Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	4.98 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.54 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**85.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.4 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	5.19 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.97 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.8 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.9 ± 6 %	5.39 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.43 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**73.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.5 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.8 ± 6 %	5.53 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.75 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.17 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.5 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.4 ± 6 %	5.79 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**80.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.25 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.3 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.3 ± 6 %	5.93 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**80.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.4 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	45.9 ± 6 %	6.21 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.78 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**77.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.2 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	50.5 Ω - 3.8 jΩ
Return Loss	- 28.4 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	50.1 Ω - 2.8 jΩ
Return Loss	- 31.1 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	53.3 Ω + 1.3 jΩ
Return Loss	- 29.3 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.6 Ω + 4.4 jΩ
Return Loss	- 24.4 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	57.2 Ω - 0.9 jΩ
Return Loss	- 23.4 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	49.7 Ω - 5.1 jΩ
Return Loss	- 25.8 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	52.4 Ω - 1.0 jΩ
Return Loss	- 31.9 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	52.4 Ω + 3.3 jΩ
Return Loss	- 28.0 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	54.4 Ω + 5.4 jΩ
Return Loss	- 23.5 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.3 Ω + 2.6 jΩ
Return Loss	- 23.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.207 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 08, 2011

DASY5 Validation Report for Head TSL

Date: 27.09.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1124

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.56 S/m; ε_r = 36; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 4.66 S/m; ε_r = 35.9; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 4.88 S/m; ε_r = 35.6; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.98 S/m; ε_r = 35.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.19 S/m; ε_r = 35.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.75, 5.75, 5.75) @ 5200 MHz, ConvF(5.5, 5.5, 5.5) @ 5300 MHz, ConvF(5.2, 5.2, 5.2) @ 5500 MHz, ConvF(5.05, 5.05, 5.05) @ 5600 MHz, ConvF(4.96, 4.96, 4.96) @ 5800 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 75.80 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 27.2 W/kg
SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.29 W/kg
Maximum value of SAR (measured) = 18.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

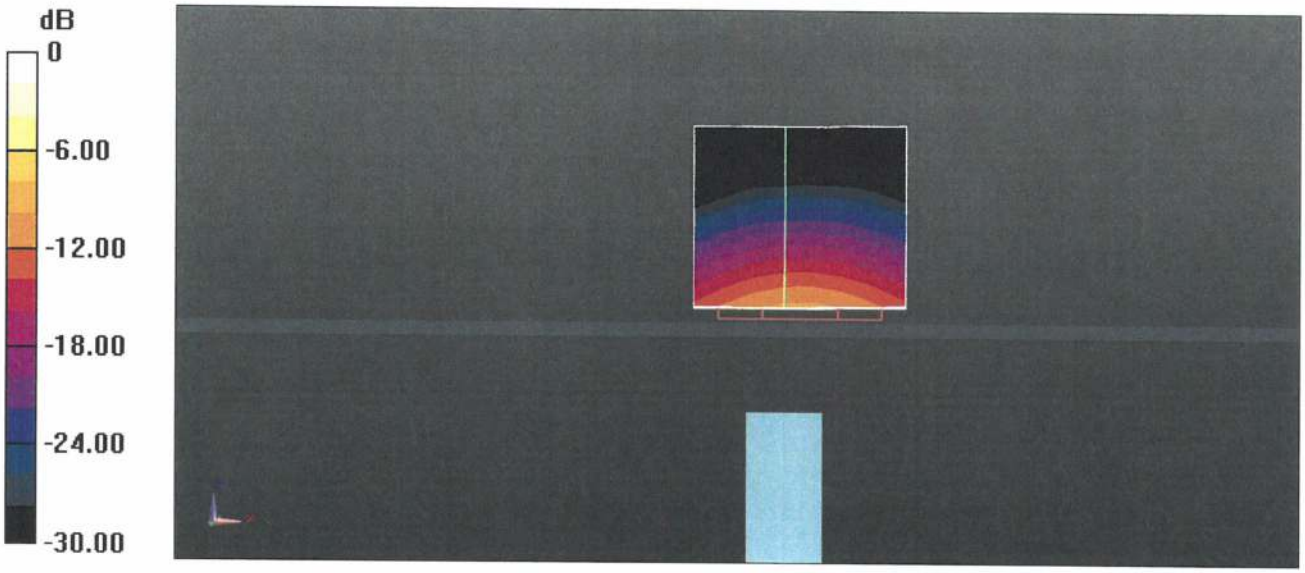
Reference Value = 75.75 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 27.8 W/kg
SAR(1 g) = 8.07 W/kg; SAR(10 g) = 2.33 W/kg
Maximum value of SAR (measured) = 18.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 75.84 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 31.3 W/kg
SAR(1 g) = 8.4 W/kg; SAR(10 g) = 2.39 W/kg
Maximum value of SAR (measured) = 19.9 W/kg

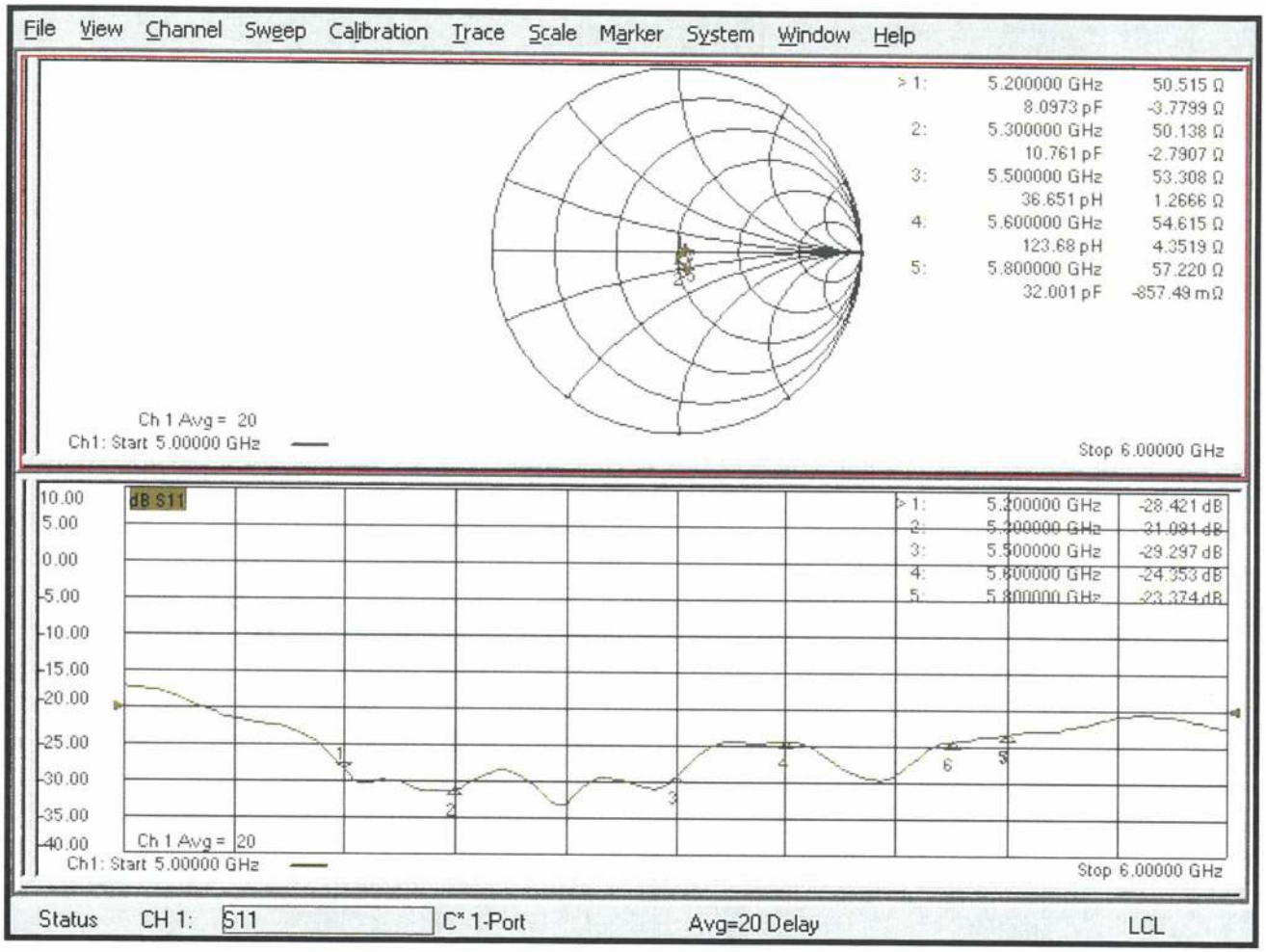
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 76.67 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 31.4 W/kg
SAR(1 g) = 8.54 W/kg; SAR(10 g) = 2.44 W/kg
Maximum value of SAR (measured) = 20.2 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.92 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 30.3 W/kg
SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.28 W/kg
Maximum value of SAR (measured) = 19.0 W/kg



