϵ_r):	50.56	52.76	-4.17	5
		e"	14.6200	Conductivity (σ):	1.96	1.91	2.71	5
	Body 2475	e'	50.3400	Relative Permittivity (ϵ_r):	50.34	52.67	-4.42	5
		e"	14.8700	Conductivity (σ):	2.05	1.99	3.08	5

SAR Lab 3

Date	Freq. (MHz)	Liquid Parameters		Measured	Target	Delta (%)	Limit ±(%)	
10/6/2014	Head 835	e'	41.7500	Relative Permittivity (ϵ_r):	41.75	41.50	0.60	5
		e"	19.6600	Conductivity (σ):	0.91	0.90	1.42	5
	Head 820	e'	41.8200	Relative Permittivity (ϵ_r):	41.82	41.60	0.52	5
		e"	19.7000	Conductivity (σ):	0.90	0.90	-0.03	5
	Head 850	e'	41.4600	Relative Permittivity (ϵ_r):	41.46	41.50	-0.10	5
		e"	19.6500	Conductivity (σ):	0.93	0.92	1.50	5
10/6/2014	Body 835	e'	52.8300	Relative Permittivity (ϵ_r):	52.83	55.20	-4.29	5
		e"	21.8600	Conductivity (σ):	1.01	0.97	4.63	5
	Body 820	e'	53.0000	Relative Permittivity (ϵ_r):	53.00	55.28	-4.12	5
		e"	21.9300	Conductivity (σ):	1.00	0.97	3.25	5
	Body 850	e'	52.7200	Relative Permittivity (ϵ_r):	52.72	55.16	-4.42	5
		e"	21.8400	Conductivity (σ):	1.03	0.99	4.57	5
10/3/2014	Head 1900	e'	40.1300	Relative Permittivity (ϵ_r):	40.13	40.00	0.33	5
		e"	13.4800	Conductivity (σ):	1.42	1.40	1.72	5
	Head 1850	e'	40.3200	Relative Permittivity (ϵ_r):	40.32	40.00	0.80	5
		e"	13.3600	Conductivity (σ):	1.37	1.40	-1.84	5
	Head 1910	e'	40.0600	Relative Permittivity (ϵ_r):	40.06	40.00	0.15	5
		e"	13.4500	Conductivity (σ):	1.43	1.40	2.03	5
10/3/2014	Body 1900	e'	53.0800	Relative Permittivity (ϵ_r):	53.08	53.30	-0.41	5
		e"	14.2900	Conductivity (σ):	1.51	1.52	-0.68	5
	Body 1850	e'	53.2500	Relative Permittivity (ϵ_r):	53.25	53.30	-0.09	5
		e"	14.1200	Conductivity (σ):	1.45	1.52	-4.44	5
	Body 1910	e'	53.1000	Relative Permittivity (ϵ_r):	53.10	53.30	-0.38	5
		e"	14.2300	Conductivity (σ):	1.51	1.52	-0.58	5

10. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are remeasured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

10.1. System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
 For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
 For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

10.2. Reference Target SAR Values

The reference SAR values can be obtained from the calibration certificate of system validation dipoles

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	Target SAR Values (W/kg)		
				1g/10g	Head	Body
D835V2	4d117	5/16/2014	835	1g	9.23	9.61
				10g	5.98	6.31
D1900V2	5d043	11/12/2013	1900	1g	40.1	39.0
				10g	21.1	20.8
D2450V2	706	5/20/2014	2450	1g	53.0	50.2
				10g	24.5	23.4

10.3. System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

SAR Lab 1

Date Tested	System Dipole		T.S. Liquid	Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.	
	Type	Serial #		Zoom Scan to 100 mW	Normalize to 1 W				
10/6/2014	D2450V2	706	Head	1g	4.95	49.5	53	-6.60	
				10g	2.25	22.5	24.5	-8.16	
10/6/2014	D2450V2	706	Body	1g	5.37	53.7	50.20	6.97	1,2
				10g	2.49	24.9	23.4	6.41	

SAR Lab 3

Date Tested	System Dipole		T.S. Liquid	Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.	
	Type	Serial #		Zoom Scan to 100 mW	Normalize to 1 W				
10/6/2014	D835V2	4d117	Head	1g	0.99	9.9	9.23	6.93	
				10g	0.65	6.5	5.98	8.03	
10/6/2014	D835V2	4d117	Body	1g	1.03	10.3	9.61	7.18	3,4
				10g	0.68	6.8	6.31	7.92	
10/3/2014	D1900V2	5d043	Head	1g	3.96	39.6	40.10	-1.25	
				10g	2.05	20.5	21.10	-2.84	
10/3/2014	D1900V2	5d043	Body	1g	4.01	40.1	39.00	2.82	5,6
				10g	2.08	20.8	20.80	0.00	

11. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
- ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

KDB 648474 D04 Handset SAR:

With headset attached, when the reported SAR for body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

KDB 248227 D01 SAR Measurements Procedures for 802.11 a/b/g Transmitters v01r02 (pg.6):

Each channel should be tested at the lowest data rate in each a-b/g mode or 4.9 GHz channel BW configuration.