0 dB = 18.0 W/kg = 12.55 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 25.09.2018,

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1124

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.39 S/m; ε_r = 46.9; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 5.53 S/m; ε_r = 46.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 5.79 S/m; ε_r = 46.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 5.93 S/m; ε_r = 46.3; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 6.21 S/m; ε_r = 45.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.35, 5.35, 5.35) @ 5200 MHz, ConvF(5.15, 5.15, 5.15) @ 5300 MHz, ConvF(4.7, 4.7, 4.7) @ 5500 MHz, ConvF(4.65, 4.65, 4.65) @ 5600 MHz, ConvF(4.53, 4.53, 4.53) @ 5800 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 68.31 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 27.9 W/kg
SAR(1 g) = 7.43 W/kg; SAR(10 g) = 2.07 W/kg
Maximum value of SAR (measured) = 17.4 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

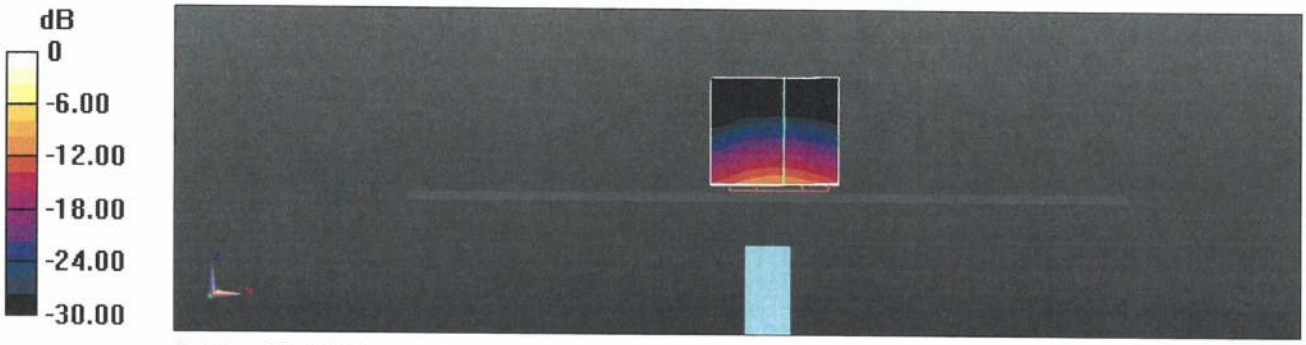
Reference Value = 68.42 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 30.3 W/kg
SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.17 W/kg
Maximum value of SAR (measured) = 18.4 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.48 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 33.5 W/kg
SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.25 W/kg
Maximum value of SAR (measured) = 19.5 W/kg

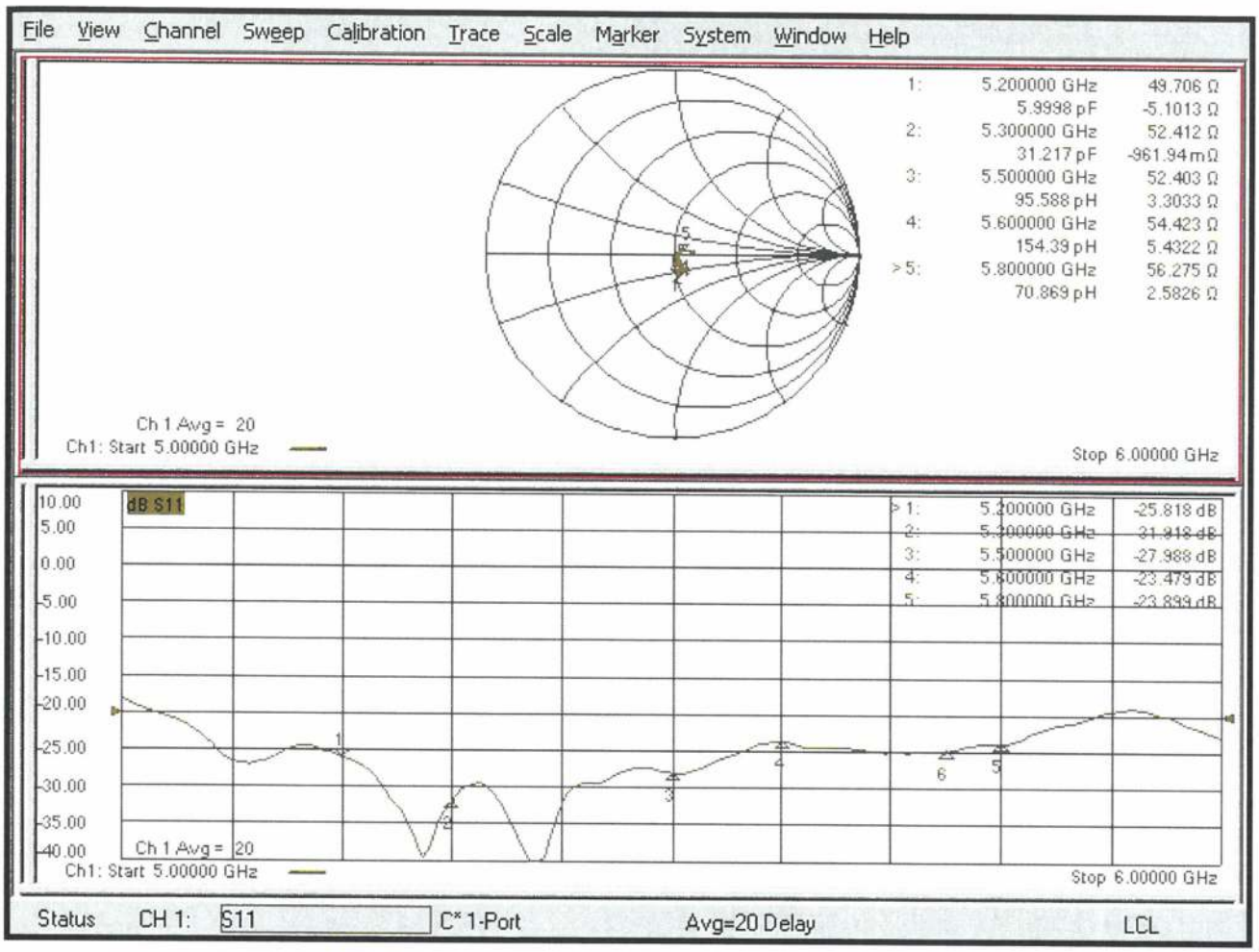
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 69.28 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 34.2 W/kg
SAR(1 g) = 8.13 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 19.8 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.16 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 33.9 W/kg
SAR(1 g) = 7.78 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 19.2 W/kg



0 dB = 17.4 W/kg = 12.41 dBW/kg

Impedance Measurement Plot for Body TSL



Dipole Verified Data

Model Name: D5GHzV2

SN:1124

Pursuant to KDB 865664 D01 V01r04 section 3.2.2 that the reference dipole calibration can be extended to 3 years if Lab. does a confirmation on return loss and impedance annually, and compliance with following conditions,

1. Return loss deviates by less than 20% from the previous measurement and have 20 dB minimum return-loss requirement
2. The real or imaginary parts of the impedance, measured at least annually, deviates by less than 5 Ω from the previous measurement.

Antenna Parameters with Body Tissue 5200 MHz

Item	Verified on 9/27, 2019	Original Cal. Result	Deviation
Impedance, transformed to feed point	**45.442Ω-6.1204Ω**	**49.7Ω-5.1jΩ**	**< 5Ω**
Return Loss	**-23.512 dB**	**-25.8 dB**	**-8.87%**

Antenna Parameters with Body Tissue 5300 MHz

Item	Verified on 9/27, 2019	Original Cal. Result	Deviation
Impedance, transformed to feed point	**49.326Ω+5.9689Ω**	**52.4Ω-1.0jΩ**	**< 5Ω**
Return Loss	**-29.107 dB**	**-31.9 dB**	**-8.76%**

Antenna Parameters with Body Tissue 5500 MHz

Item	Verified on 9/27, 2019	Original Cal. Result	Deviation
Impedance, transformed to feed point	**51.329Ω-3.5768Ω**	**52.4Ω+3.3jΩ**	**< 5Ω**
Return Loss	**-27.428 dB**	**-28 dB**	**-2.04%**

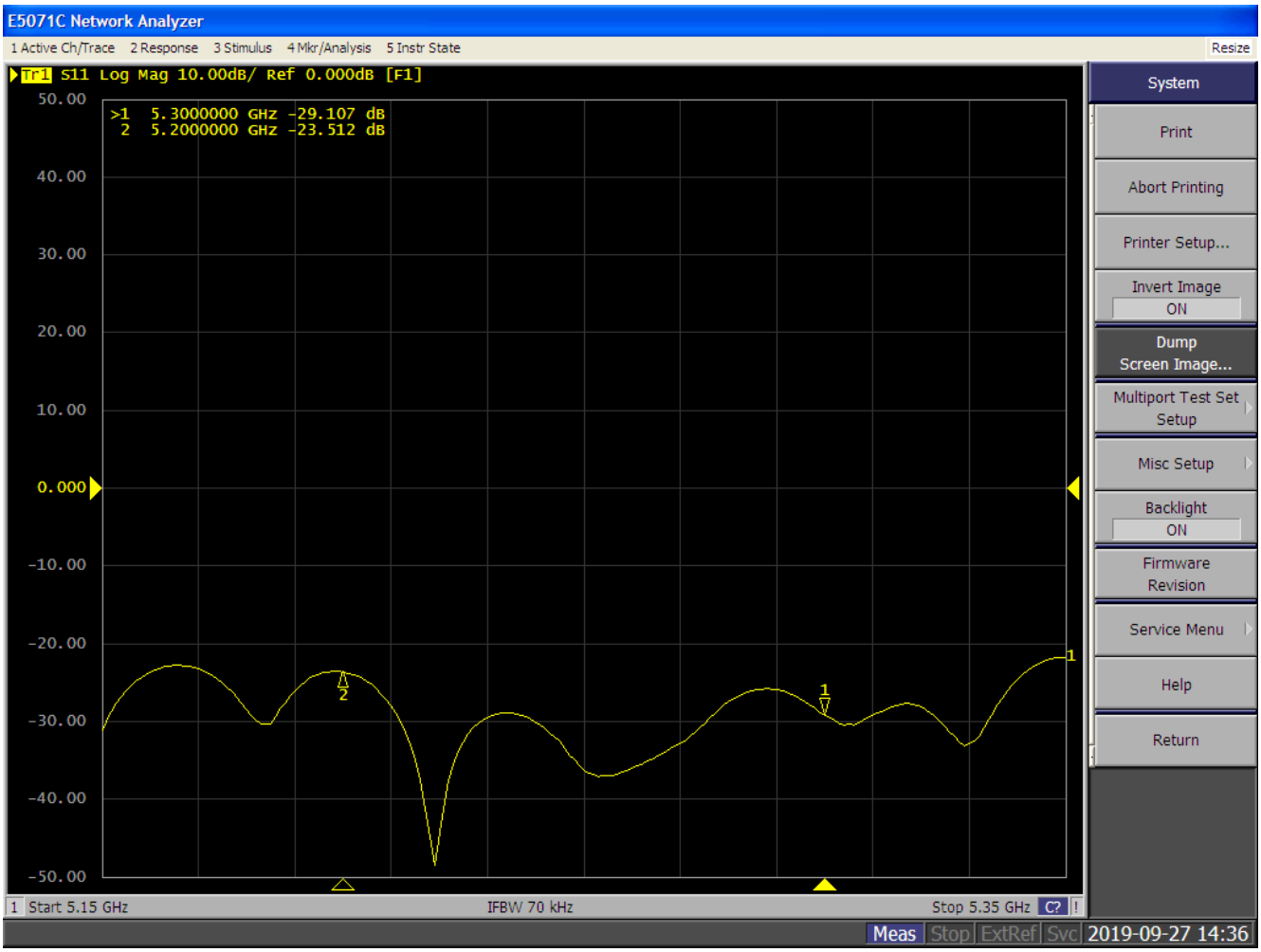
Antenna Parameters with Body Tissue 5600 MHz