When the extrapolated maximum peak SAR for the maximum output channel is ≤ 1.6 W/kg and the 1-g averaged SAR is ≤ 0.8 W/kg, testing of other channels in the "default test channels" or "required test channels" configuration is optional.

11.1. GSM850

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
						Tune-up limit	Meas.	Meas.	Scaled	
Head	Voice	0	Left Touch	190	836.6	33.0	32.6	0.273	0.299	1
			Left Tilt	190	836.6	33.0	32.6	0.168	0.184	
			Right Touch	190	836.6	33.0	32.6	0.292	0.320	
			Right Tilt	190	836.6	33.0	32.6	0.199	0.218	
Head VoIP	GPRS 3 Slots	0	Left Touch	190	836.6	29.0	28.3	0.296	0.348	2
			Left Tilt	190	836.6	29.0	28.3	0.181	0.213	
			Right Touch	190	836.6	29.0	28.3	0.316	0.371	
			Right Tilt	190	836.6	29.0	28.3	0.210	0.247	
Body-worn	Voice	10	Rear	190	836.6	33.0	32.6	0.482	0.529	3
			Front	190	836.6	33.0	32.6	0.361	0.396	
Body-worn(VoIP) & Hotspot	GPRS 3 Slots	10	Rear	190	836.6	29.0	28.3	0.525	0.617	4
			Front	190	836.6	29.0	28.3	0.401	0.471	
Hotspot			Edge 2	190	836.6	29.0	28.3	0.249	0.293	
			Edge 3	190	836.6	29.0	28.3	0.066	0.078	
			Edge 4	190	836.6	29.0	28.3	0.242	0.284	

11.2. GSM1900

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.	
						Tune-up limit	Meas.	Meas.	Scaled		
Head	Voice	0	Left Touch	661	1880	29.7	29.4	0.244	0.261	5	
			Left Tilt	661	1880	29.7	29.4	0.117	0.125		
			Right Touch	661	1880	29.7	29.4	0.337	0.361		
			Right Tilt	661	1880	29.7	29.4	0.124	0.133		
Head VoIP	GPRS 2 Slots	0	Left Touch	661	1880	27.7	27.3	0.280	0.307	6	
			Left Tilt	661	1880	27.7	27.3	0.143	0.157		
			Right Touch	661	1880	27.7	27.3	0.402	0.441		
			Right Tilt	661	1880	27.7	27.3	0.152	0.167		
Body-worn	Voice	10	Rear	661	1880	29.7	29.4	0.651	0.698	7	
			Front	661	1880	29.7	29.4	0.498	0.534		
Body-worn(VoIP) & Hotspot	GPRS 2 Slots	10	Rear	512	1850	27.7	27.3	0.803	0.880	8	
				661	1880	27.7	27.3	0.817	0.896		
				810	1910	27.7	27.2	0.690	0.774		
Hotspot			Front	661	1880	27.7	27.3	0.624	0.684		
				Edge 2	661	1880	27.7	27.3	0.116		0.127
				Edge 3	661	1880	27.7	27.3	0.425		0.466
			Edge 4	661	1880	27.7	27.3	0.120	0.132		

11.3. Wi-Fi (DTS Band)

Frequency Band	RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	
2.4 GHz	Head	802.11b 1 Mbps	0	Left Touch	6	2437	16.5	16.3	0.177	0.185	9
				Left Tilt	6	2437	16.5	16.3	0.135	0.141	
				Right Touch	6	2437	16.5	16.3	0.424	0.444	
				Right Tilt	6	2437	16.5	16.3	0.167	0.175	
	Body-worn, Wi-Fi Direct & Hotspot	802.11b 1 Mbps	10	Rear	6	2437	16.5	16.3	0.134	0.140	10
				Front	6	2437	16.5	16.3	0.086	0.090	
	Hotspot	802.11b 1 Mbps	10	Edge 1	6	2437	16.5	16.3	0.048	0.050	
				Edge 4	6	2437	16.5	16.3	0.118	0.124	

11.4. Bluetooth

11.4.1. Standalone SAR Test Exclusion Considerations

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(\text{GHz})}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Body-worn Accessory Exposure Conditions

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	Result
(dBm)	(mW)			
9.0	8	10	2.480	1.3

Conclusion:

The computed value is < 3 ; therefore, Bluetooth qualifies for Standalone SAR test exclusion.