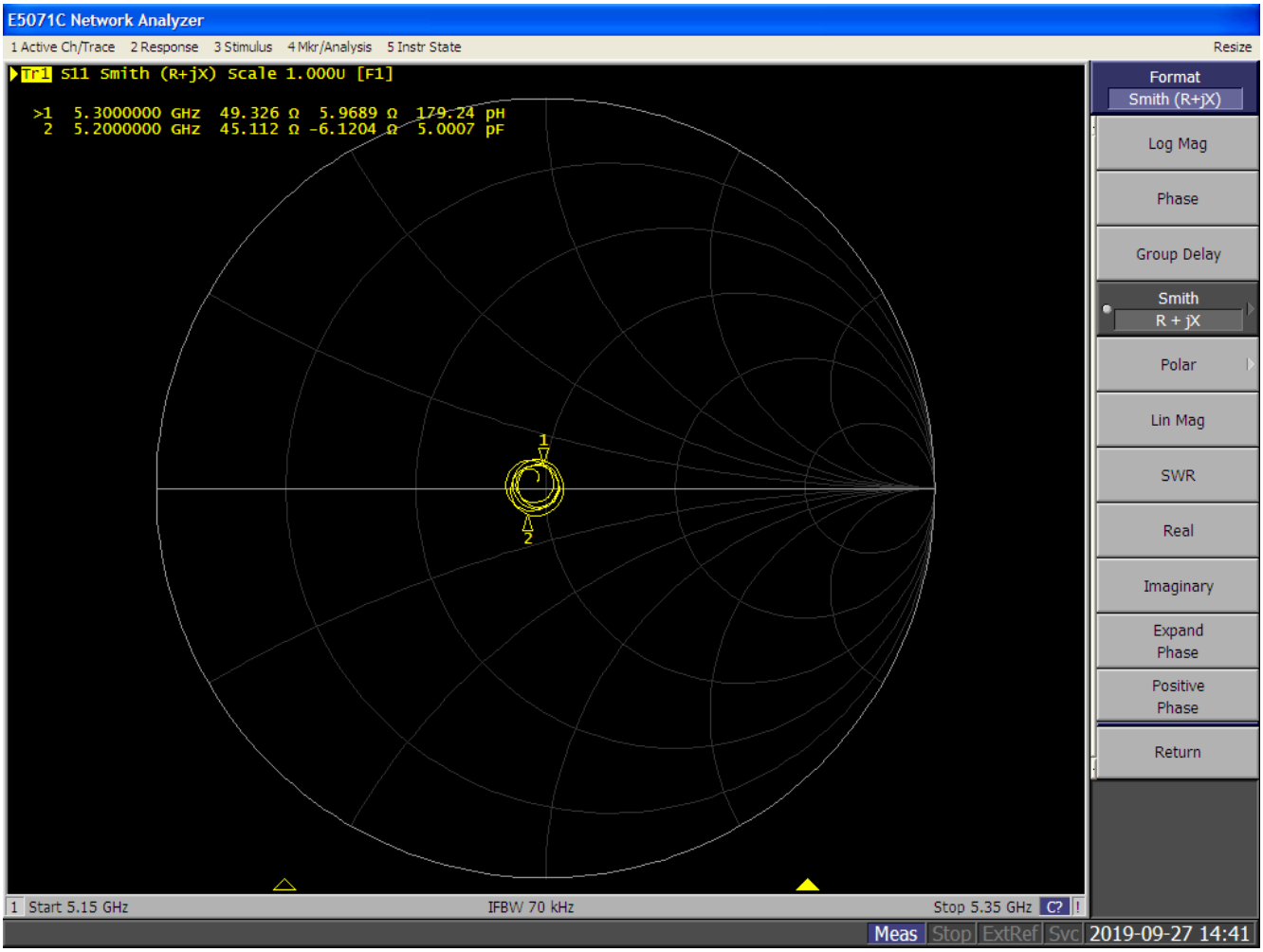
Item	Verified on 9/27, 2019	Original Cal. Result	Deviation
Impedance, transformed to feed point	**56.217Ω+916.30mΩ**	**54.4Ω+5.4jΩ**	**< 5Ω**
Return Loss	**-24.798 dB**	**-23.5 dB**	**5.52%**

Antenna Parameters with Body Tissue 5800 MHz

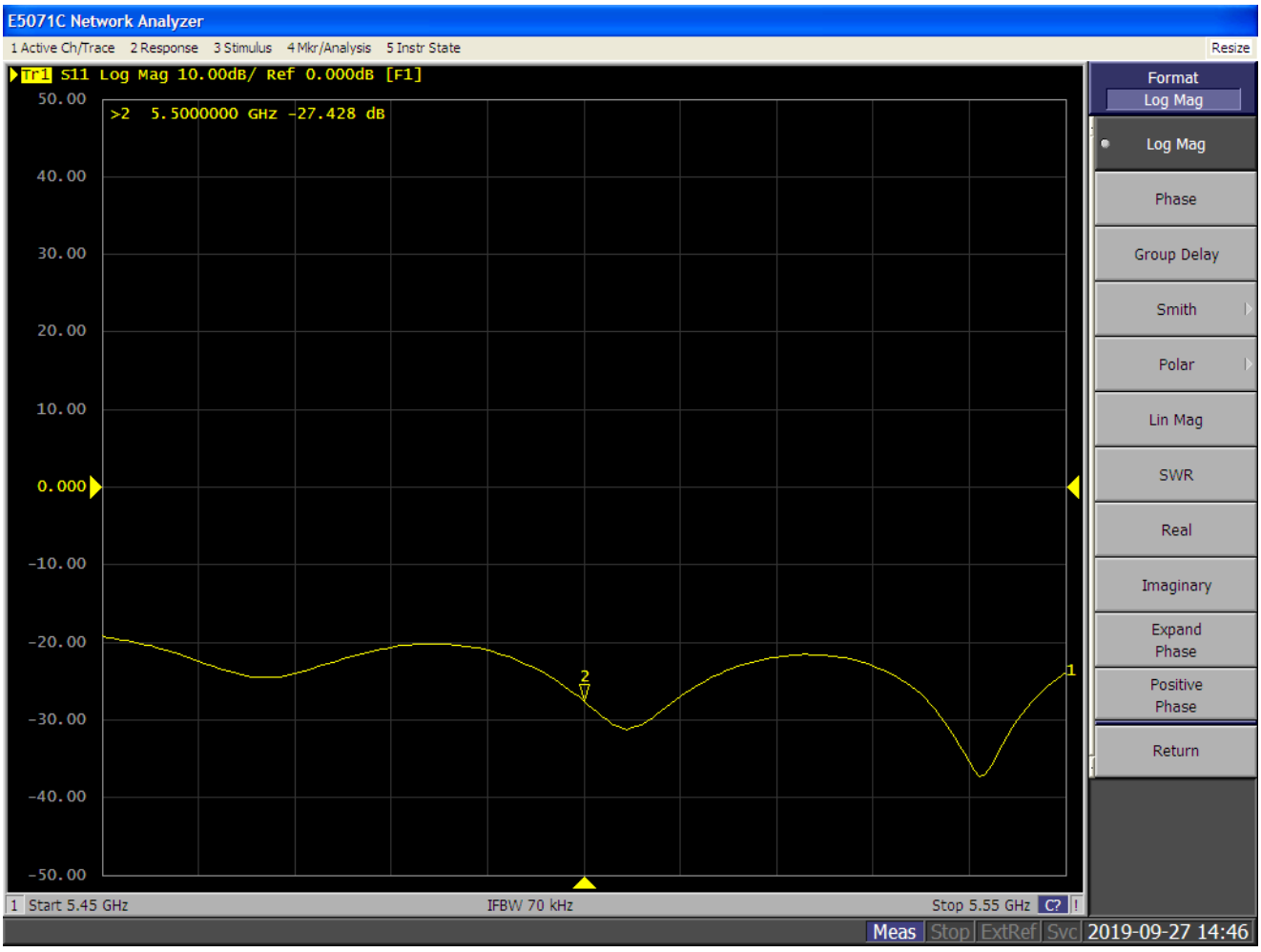
Item	Verified on 9/27, 2019	Original Cal. Result	Deviation
Impedance, transformed to feed point	**55.052Ω−2.4744Ω**	**56.3Ω+2.6jΩ**	**< 5Ω**
Return Loss	**-21.381 dB**	**-23.9 dB**	**-10.54%**