11.4.2. Estimated SAR

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f_{(\text{GHz})}/x}]$ W/kg for test separation distances ≤ 50 mm; where $x = 7.5$ for 1-g SAR, and $x = 18.75$ for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

Estimated SAR Result for Body-worn Accessory Conditions:

Test Configuration	Max. tune-up tolerance limit (mW)	Min. test separation distance (mm)	Frequency (GHz)	Estimated 1-g SAR (W/kg)
Rear/Front	8	10	2.480	0.168

12. SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 SAR measurement 100 MHz to 6 GHz v01. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

- 1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
- 3) Perform a second repeated measurement only if the **ratio of largest to smallest SAR** for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

12.1. The Highest Measured SAR Configuration in Each Frequency Band

Frequency Band (MHz)	Air Interface	Head (W/kg)	Body-worn Accessory (W/kg)	Wireless Router (Hotspot) and Wi-Fi Direct (W/kg)	Repeated SAR (Yes/No)
850	GSM 850		0.525		No
1900	GSM 1900		0.817		Yes
2400	Wi-Fi 802.11b/g/n	0.424			No

12.2. Repeated Measurement Results

Frequency band	Test Position	Antenna	Mode	Ch #.	Freq. (MHz)	Meas. SAR (W/kg)		Largest to Smallest SAR Ratio	Note
						Original	Repeated		
GSM1900	Rear	WWAN	GPRS 2 slots	661	1880.0	0.817	0.786	1.04	1

Note(s):

1. Second Repeated Measurement is not required since the ratio of the largest to smallest SAR for the original and first repeated measurement is not > 1.20.

13. Simultaneous Transmission SAR Analysis

13.1. Sum of the SAR for GSM850 & Wi-Fi & BT

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario			Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
			① GSM850	② Wi-Fi(DTS)	③ Bluetooth		
Head	Left Touch	① + ②	0.348	0.185		0.533	No
	Left Tilt	① + ②	0.213	0.141		0.354	No
	Right Touch	① + ②	0.371	0.444		0.815	No
	Right Tilt	① + ②	0.247	0.175		0.422	No
Body-w orn Accessory & Hotspot	Rear	① + ②	0.617	0.140		0.757	No
		① + ③	0.617		0.168	0.785	No
	Front	① + ②	0.471	0.090		0.561	No
		① + ③	0.471		0.168	0.639	No
Hotspot	Edge 1	① + ②		0.050		0.050	No
	Edge 2	① + ②	0.249			0.249	No
	Edge 3	① + ②	0.078			0.078	No
	Edge 4	① + ②	0.284	0.124		0.408	No

Simultaneous transmission SAR test exclusion

As the Sum of the SAR is not greater than 1.6 W/kg simultaneous transmissions SAR testing is excluded.

13.2. Sum of the SAR for GSM1900 & Wi-Fi & BT

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario			Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
			① GSM1900	② Wi-Fi(DTS)	③ Bluetooth		
Head	Left Touch	① + ②	0.307	0.185		0.492	No
	Left Tilt	① + ②	0.157	0.141		0.298	No
	Right Touch	① + ②	0.441	0.444		0.885	No
	Right Tilt	① + ②	0.167	0.175		0.342	No
Body-w orn Accessory & Hotspot	Rear	① + ②	0.896	0.140		1.036	No
		① + ③	0.896		0.168	1.064	No
	Front	① + ②	0.684	0.090		0.774	No
		① + ③	0.684		0.168	0.852	No
Hotspot	Edge 1	① + ②		0.050		0.050	No
	Edge 2	① + ②	0.127			0.127	No
	Edge 3	① + ②	0.466			0.466	No
	Edge 4	① + ②	0.132	0.124		0.256	No

Simultaneous transmission SAR test exclusion

As the Sum of the SAR is not greater than 1.6 W/kg simultaneous transmissions SAR testing is excluded.

14. Appendixes

Refer to separated files for the following appendixes.

- 14.1. Photos and Antenna Locations**
- 14.2. System Performance Check Plots**
- 14.3. Highest SAR Test Plots**
- 14.4. Tissue Material Ingredients**
- 14.5. Calibration Certificate for E-Field Probe EX3DV4 - SN 3773**
- 14.6. Calibration Certificate for E-Field Probe EX3DV4 - SN 3902**
- 14.7. Calibration Certificate for D835V2 - SN 4d117**
- 14.8. Calibration Certificate for D1900V2- SN 5d043**
- 14.9. Calibration Certificate for D2450V2 - SN 706**

END OF REPORT