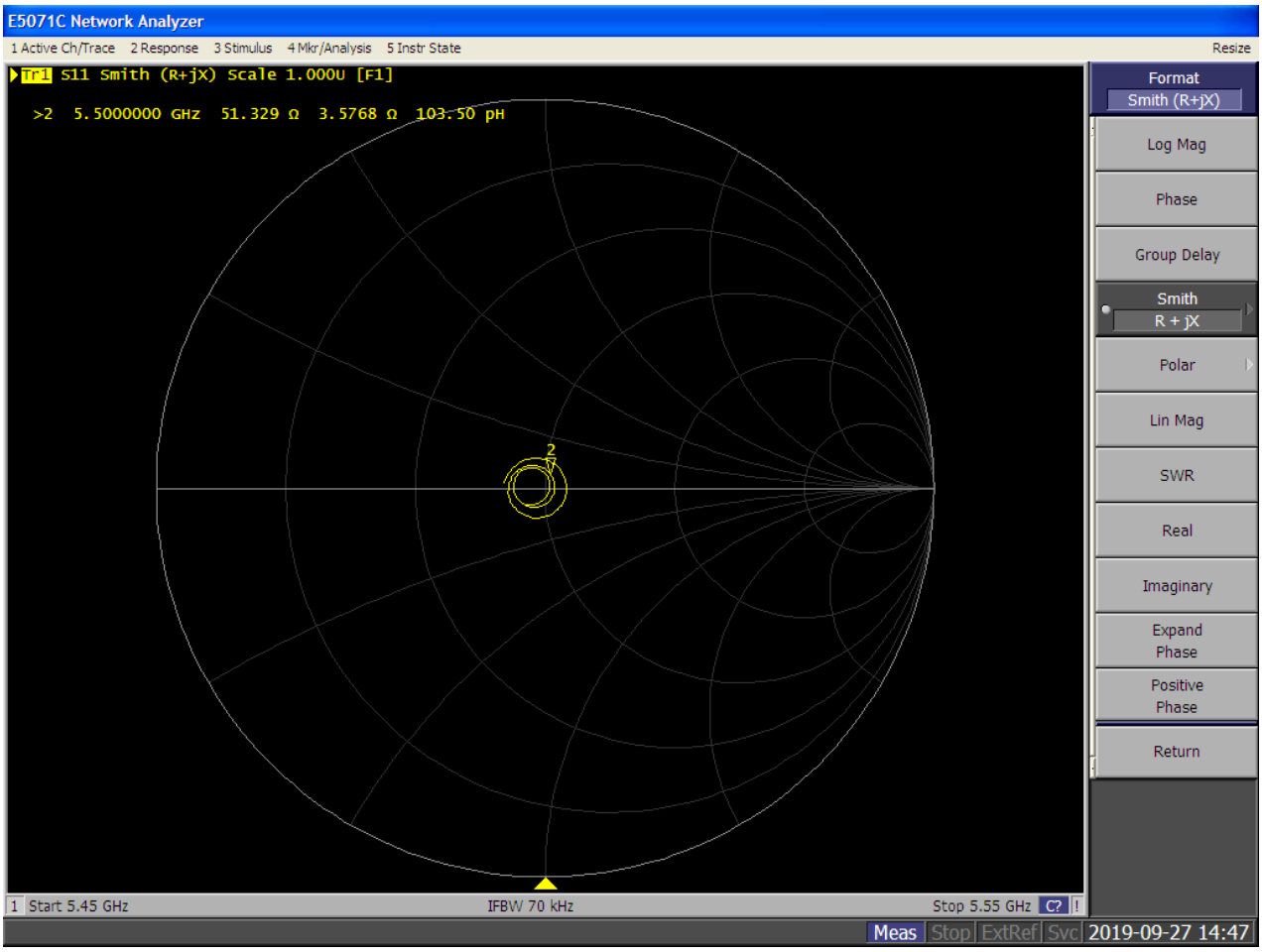
Plot for Antenna Parameters with Body Tissue 5200 MHz & 5300 MHz



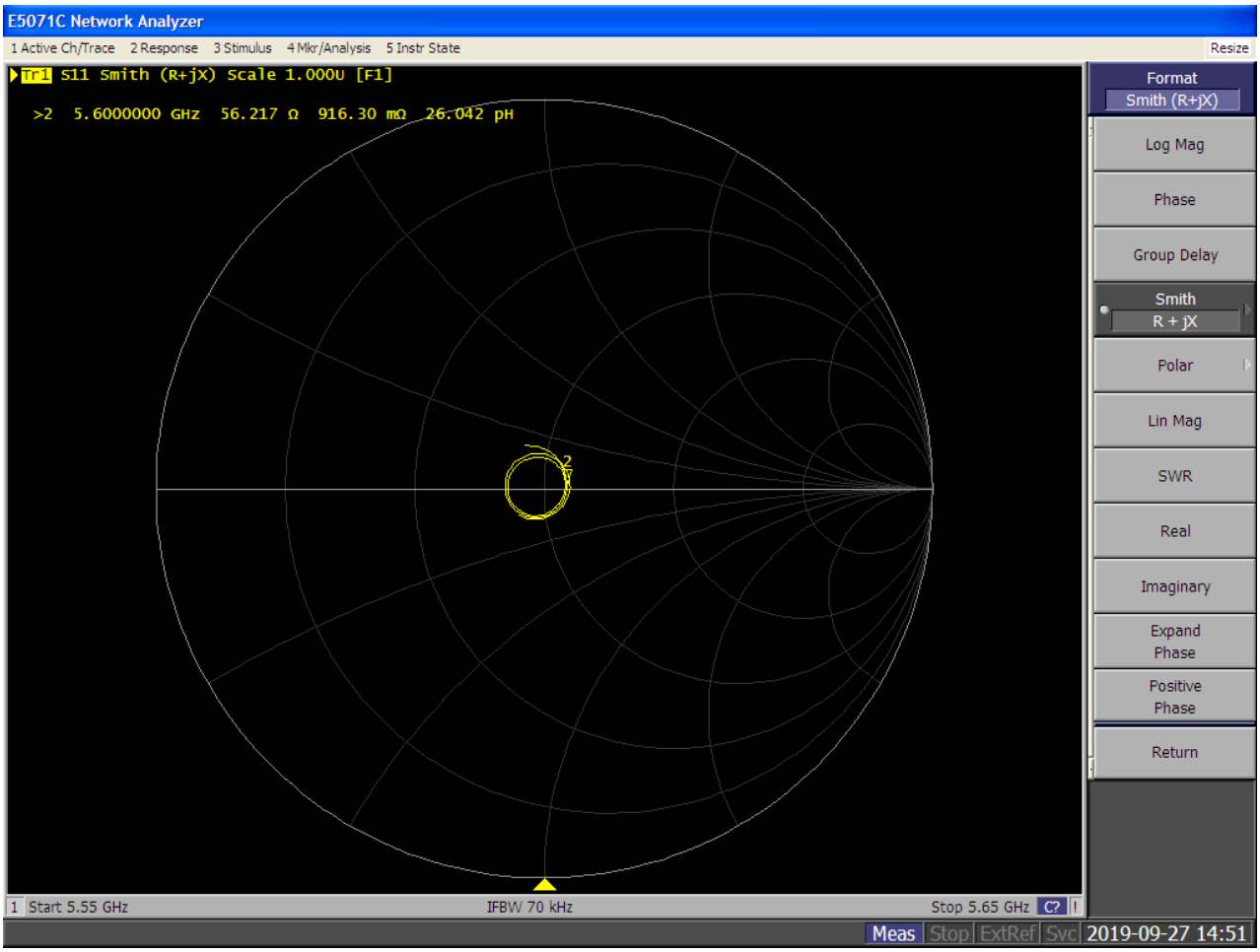


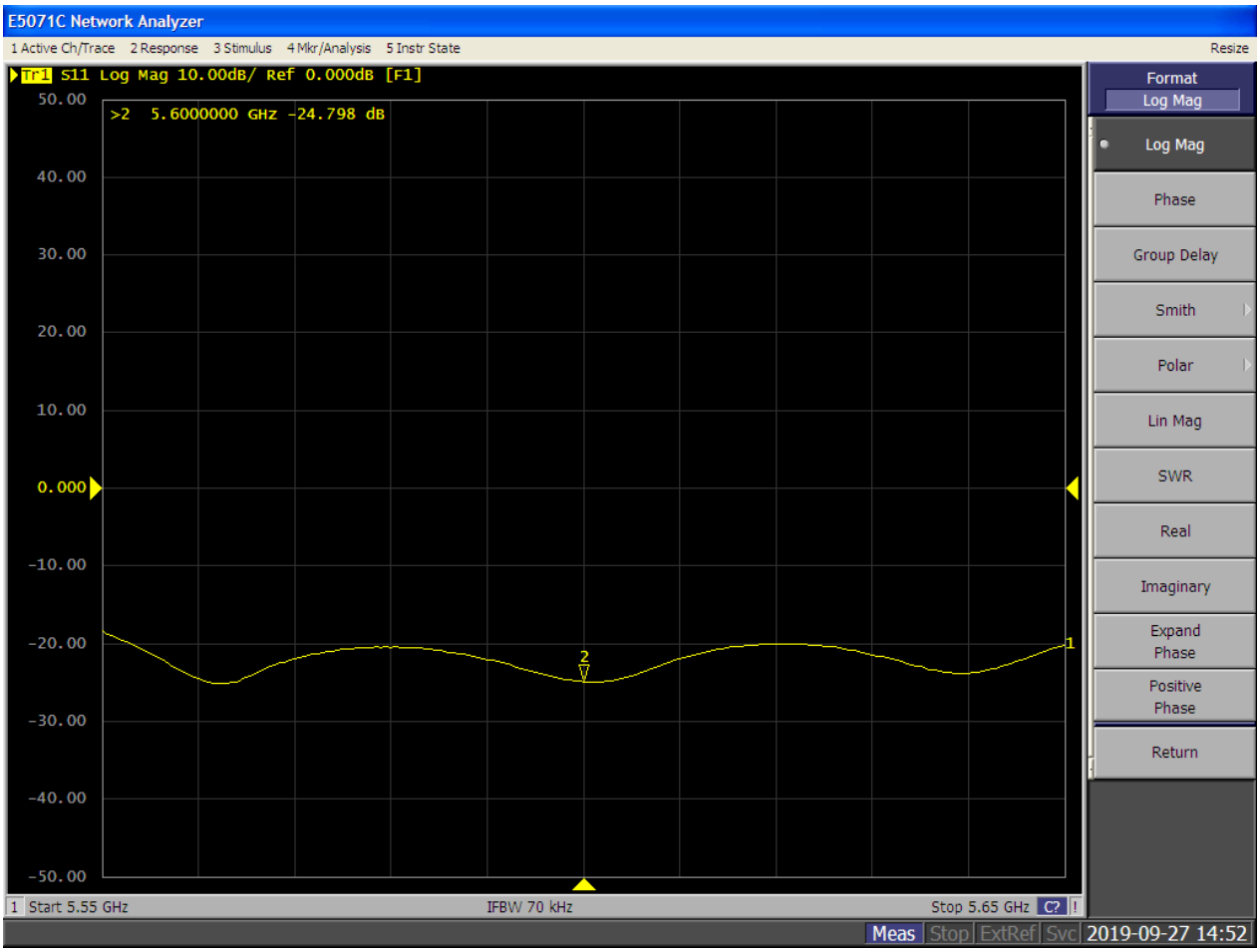
Plot for Antenna Parameters with Body Tissue 5500 MHz



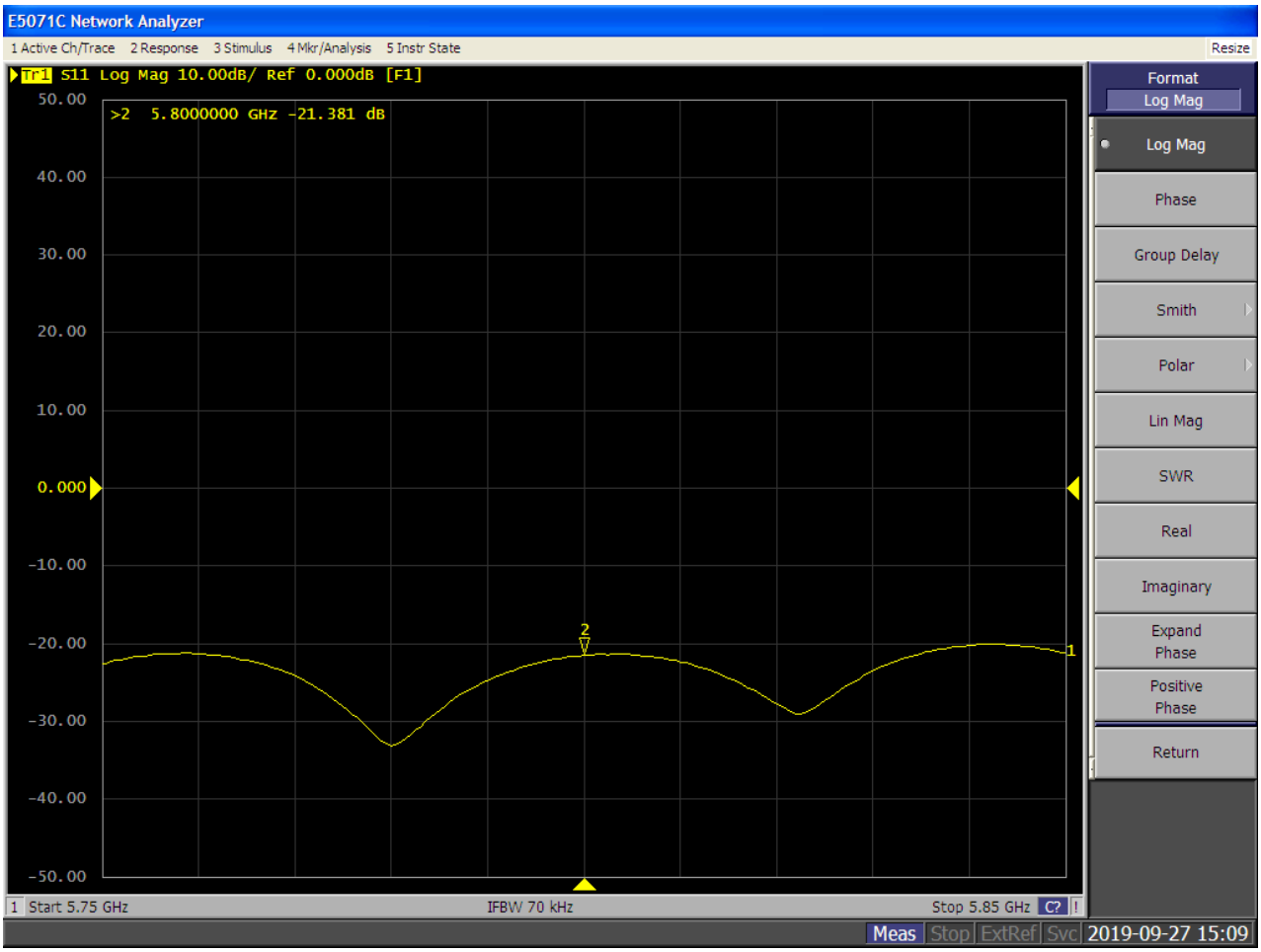


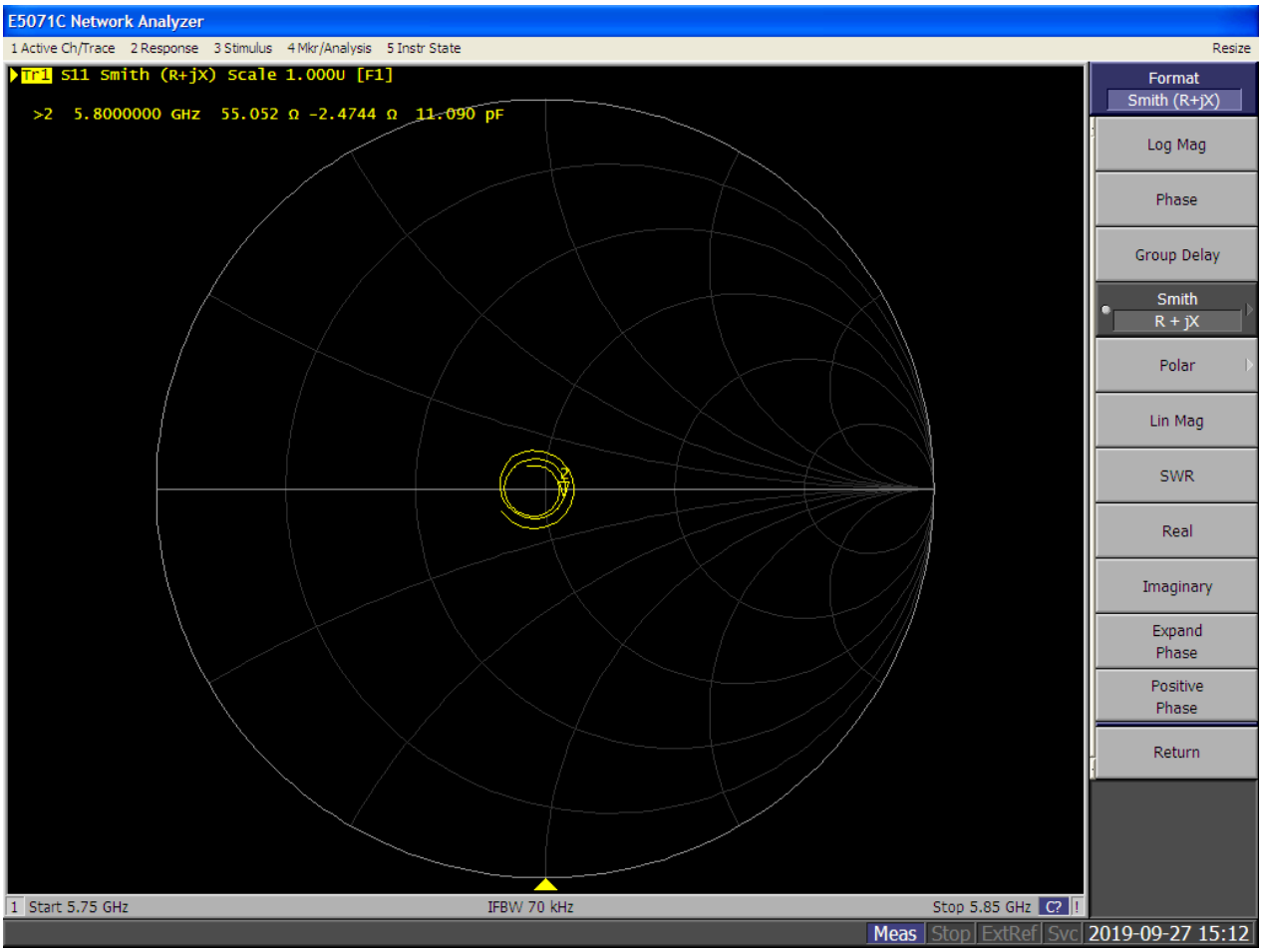
Plot for Antenna Parameters with Body Tissue 5600 MHz





Plot for Antenna Parameters with Body Tissue 5800 MHz




E5071C Network Analyzer
1 Active Ch/Trace 2 Response 3 Stimulus 4 Mkr/Analysis 5 Instr State
Resize
Tr1 S11 Smith (R+jX) Scale 1.000U [F1]
>2 5.8000000 GHz 55.052 Ω -2.4744 Ω 11.090 pF
Format
Smith (R+jX)
Log Mag
Phase
Group Delay
Smith
R + jX
Polar
Lin Mag
SWR
Real
Imaginary
Expand Phase
Positive Phase
Return
1 Start 5.75 GHz
IFBW 70 kHz
Stop 5.85 GHz
Meas
Stop
ExtRef
Svc
2019-09-27 15:12

Dipole Verified Data

Model Name: D5GHzV2

SN:1124

Pursuant to KDB 865664 D01 V01r04 section 3.2.2 that the reference dipole calibration can be extended to 3 years if Lab. does a confirmation on return loss and impedance annually, and compliance with following conditions,

1. Return loss deviates by less than 20% from the previous measurement and have 20 dB minimum return-loss requirement
2. The real or imaginary parts of the impedance, measured at least annually, deviates by less than 5 Ω from the previous measurement.

Antenna Parameters with Body Tissue 5200 MHz

Item	Verified on 9/29, 2020	Original Cal. Result	Deviation
Impedance, transformed to feed point	**50.447Ω-0.20549Ω**	**50.5Ω-3.8jΩ**	**< 5Ω**
Return Loss	**-29.421 dB**	**-28.4 dB**	**3.471%**

Antenna Parameters with Body Tissue 5300 MHz

Item	Verified on 9/29, 2020	Original Cal. Result	Deviation
Impedance, transformed to feed point	**50.023Ω+1.0196Ω**	**50.1Ω-2.8jΩ**	**< 5Ω**
Return Loss	**-30.251 dB**	**-31.9 dB**	**-5.17%**

Antenna Parameters with Body Tissue 5500 MHz

Item	Verified on 9/29, 2020	Original Cal. Result	Deviation
Impedance, transformed to feed point	**52.680Ω-3.3604Ω**	**53.3Ω+1.3jΩ**	**< 5Ω**
Return Loss	**-29.494 dB**	**-29.3 dB**	**0.66%**

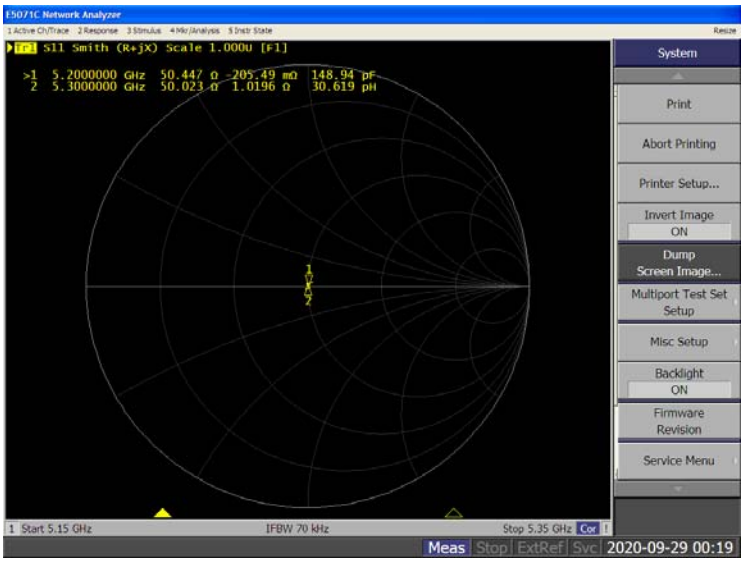
Antenna Parameters with Body Tissue 5600 MHz

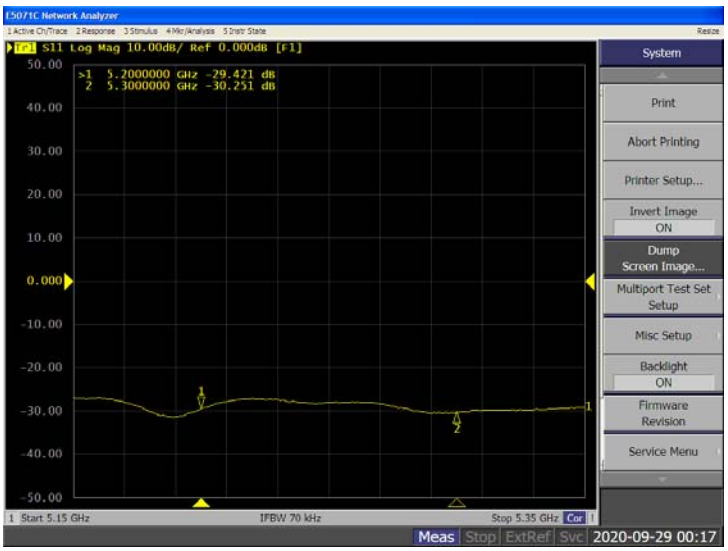
Item	Verified on 9/29, 2020	Original Cal. Result	Deviation
Impedance, transformed to feed point	**53.082Ω+4.8210Ω**	**54.6Ω+4.4jΩ**	**< 5Ω**
Return Loss	**-24.711 dB**	**-24.4 dB**	**1.27%**

Antenna Parameters with Body Tissue 5800 MHz

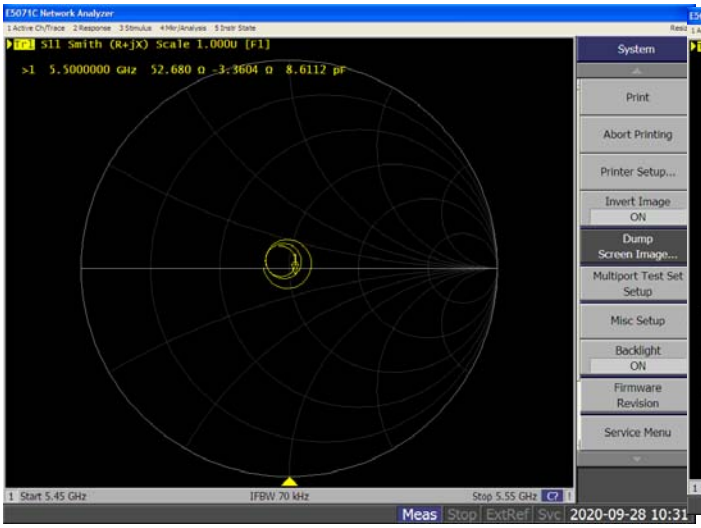
Item	Verified on 9/29, 2020	Original Cal. Result	Deviation
Impedance, transformed to feed point	**56.925Ω−2.0252Ω**	**57.2Ω+0.9jΩ**	**< 5Ω**
Return Loss	**-23.808 dB**	**-23.4 dB**	**1.74%**

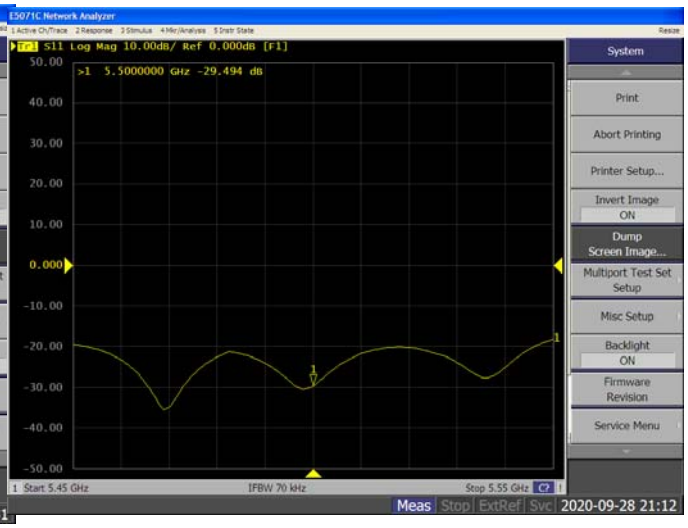
Plot for Antenna Parameters with Body Tissue 5200 MHz& 5300 MHz



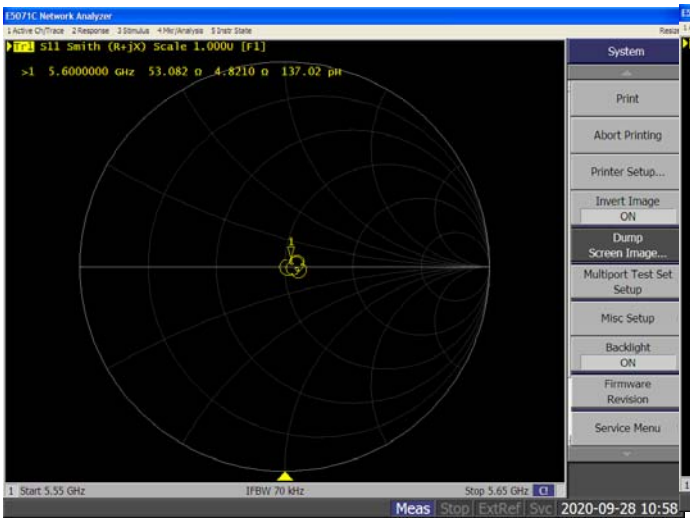


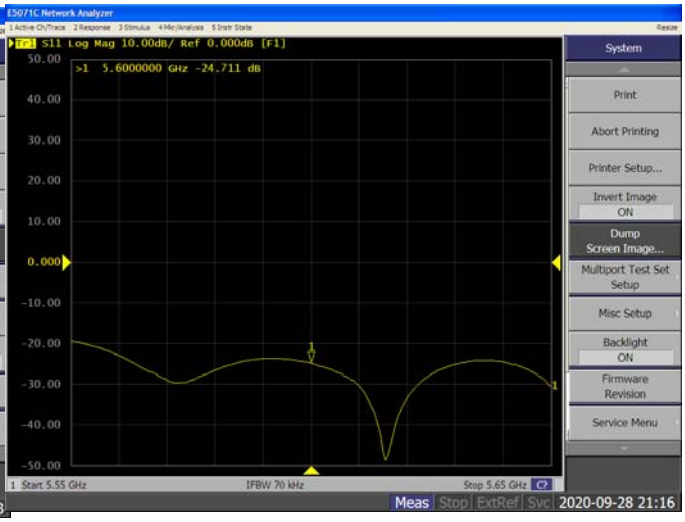
Plot for Antenna Parameters with Body Tissue 5500 MHz





Plot for Antenna Parameters with Body Tissue 5600 MHz





Plot for Antenna Parameters with Body Tissue 5800 MHz